

EDITION  
8

# SYSTEMS ANALYSIS AND DESIGN



KENDALL & KENDALL

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# SYSTEMS ANALYSIS AND DESIGN

EIGHTH EDITION

KENNETH E. KENDALL

Rutgers University

*School of Business—Camden*  
Camden, New Jersey

JULIE E. KENDALL

Rutgers University

*School of Business—Camden*  
Camden, New Jersey

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whose lifelong example of working together will inspire us forever.*

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# PREFACE



## NEW TO THIS EDITION

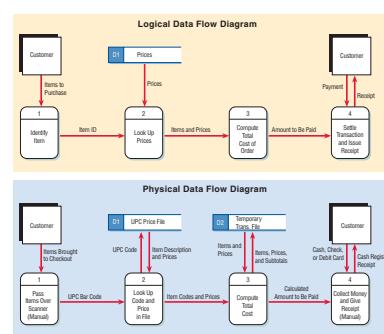
The eighth edition of Kendall & Kendall: *Systems Analysis and Design* includes substantial changes mandated by the rapid changes in the IS field in the last three years, and they are included as a response to the input of our adopters, students, and reviewers. Many new and updated features are integrated throughout. In particular:

- Early introduction of three methodologies: SDLC, agile approaches, and object-oriented systems analysis and design with UML, along with reasons and situations for when to use them (Chapter 1)
- Expanded coverage of COTS due to their increasing use in organizations (Chapter 3)
- Object-oriented analysis and design expanded and featured in the center of the text so it can be more easily incorporated into term projects (Chapter 10)
- New object-oriented analysis and design problems included in the O-O CPU Episode (Chapter 10)
- New feature throughout the text called *Mac Appeal*, which discusses innovative software available on Macs
- New coverage of cloud computing (Chapter 16)
- New section on SOA (service-oriented architecture) (Chapter 16)
- New end-of-chapter Review Questions, Problems, and Group Exercises
- Reorganized, updated, and strengthened chapter on agile methods (Chapter 6)
- Strengthened project management by introducing the project charter early in the process (Chapter 3)
- Early introduction of how to prepare the systems proposal (Chapter 3)
- Updated and streamlined *CPU Case Episodes*, the case that runs throughout the text. Students can use Microsoft Access, Microsoft Visio, or Visible Analyst to complete new assignments throughout the text
- Updated scenarios, problems, and graphics throughout the text to accompany HyperCase 2.8, a graphical simulation for the Web that allows students to apply their new skills

## DESIGN FEATURES

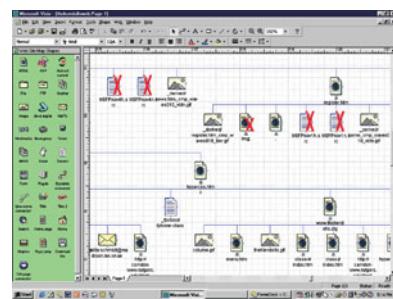
Figures take on a stylized look in order to help students more easily grasp the subject matter.

**Conceptual diagrams** are used to introduce the many tools that systems analysts have at their disposal. This example shows the differences between logical data flow diagrams and physical data flow diagrams. Conceptual diagrams are color coded so that students can distinguish easily among them, and their functions are clearly indicated. Many other important tools are illustrated, including use case diagrams, sequence diagrams, and class diagrams.



**Computer displays** demonstrate important software features that are useful to the analyst. This example shows how a Web site can be evaluated for broken links by using a package such as Microsoft Visio. Actual screen shots show important aspects of design. Analysts are continuously seeking to improve the appearance of the screens and Web pages they design. Colorful examples help to illustrate why some screen designs are particularly effective.

**Paper forms** are used throughout to show input and output design as well as the design of questionnaires.



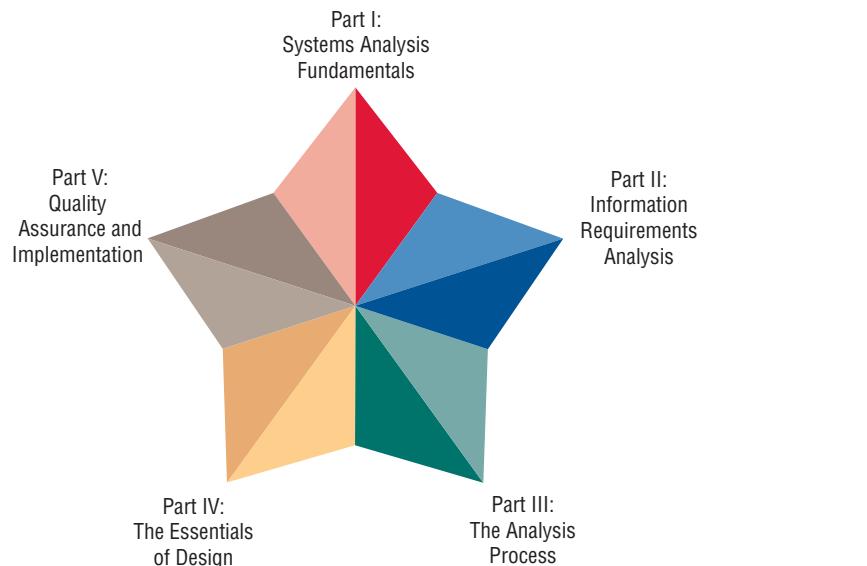
Blue ink is always used to show writing or data input, thereby making it easier to identify what was filled in by users. Although most organizations have computerization of manual processes as their eventual goal, much data capture is still done using paper forms. Improved form design enables analysts to ensure accurate and complete input and output. Better forms can also help streamline new internal workflows that result from newly automated business-to-consumer (B2C) applications for ecommerce on the Web.

**Tables** are used when an important list needs special attention, or when information needs to be organized or classified. In addition, tables are used to supplement the understanding of the reader in a way that departs from

how material is organized in the narrative portion of the text. Most analysts find tables a useful way to organize numbers and text into a meaningful “snapshot.”

This example of a table from Chapter 3 shows how analysts can refine their activity plans for analysis by breaking them down into smaller tasks and then estimating how much time it will take to complete them. The underlying philosophy of our book is that systems analysis and design is a process that integrates the use of many tools with the unique talents of the systems analyst to systematically improve business through the implementation or modification of computerized information systems. Systems analysts can grow in their work by taking on new IT challenges and keeping current in their profession through the application of new techniques and tools.

## A BRIEF TOUR OF THE EIGHTH EDITION

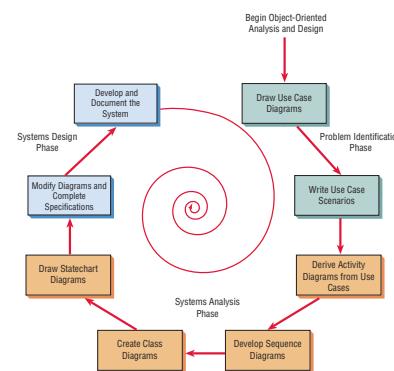


Systems analysis and design is typically taught in one or two semesters. Our book may be used in either situation. The text is appropriate for undergraduate (junior or senior) curricula at a four-year university, graduate school, or community college. The level and length of the course can be varied and supplemented by using real-world projects, HyperCase, or other materials available on the Instructor Resource Center.

The text is divided into five major parts: Systems Analysis Fundamentals (Part I), Information Requirements Analysis (Part II), The Analysis Process (Part III), The Essentials of Design (Part IV), and Quality Assurance and Implementation (Part V).

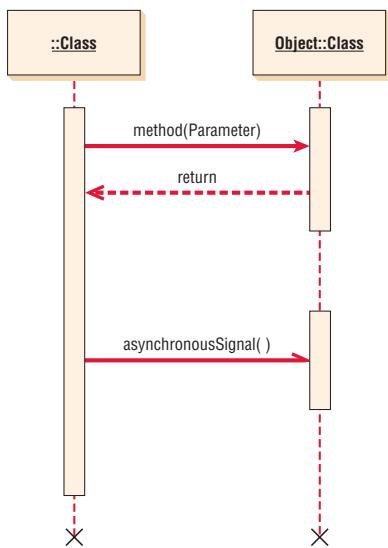
**Part I (Chapters 1–3)** stresses the basics that students need to know about what an analyst does and introduces the three main methodologies of the systems development life cycle (SDLC), agile approaches, and object-oriented analysis with UML, along with reasons and situations for when to use them. Part I shows how a variety of emerging information systems, including mobile and wireless technologies, and enterprise systems integrate IT and fit into organizations; how to determine whether a systems project is worthy of commitment; ecommerce project management; and how to manage a systems project using special software tools. The three roles of the systems analyst as consultant, supporting expert, and agent of change are introduced, and ethical issues and professional guidelines for serving as a systems consultant are covered. There is also material on virtual teams and virtual organizations, and the concept of HCI is introduced. The use of open source software (OSS) is also introduced. Chapter 2 includes how to initially approach an organization by drawing context-level data flow diagrams, using entity-relationship models, and developing use cases and use case scenarios. Chapter 3 introduces expanded material on creating the project charter and introduces writing the systems proposal early in the process, no matter what method of analysis and design has been chosen. Expanded coverage of evaluating software and hardware, and when to use COTS (commercial off-the-shelf software), is included. This chapter teaches several methods for forecasting costs and benefits, which are necessary to the discussion of acquiring software and hardware. Chapter 3 helps students evaluate software by assessing trade-offs among creating custom software, purchasing commercial-off-the-shelf (COTS) software, or outsourcing to an application service provider (ASP). Creating a problem definition and determining feasibility are also covered. Chapter 3 guides students in professionally writing and presenting an effective systems proposal, one that incorporates figures and graphs to communicate with users.

**Part II (Chapters 4–6)** emphasizes the use of systematic and structured methodologies for performing information requirements analysis. Attention to analysis helps analysts ensure that they are addressing the correct problem before designing the system. Chapter 4 introduces a group of interactive methods, including interviewing, joint application design (JAD), and constructing questionnaires. Chapter 5 introduces a group of unobtrusive methods for ascertaining information requirements of users. These methods include sampling, investigating hard and archival data, and observation of decision makers' behavior and their physical environment. Chapter 6 on agile modeling and prototyping is innovative in its treatment of prototyping as another data-gathering technique that enables the analyst to solve the right problem by getting users involved from the start. Agile approaches have their roots in prototyping, so this chapter begins with prototyping to provide a proper context for understanding, and then takes up the agile approach. The values and principles, activities, resources, practices, processes, and tools associated with agile methodologies are presented. This chapter also includes material on rapid application development (RAD) for human information-requirements gathering and interface design.



Prototype Evaluation Form			
Observer Name:	Michael Covello		
System or Project Name:	Cloud Computing Data Center		
Program Name or Number:	Prod. Maint. System Advanced Water Filtration		
User Name:	User 1	User 2	User 3
Period Observed:	10/01/2010	10/02/2010	10/03/2010
User Reactions:	Generally favorable, gets excited by new features	Excellent	
User Suggestions:	Add due date when maintenance was performed.	Place a form number at top for reference. Place word WEEKLY in title.	
Improvements:			
Revision Plans:	Modify on 10/06/2010. Review with Andy and Pam.		

**Part III (Chapters 7–10)** details the analysis process. It builds on the previous two parts to move students into analysis of data flows as well as structured and semistructured decisions. It provides step-by-step details on how to use structured techniques to draw data flow diagrams (DFDs). Chapter 7 provides coverage of how to create child diagrams; how to develop both logical and physical data flow diagrams; and how to partition data flow diagrams. Chapter 8 features material on the data repository and vertical balancing of data flow diagrams. Chapter 8 also includes extensive coverage of extensible markup language (XML) and demonstrates how to use data dictionaries to create XML. Chapter 9 includes material on developing process specifications. A discussion of both logical and physical process specifications shows how to use process specifications for horizontal balancing. Chapter 9 also covers how to diagram structured decisions with the use of structured English, decision tables, and decision trees. In addition, the chapter covers how to choose an appropriate decision analysis method for analyzing structured decisions and creating process specifications. Push technologies are also introduced.



Part III concludes with Chapter 10 on object-oriented systems analysis and design. This chapter includes an in-depth section on using unified modeling language (UML). There is detailed coverage of the use case model, creating the class model diagram with UML, sequence diagrams, creating gen/spec diagrams, use case scenarios, and activity diagrams. Through several examples and Consulting Opportunities, this chapter demonstrates how to use an object-oriented approach. Consulting Opportunities, diagrams, and problems enable students to learn and use UML to model systems from an object-oriented perspective. Students learn the appropriate situations for using an object-oriented approach. This chapter helps students to decide whether to use the SDLC, the agile approach, or object-oriented systems analysis and design to develop a system.

**Part IV (Chapters 11–14)** covers the essentials of design. It begins with designing output, because many practitioners believe systems to be output driven. The design of Web-based forms is covered in detail. Particular attention is paid to relating output method to content, the effect of output on users, and designing good forms and screens. Chapter 11 compares advantages and disadvantages of output, including Web displays, audio, DVD, and electronic output such as email and RSS feeds. Designing a Web site for ecommerce purposes is emphasized, and output production and XML is covered. Chapter 12 includes innovative material on designing Web-based input forms, as well as other electronic forms design. Also included is computer-assisted forms design.



Chapter 12 features in-depth coverage of Web site design, including guidelines on when designers should add video, audio, and animation to Web site designs. The chapter also covers uses of Web push and pull technologies for output designs. There is detailed consideration of how to create effective graphics for corporate Web sites and ways to design effective onscreen navigation for Web site users.

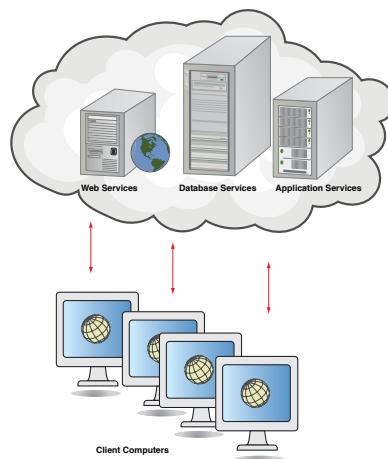
Coverage of intranet and extranet page design is also included. Consideration of database integrity constraints has been included as well, in addition to how the user interacts with the computer and how to design an appropriate interface. The importance of user feedback is also found in Part IV. How to design accurate data entry procedures that take full advantage of computer and human capabilities to assure entry of quality data is emphasized here.

Chapter 13 demonstrates how to use the entity-relationship diagram to determine record keys, as well as providing guidelines for file/database relation design. Students are shown the relevance of database design for the overall usefulness of the system, and how users actually use databases.

Chapter 14 emphasizes Human–Computer Interaction (HCI), especially as it relates to interface design. It introduces HCI, discussing its importance in designing systems that suit individuals and assisting them in achieving personal and organizational goals through their use of information technology. The concepts of usability, fit, perceived usefulness, and perceived ease of use are introduced, as is the Technology Acceptance Model (TAM), so that systems students can knowledgeably incorporate HCI practices into their designs. Chapter 14 also features material on designing easy onscreen navigation for Web site visitors. The chapter presents innovative approaches to searching on the Web, highlights material on GUI design, and provides innovative approaches to designing dialogs. Chapter 14 articulates specialized design considerations for ecommerce Web sites. Mashups, new applications created by combining two or more Web-based application programming interfaces, are also introduced. Chapter 14 also includes extensive coverage on how to formulate queries, all within the framework of HCI.

#### **Part V (Chapters 15 and 16) concludes the book.**

Chapter 15 focuses on designing accurate data entry procedures and includes material on managing the supply chain through the effective design of business-to-business (B2B) ecommerce. Chapter 16 emphasizes taking a total quality approach to improving software design and maintenance. In addition, material on system security and firewalls is included. Testing, auditing, and maintenance of systems are discussed in the context of total quality management. This chapter helps students understand how service-oriented architecture (SOA) and cloud computing are changing the nature of information systems design. In addition, students learn how to design appropriate training programs for users of the new system, how to recognize the differences among physical conversion strategies, and how to be able to recommend an appropriate one to a client. Chapter 16 also presents techniques for modeling networks, which can be done with popular tools such as Microsoft Visio.



Material on security and privacy in relation to designing ecommerce applications is included. Coverage of security, specifically firewalls, gateways, public key infrastructure (PKI), secure electronic translation (SET), secure socket layering (SSL), virus protection software, URL filtering products, email filtering products, and virtual private networks (VPN), is included. Additionally, current topics of interest to designers of ecommerce applications, including the development and posting of corporate privacy policies, are covered.

Important coverage of how the analyst can promote and then monitor a corporate Web site is included in this section, which features Web activity monitoring, Web site promotion, Web traffic analysis, and audience profiling to ensure the effectiveness of new ecommerce systems. Techniques for evaluating the completed information systems project are covered systematically as well.

The eighth edition contains an updated **Glossary** of terms and a separate list of updated **Acronyms** used in the book and in the systems analysis and design field.

## PEDAGOGICAL FEATURES

Chapters in the eighth edition contain:

- **Learning Objectives** at the beginning of each chapter
- **Summaries** that tie together the salient points of each chapter while providing an excellent source of review for exams
- **Keywords and Phrases**
- **Review Questions**
- **Problems**
- **Group Projects** that help students work together in a systems team to solve important problems that are best solved through group interaction
- **Consulting Opportunities**—now more than 60 minicases throughout the book

- **Mac Appeal** columns that update students on design software available on the Mac and iPhone
- **HyperCase Experiences**
- **CPU Case Episodes**—parts of an ongoing case threaded throughout the book

## CONSULTING OPPORTUNITIES

The eighth edition presents more than 60 Consulting Opportunities, and many of them address relevant and emerging topics that have arisen in the field, including designing systems from an HCI perspective, ecommerce applications for the Web, COTS software, and using UML to model information systems from an object-oriented perspective. Consulting Opportunities can be used for stimulating in-class discussions, or assigned as homework or take-home exam questions.

Because not all systems are extended two- or three-year projects, our book contains many Consulting Opportunities that can be solved quickly in 20 to 30 minutes of group discussion or individual writing. These minicases, written in a humorous manner to enliven the material, require students to synthesize what they have learned up to that point in the course, ask students to mature in their professional and ethical judgment, and expect students to articulate the reasoning that led to their systems decisions.

		AIR CONDUCTION			BONE CONDUCTION				
Patient Last Name	Examining Station	Patient Number	First Exam	Claim number	Right ear	Left ear	Right ear	Left ear	Middle Initial
500	1000	2000	4000	6000	500	1000	2000	4000	6000
500	1000	2000	4000	6000	500	1000	2000	4000	6000

SPEECH AUDIOMETRY SECT. SPEECH RECEP. THRESHOLD  
Comments:  
Right Ear [ ]  
Left Ear [ ]  
RIGHT EAR DISCR.  
% [ ] Masking [ ]  
LEFT EAR DISCRIM. Exam. Audiologist's No.  
% [ ] Masking [ ]  
Referred to [ ]  
Reason for referral [ ]  
Examining Audiologist [ ]  
Next Aptd. [ ]

## HYPERCASE EXPERIENCES

HyperCase® Experiences that pose challenging student exercises are present in each chapter. New scenarios, graphics, and problems to accompany HyperCase version 2.8 are included in the eighth edition. HyperCase has organizational problems featuring state-of-the-art technological systems. HyperCase represents an original virtual organization that allows students who access it to become immediately immersed in organizational life. Students will interview people, observe office environments, analyze their prototypes, and review the documentation of their existing systems. HyperCase 2.8 is Web-based, interactive software that presents an organization called Maple Ridge Engineering (MRE) in a colorful, three-dimensional graphics environment. HyperCase permits professors to begin approaching the systems analysis and design class with exciting multimedia material. Carefully watching their use of time and managing multiple methods, students use the hypertext characteristics of HyperCase on the Web to create their own individual paths through the organization.

Maple Ridge Engineering is drawn from the actual consulting experiences of the authors of the original version (Raymond Barnes, Richard Baskerville, Julie E. Kendall, and Kenneth E. Kendall). Allen Schmidt joined the project for version 2.0 and has remained with it. Peter Schmidt was the HTML programmer, and Jason Reed created the images for the initial Web version.

In each chapter, there are newly updated HyperCase Experiences that include assignments (and even some clues) to help students solve the difficult organizational problems including developing new systems, merging departments, hiring of employees, security, ecommerce, and disaster recovery planning they encounter at MRE. HyperCase has been fully tested in classrooms, and was an award winner in the Decision Sciences Institute Innovative Instruction competition.

**HYPERCASE® EXPERIENCE 3.2**

You find Bill, Create an inventory form to simplify your work. At the bottom of the screen, you see the text, do you need to evaluate of GEMS, a software package for the Management Systems employees. In a paragraph, briefly critique this custom software by comparing it with other software packages such as SAP, Oracle, and Microsoft Project.

1. Complete a computer equipment inventory for the Training and Management Systems Unit, describing all the systems

2. Using the software evaluation guidelines given in the text, do you need to evaluate of GEMS, a software package for the Management Systems employees. In a paragraph, briefly critique this custom software by comparing it with other software packages such as SAP, Oracle, and Microsoft Project.

3. List the strengths and benefits of GEMS as reported by the management systems employees.

4. Briefly describe the two alternatives Sweden is considering for the future of its information systems.

5. What organizational and political factors should Sweden consider in preparing its new system in MRE? (In a brief paragraph, discuss these factors.)

## CPU CASE EPISODES

In keeping with our belief that a variety of approaches are important, we have once again integrated the Central Pacific University (CPU) case into every chapter of the eighth edition. The

CPU case makes use of Microsoft Access, Microsoft Visio, and the popular CASE tool Visible Analyst by Visible Systems, Inc., for the example screen shots and the student exercises.

The CPU case takes students through all phases of the systems development life cycle. This running case gives students an opportunity to solve problems on their own, using a variety of tools and data that users of the book can download from the Web containing Microsoft Visio, Microsoft Access, and Visible Analyst exercises specifically keyed to each chapter of the book. Additionally, partially completed exercises in Microsoft Access files are available for student use on the Web. The CPU case has been fully tested in classrooms around the world with a variety of students over numerous terms. The case is detailed, rigorous, and rich enough to stand alone as a systems analysis and design project spanning one or two terms. Alternatively, the CPU case can be used as a way to teach the use of CASE tools in conjunction with the assignment of a one- or two-term, real-world project outside the classroom.

## EXPANDED WEB SUPPORT

Kendall & Kendall's *Systems Analysis and Design*, Eighth Edition, features Web-based support for solid but lively pedagogical techniques in the information systems field.

- The Web site, located at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall), contains a wealth of critical learning and support tools, which keep class discussions exciting.
- **HyperCase 2.8**, is an award-winning, virtually interactive organization game. Students are encouraged to interview people in the organization, analyze problems, modify data flow diagrams and data dictionaries, react to prototypes, and design new input and output. HyperCase now has a distinctive 3-D look.
- **Student Exercises based on the ongoing CPU case**, with partially solved problems and examples stored in Microsoft Access and Visible Analyst files, allow students to develop a Web-based computer management system.

### EPISODE 13 CPU CASE

ALLEN SCHMITZ, JULIE E. KENDALL, AND KENNETH E. KENDALL

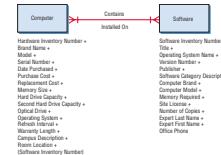
#### Back to Data Basics

After numerous interviews, prototypes, data flow diagrams, data dictionary entries, and UML diagrams have been completed, Anna and Chip both work on the entity-relationship model. "I'll be responsible for the hardware side of the system," says Anna, "and Chip will handle the software side." They begin with an entity-relationship diagram. "Let's compare the two diagrams for accuracy and consistency when we're done," Anna suggests, and so they do.

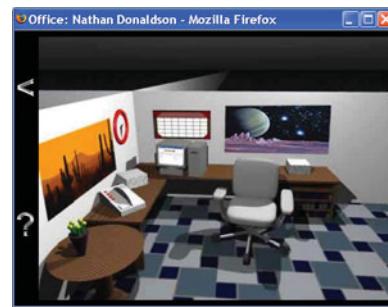
Figure E13.1 shows the entity-relationship diagram for the computer inventory system. Visible Analyst calls each of the rectangles an entity. Each entry represents a database table of information stored in the system. The rectangles are connected by lines representing relationships between entities. A diamond represents a many-to-many relationship diagram. Each of the diamond rectangles represents an associative entity representing a relationship between the data entities. These are often used in databases to represent an associative entity that cannot exist without the constraints of both entities. There are also lines connecting the rectangles to the diamond rectangles representing both an association and an attribute entry.

"We've got a pretty good diagram, starting with the simplest portion of the system," Chip tells Anna. "The first data entities created are SOFTWARE and COMPUTER. The relationship is that software could be installed on many computers, so it is one-to-many. Since the software is not part of the hardware package could be installed in many computers, this relationship is one-to-many. Each computer may also have more than one operating system installed. This is another one-to-many relationship. Because there is a one-to-many relationship for each of the data entities, the full relationship between them is many-to-many."

Chip goes on to say, "This first view is far from normalized. Notice that the SOFTWARE INVENTORY NUMBER is a repeating element on the HARDWARE entity. I will have to create several entities to get rid of this repeating element. The HARDWARE entity will be renamed to COMPUTER and the INVENTORY NUMBER will be removed and placed in a relational entity. Refer to the entity-relationship diagram illustrating the data entities and their relationships. Notice that the data entities are represented by rectangles that are dependent on only a part of the key, so the keys are also in the second normal form. There are, however, elements that are not part of the key that is represented in the diagram, and they will have to be represented in the third normal form. The OPERATING SYSTEM entity is an example of this. The elements are not part of the computer hardware but are installed on the computer or the computer is used to run the operating system. Rather than having to change the version of the operating system on many of the COMPUTER records, it would only have to be changed once."



**FIGURE E13.1**  
Unnormalized entity-relationship diagram for the computer system. The many-to-many relationships will have to be defined as an associative entity.



## EXPANDED INSTRUCTOR SUPPLEMENTAL WEB SUPPORT

Extended support for instructors using this edition can be found at the official Web site located at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Resources include:

- A complete set of **PowerPoint presentation slides** for use in lectures
- **Image Library**, a collection of all text art organized by chapter
- **Instructor's Manual** with answers to problems, solutions to cases, and suggestions for approaching the subject matter
- **Test Item File** in Microsoft Word and TestGen with WebCT- and Blackboard-ready conversions
- **Solutions to Student Exercises** based on the ongoing CPU case, with solutions and examples stored in Visible Analyst files and Microsoft Access files.

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# ACKNOWLEDGMENTS



Rapid and dramatic changes in IT occurred as we were writing the eighth edition of *Systems Analysis and Design*. We are delighted that this edition is being published at the right time for us to capture many of these changes in systems development.

One major change is that three primary approaches to development are emerging—the SDLC, agile approaches, and object-oriented systems analysis and design—and we are able to show where and in what situations each is useful to you as a systems analyst.

Another big change is the rapidly increasing use of the Web as a platform for information systems. Service-oriented architecture and cloud computing both change the way that the analyst approaches designing systems solutions. Along with the Web, analysts are being pushed to design for a wide spectrum of emerging information technologies such as wireless and mobile technologies, enterprise systems, and virtual contexts such as virtual teams and virtual organizations.

Another major change addressed in this edition is the ability of users to personalize and customize their desktops, workspaces, and Web pages, and even for users to alter the professional designs of systems analysts. Analysts see the big picture that users cannot see, and they must always be aware of the organizational impacts of changing systems.

Throughout the book you will learn and apply numerous techniques, methods, tools, and approaches. But when the time comes to interpret what is happening in the organization and to develop meaningful information systems from the application of rules to your analysis, your training combines with creativity to produce a system that is in some ways a surprise: It is structured, yet intuitive; multilayered and complex, in keeping with the character of the organization and uniquely reflective of you as a systems analyst and a human being.

Our students deserve credit for this new edition by providing feedback and suggestions for improvements and asking for increased depth in certain topics. Students told us that they rapidly put to use the new material on object-oriented systems analysis and design as well as that on agile modeling. Their eagerness to teach us new things keeps the book fresh. We want to thank our coauthor, Allen Schmidt, who once again worked with us on the *CPU Case Episodes* and HyperCase 2.8, for all of his hard work, dedication, and humor during our collaboration. He is a wonderful person. Our appreciation also goes to Peter Schmidt and Jason Reed for their improvements to the early HyperCase. We also want to thank the other two original authors of HyperCase, Richard Baskerville and Raymond Barnes, who contributed so much.

We would like to thank our eighth edition production team, especially our executive editor, Bob Horan, whose wisdom and calm demeanor are always inspiring. We are also grateful to Kelly Loftus, our extremely capable assistant editor, for her unruffled competency and for her optimism in keeping the project going. Ana Jankowski, our production editor, also deserves thanks for helping us succeed in making this a strong, complete, and accurate revision. Their help and enthusiasm facilitated the completion of the project in a smooth and timely manner.



Julie and Ken Kendall personally thank Shrek (Brian d'Arcy James) and all of our dear friends in the theatre and the performing arts.

We are also grateful for the encouragement and support of the entire Rutgers community, including our Chancellor Wendell Pritchett, our colleagues in the School of Business-Camden and throughout all of Rutgers, our staff, and our Board of Governors. They have been very enthusiastic about this edition as well as the many translations of *Systems Analysis and Design* available in Spanish, Chinese, and Indonesian.

All the reviewers for the eighth edition deserve our thanks as well. Their thoughtful comments and suggestions helped to strengthen the book. They are:

Stephen T. Brower, Raritan Valley Community College  
Robert F. Cope III, Southeastern Louisiana University  
Junhua Ding, East Carolina University  
Jon Gant, University of Illinois  
Cliff Layton, Rogers State University  
Keng Siau, University of Nebraska–Lincoln

Many of our colleagues and friends have encouraged us through the process of writing this book. We thank them for their comments on our work. They include: Ayman Abu Hamdieh; Macedonio Alanis; Michel Avital; the Ciupeks; Charles J. Coleman; Roger T. Danforth; Gordon Davis; EgoPo; Paul Gray; Nancy V. Gulick; Andy and Pam Hamingson; Blake Ives; Richard Kalina; Carol Latta; Ken and Jane Laudon; Richard Levao; Joel and Bobbie Porter; Caryn Schmidt; Marc and Jill Schniederjans; Gabriel Shanks; Detmar W. Straub, Jr.; the Vargas; Merrill Warkentin; Jeff and Bonnie Weil; Ping Zhang, and all of our friends and colleagues in the Association for Information Systems, the Decision Sciences Institute, IFIP Working Group 8.2, and all those involved in the PhD Project (founded by the KPMG Foundation), which serves minority doctoral students in information systems.

Our heartfelt thanks go to the memory of Julia A. Kendall and to the memory of Edward J. Kendall. Their belief that love, goals, and hard work are an unbeatable combination continues to infuse our every endeavor.

# Systems, Roles, and Development Methodologies

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Recall the basic types of computer-based systems that a systems analyst needs to address.
2. Understand how users working in context with new technologies change the dynamics of a system.
3. Realize what the many roles of a systems analyst are.
4. Comprehend the fundamentals of three development methodologies: SDLC, the agile approach, and object-oriented systems analysis and design.
5. Understand what CASE tools are and how they help a systems analyst.



Organizations have long recognized the importance of managing key resources such as people and raw materials. Information has now moved to its rightful place as a key resource. Decision makers now understand that information is not just a by-product of conducting business; rather, it fuels business and can be the critical factor in determining the success or failure of a business.

To maximize the usefulness of information, a business must manage it correctly, just as it manages other resources. Managers need to understand that costs are associated with the production, distribution, security, storage, and retrieval of all information. Although information is all around us, it is not free, and its strategic use for positioning a business competitively should not be taken for granted.

The ready availability of networked computers, along with access to the Internet and the Web, has created an information explosion throughout society in general and business in particular. Managing computer-generated information differs in significant ways from handling manually produced data. Usually there is a greater quantity of computer information to administer. Costs of organizing and maintaining it can increase at alarming rates, and users often treat it less skeptically than information obtained in different ways. This chapter examines the fundamentals of different kinds of information systems, the varied roles of systems analysts, and the phases in the systems development life cycle (SDLC) as they relate to Human–Computer Interaction (HCI) factors; it also introduces Computer-Aided Software Engineering (CASE) tools.



## TYPES OF SYSTEMS

Information systems are developed for different purposes, depending on the needs of human users and the business. Transaction processing systems (TPS) function at the operational level of the organization; office automation systems (OAS) and knowledge work systems (KWS) support work at the knowledge level. Higher-level systems include management information systems (MIS) and decision support systems (DSS). Expert systems apply the expertise of decision makers to solve specific, structured problems. On the strategic level of management we find executive support systems (ESS). Group decision support systems (GDSS) and the more generally described computer-supported collaborative work systems (CSCWS) aid group-level decision making of a semistructured or unstructured variety.

The variety of information systems that analysts may develop is shown in Figure 1.1. Notice that the figure presents these systems from the bottom up, indicating that the operational, or lowest, level of the organization is supported by TPS, and the strategic, or highest, level of semistructured and unstructured decisions is supported by ESS, GDSS, and CSCWS at the top. This text uses the terms *management information systems*, *information systems (IS)*, *computerized information systems*, and *computerized business information systems* interchangeably to denote computerized information systems that support the broadest range of user interactions with technologies and business activities through the information they produce in organizational contexts.

### Transaction Processing Systems

Transaction processing systems (TPS) are computerized information systems that were developed to process large amounts of data for routine business transactions such as payroll and inventory. A TPS eliminates the tedium of necessary operational transactions and reduces the time once required to perform them manually, although people must still input data to computerized systems.

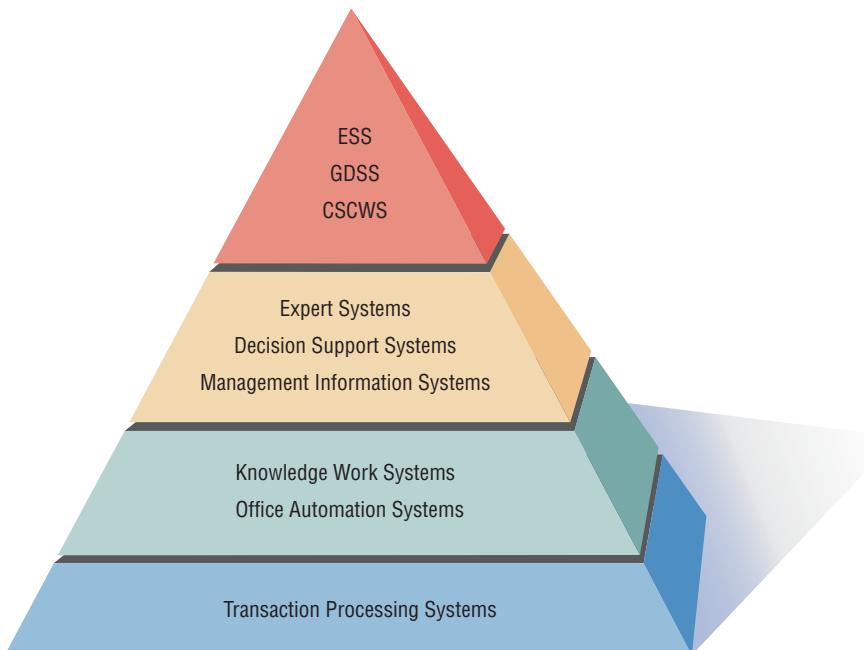
Transaction processing systems are boundary-spanning systems that permit the organization to interact with external environments. Because managers look to the data generated by the TPS for up-to-the-minute information about what is happening in their companies, it is essential to the day-to-day operations of business that these systems function smoothly and without interruption.

### Office Automation Systems and Knowledge Work Systems

At the knowledge level of the organization are two classes of systems. Office automation systems (OAS) support data workers, who do not usually create new knowledge but rather analyze information to transform data or manipulate it in some way before sharing it with, or formally disseminating it throughout, the organization and, sometimes, beyond. Familiar aspects of OAS include

**FIGURE 1.1**

A systems analyst may be involved with any or all of these systems.



word processing, spreadsheets, desktop publishing, electronic scheduling, and communication through voice mail, email (electronic mail), and teleconferencing.

Knowledge work systems (KWS) support professional workers such as scientists, engineers, and doctors by aiding them in their efforts to create new knowledge (often in teams) and by allowing them to contribute it to their organization or to society at large.

## Management Information Systems

Management information systems (MIS) do not replace transaction processing systems; rather, all MIS include transaction processing. MIS are computerized information systems that work because of the purposeful interaction between people and computers. By requiring people, software, and hardware to function in concert, management information systems support users in accomplishing a broader spectrum of organizational tasks than transaction processing systems, including decision analysis and decision making.

To access information, users of the management information system share a common database. The database stores both data and models that help the user interact with, interpret, and apply that data. Management information systems output information that is used in decision making. A management information system can also help integrate some of the computerized information functions of a business.

## Decision Support Systems

A higher-level class of computerized information systems is decision support systems (DSS). DSS are similar to the traditional management information system because they both depend on a database as a source of data. A decision support system departs from the traditional management information system because it emphasizes the support of decision making in all its phases, although the actual decision is still the exclusive province of the decision maker. Decision support systems are more closely tailored to the person or group using them than is a traditional management information system. Sometimes they are discussed as systems that focus on business intelligence.

## Artificial Intelligence and Expert Systems

Artificial intelligence (AI) can be considered the overarching field for expert systems. The general thrust of AI has been to develop machines that behave intelligently. Two avenues of AI research are (1) understanding natural language and (2) analyzing the ability to reason through a problem to its logical conclusion. Expert systems use the approaches of AI reasoning to solve the problems put to them by business (and other) users.

Expert systems are a very special class of information system that has been made practical for use by business as a result of widespread availability of hardware and software such as personal computers (PCs) and expert system shells. An expert system (also called a knowledge-based system) effectively captures and uses the knowledge of a human expert or experts for solving a particular problem experienced in an organization. Notice that unlike DSS, which leave the ultimate judgment to the decision maker, an expert system selects the best solution to a problem or a specific class of problems.

The basic components of an expert system are the knowledge base, an inference engine connecting the user with the system by processing queries via languages such as structured query language (SQL), and the user interface. People called knowledge engineers capture the expertise of experts, build a computer system that includes this expert knowledge, and then implement it.

## Group Decision Support Systems and Computer-Supported Collaborative Work Systems

Organizations are becoming increasingly reliant on groups or teams to make decisions together. When groups make semistructured or unstructured decisions, a group decision support system may afford a solution. Group decision support systems (GDSS), which are used in special rooms equipped in a number of different configurations, permit group members to interact with electronic support—often in the form of specialized software—and a special group facilitator. Group decision support systems are intended to bring a group together to solve a problem with the help of various supports such as polling, questionnaires, brainstorming, and scenario creation. GDSS software can be designed to minimize typical negative group behaviors such as lack of participation due to fear

of reprisal for expressing an unpopular or contested viewpoint, domination by vocal group members, and “group think” decision making. Sometimes GDSS are discussed under the more general term *computer-supported collaborative work systems* (CSCWS), which might include software support called groupware for team collaboration via networked computers. Group decision support systems can also be used in a virtual setting.

### Executive Support Systems

When executives turn to the computer, they are often looking for ways to help them make decisions on the strategic level. Executive support systems (ESS) help executives organize their interactions with the external environment by providing graphics and communications technologies in accessible places such as boardrooms or personal corporate offices. Although ESS rely on the information generated by TPS and MIS, executive support systems help their users address unstructured decision problems, which are not application specific, by creating an environment that helps them think about strategic problems in an informed way. ESS extend and support the capabilities of executives, permitting them to make sense of their environments.

## INTEGRATING TECHNOLOGIES FOR SYSTEMS

As users adopt new technologies, some of the systems analyst’s work will be devoted to integrating traditional systems with new ones to ensure a useful context, as shown in Figure 1.2. This section describes some of the new information technologies systems analysts will be using as people work to integrate their ecommerce applications into their traditional businesses or as they begin entirely new ebusinesses.

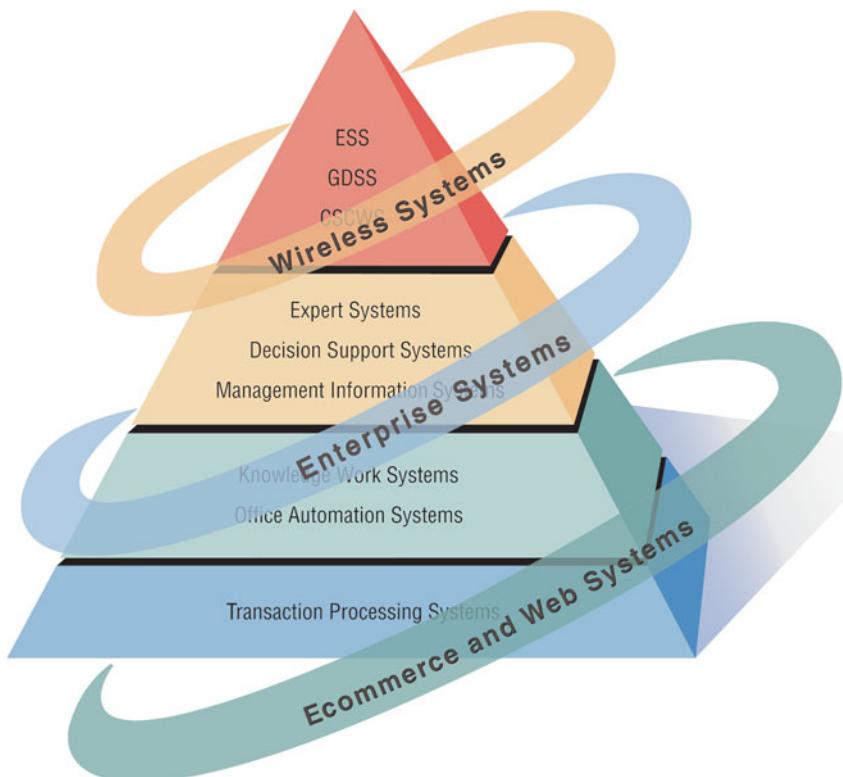
### Ecommerce Applications and Web Systems

Many of the systems discussed here can be imbued with greater functionality if they are migrated to the World Wide Web or if they are originally conceived and implemented as Web-based technologies. There are many benefits to mounting or improving an application on the Web:

1. Increasing user awareness of the availability of a service, product, industry, person, or group.
2. The possibility of 24-hour access for users.

**FIGURE 1.2**

Systems analysts need to be aware that integrating technologies affect all types of users and systems.



3. Improving the usefulness and usability of the interface design.
4. Creating a system that can extend globally rather than remain local, thus reaching people in remote locations without worry of the time zone in which they are located.

## Enterprise Systems

Many organizations envision potential benefits from the integration of many information systems existing on different management levels and within different functions. Some authors discuss integration as service-oriented architecture (SOA), which exists in layers. Enterprise systems would comprise the top layer. Enterprise systems, also called enterprise resource planning (ERP) systems, are designed to perform this integration. Instituting ERP requires enormous commitment and organizational change. Often systems analysts serve as consultants to ERP endeavors that use proprietary software. Popular ERP software includes that from SAP and Oracle. Some of these packages are targeted toward moving enterprises onto the Web. Typically, analysts as well as some users require vendor training, support, and maintenance to be able to properly design, install, maintain, update, and use a particular ERP package.

## Systems for Wireless and Mobile Devices

Analysts are being asked to design a plethora of new systems and applications for adventurous users, including many for wireless and mobile devices such as the Apple iPhone, iPod, or the BlackBerry. In addition, analysts may find themselves designing standard or wireless communications networks for users that integrate voice, video, text messaging, and email into organizational intranets or industry extranets. Wireless ecommerce is referred to as mcommerce (mobile commerce).

Wireless local area networks (WLANs); wireless fidelity networks, called Wi-Fi; and personal wireless networks that bring together many types of devices under the standard called Bluetooth are all systems that you may be asked to design. In more advanced settings, analysts may be called on to design intelligent agents, software that can assist users with tasks in which the software learns users' preferences over time and then acts on those preferences. For example, in the use of pull technology, an intelligent agent would search the Web for stories of interest to the user, having observed the user's behavior patterns with information over time, and would conduct searches on the Web without continual prompting from the user.

## Open Source Software

An alternative to traditional software development in which proprietary code is hidden from the users is called open source software (OSS). With OSS, the code, or computer instructions, can be studied, shared, and modified by many users and programmers. Rules of this community include the idea that any program modifications must be shared with all the people on the project.

Development of OSS has also been characterized as a philosophy rather than simply as the process of creating new software. Often those involved in OSS communities view it as a way to help societies change. Widely known open source projects include Apache for developing a Web server, the browser called Mozilla Firefox, and Linux, which is a Unix-like open source operating system.

However, it would be an oversimplification to think of OSS as a monolithic movement, and it does little to reveal what type of users or user analysts are developing OSS projects and on what basis. To help us understand the open source movement, researchers have recently categorized open source communities into four community types—ad hoc, standardized, organized, and commercial—along six different dimensions—general structure, environment, goals, methods, user community, and licensing. Some researchers argue that OSS is at a crossroads and that the commercial and community OSS groups need to understand where they converge and where the potential for conflict exists.

Open source development is useful for many applications running on diverse technologies, including handheld devices and communication equipment. Its use may encourage progress in creating standards for devices to communicate more easily. Widespread use of OSS may alleviate some of the severe shortages of programmers by placing programming tools in the hands of students in developing countries sooner than if they were limited to using proprietary packages, and it may lead to solving large problems through intense and extensive collaboration.

## NEED FOR SYSTEMS ANALYSIS AND DESIGN

Systems analysis and design, as performed by systems analysts, seeks to understand what humans need to analyze data input or data flow systematically, process or transform data, store data, and output information in the context of a particular organization or enterprise. By doing thorough analysis, analysts seek to identify and solve the right problems. Furthermore, systems analysis and design is used to analyze, design, and implement improvements in the support of users and the functioning of businesses that can be accomplished through the use of computerized information systems.

Installing a system without proper planning leads to great user dissatisfaction and frequently causes the system to fall into disuse. Systems analysis and design lends structure to the analysis and design of information systems, a costly endeavor that might otherwise have been done in a haphazard way. It can be thought of as a series of processes systematically undertaken to improve a business through the use of computerized information systems. Systems analysis and design involves working with current and eventual users of information systems to support them in working with technologies in an organizational setting.

User involvement throughout the systems project is critical to the successful development of computerized information systems. Systems analysts, whose roles in the organization are discussed next, are the other essential component in developing useful information systems.

Users are moving to the forefront as software development teams become more international in their composition. This means that there is more emphasis on working with software users; on performing analysis of their business, problems, and objectives; and on communicating the analysis and design of the planned system to all involved.

New technologies also are driving the need for systems analysis. Ajax (Asynchronous JavaScript and XML) is not a new programming language, but a technique that uses existing languages to make Web pages function more like a traditional desktop application program. Building and redesigning Web pages that utilize Ajax technologies will be a task facing analysts. New programming languages, such as the open source Web framework, *Ruby on Rails*, which is a combination programming language and code generator for creating Web applications, will require more analysis.

## ROLES OF THE SYSTEMS ANALYST

The systems analyst systematically assesses how users interact with technology and how businesses function by examining the inputting and processing of data and the outputting of information with the intent of improving organizational processes. Many improvements involve better support of users' work tasks and business functions through the use of computerized information systems. This definition emphasizes a systematic, methodical approach to analyzing—and potentially improving—what is occurring in the specific context experienced by users and created by a business.

Our definition of a systems analyst is necessarily broad. The analyst must be able to work with people of all descriptions and be experienced in working with computers. The analyst plays many roles, sometimes balancing several at the same time. The three primary roles of the systems analyst are consultant, supporting expert, and agent of change.

### Systems Analyst as Consultant

The systems analyst frequently acts as a systems consultant to humans and their businesses and, thus, may be hired specifically to address information systems issues within a business. Such hiring can be an advantage because outside consultants can bring with them a fresh perspective that other people in an organization do not possess. It also means that outside analysts are at a disadvantage because an outsider can never know the true organizational culture. As an outside consultant, you will rely heavily on the systematic methods discussed throughout this text to analyze and design appropriate information systems for users working in a particular business. In addition, you will rely on information systems users to help you understand the organizational culture from others' viewpoints.

### Systems Analyst as Supporting Expert

Another role that you may be required to play is that of supporting expert within a business for which you are regularly employed in some systems capacity. In this role the analyst draws on professional expertise concerning computer hardware and software and their uses in the business.



## CONSULTING OPPORTUNITY 1.1

### Healthy Hiring: Ecommerce Help Wanted

“You’ll be happy to know that we made a strong case to management that we should hire a new systems analyst to specialize in ecommerce development,” says Al Falfa, a systems analyst for the multioutlet international chain of Marathon Vitamin Shops. He is meeting with his large team of systems analysts to decide on the qualifications that their new team member should possess. Al continues, saying, “In fact, they were so excited by the possibility of our team helping to move Marathon into an ecommerce strategy that they’ve said we should start our search now and not wait until the fall.”

Ginger Rute, another analyst, agrees, saying, “The demand for Web site developers is still outstripping the supply. We should move quickly. I think our new person should be knowledgeable in system modeling, JavaScript, C++, Rational Rose, and familiar with Ajax, just to name a few.”

Al looks surprised at Ginger’s long list of skills but then replies, “Well, that’s certainly one way we could go. But I would also like to see a person with some business savvy. Most of the people coming out of school will have solid programming skills, but they should know about accounting, inventory, and distribution of goods and services, too.”

The newest member of the systems analysis group, Vita Ming, finally breaks into the discussion. She says, “One of the reasons I chose to come to work with all of you was that I thought we all got along quite well together. Because I had some other opportunities, I looked very carefully at what the atmosphere was here. From what I’ve seen, we’re a friendly group. Let’s be sure to hire someone who has a good personality and who fits in well with us.”

Al concurs, continuing, “Vita’s right. The new person should be able to communicate well with us, and with business clients, too.

We are always communicating in some way, through formal presentations, drawing diagrams, or interviewing users. If they understand decision making, it will make their job easier, too. Also, Marathon is interested in integrating ecommerce into the entire business. We need someone who at least grasps the strategic importance of the Web. Page design is such a small part of it.”

Ginger interjects again with a healthy dose of practicality, saying, “Leave that to management. I still say the new person should be a good programmer.” Then she ponders aloud, “I wonder how important UML will be?”

After listening patiently to everyone’s wish list, one of the senior analysts, Cal Siem, speaks up, joking, “We’d better see if Superman is available!”

As the group shares a laugh, Al sees an opportunity to try for some consensus, saying, “We’ve had a chance to hear a number of different qualifications. Let’s each take a moment and make a list of the qualifications we personally think are essential for the new ecommerce development person to possess. We’ll share them and continue discussing until we can describe the person in enough detail to turn a description over to the human resources group for processing.”

What qualifications should the systems analysis team be looking for when hiring their new ecommerce development team member? Is it more important to know specific languages or to have an aptitude for picking up languages and software packages quickly? How important is it that the person being hired has some basic business understanding? Should all team members possess identical competencies and skills? What personality or character traits are desirable in a systems analyst who will be working in ecommerce development?

This work is often not a full-blown systems project, but rather it entails a small modification or decision affecting a single department.

As the supporting expert, you are not managing the project; you are merely serving as a resource for those who are. If you are a systems analyst employed by a manufacturing or service organization, many of your daily activities may be encompassed by this role.

#### Systems Analyst as Agent of Change

The most comprehensive and responsible role that the systems analyst takes on is that of an agent of change, whether internal or external to the business. As an analyst, you are an agent of change whenever you perform any of the activities in the systems development life cycle (discussed in the next section) and are present and interacting with users and the business for an extended period (from two weeks to more than a year). An agent of change can be defined as a person who serves as a catalyst for change, develops a plan for change, and works with others in facilitating that change.

Your presence in the business changes it. As a systems analyst, you must recognize this fact and use it as a starting point for your analysis. Hence, you must interact with users and management (if they are not one and the same) from the very beginning of your project. Without their help you cannot understand what they need to support their work in the organization, and real change cannot take place.

If change (that is, improvements to the business that can be realized through information systems) seems warranted after analysis, the next step is to develop a plan for change along with the people who must enact the change. Once a consensus is reached on the change that is to be made, you must constantly interact with those who are changing.

As a systems analyst acting as an agent of change, you advocate a particular avenue of change involving the use of information systems. You also teach users the process of change, because changes in the information system do not occur independently; rather, they cause changes in the rest of the organization as well.

### Qualities of the Systems Analyst

From the foregoing descriptions of the roles the systems analyst plays, it is easy to see that the successful systems analyst must possess a wide range of qualities. Many different kinds of people are systems analysts, so any description is destined to fall short in some way. There are some qualities, however, that most systems analysts seem to display.

Above all, the analyst is a problem solver. He or she is a person who views the analysis of problems as a challenge and who enjoys devising workable solutions. When necessary, the analyst must be able to systematically tackle the situation at hand through skillful application of tools, techniques, and experience. The analyst must also be a communicator capable of relating meaningfully to other people over extended periods of time. Systems analysts need to be able to understand humans' needs in interacting with technology, and they need enough computer experience to program, to understand the capabilities of computers, to glean information requirements from users, and to communicate what is needed to programmers. They also need to possess strong personal and professional ethics to help them shape their client relationships.

The systems analyst must be a self-disciplined, self-motivated individual who is able to manage and coordinate other people, as well as innumerable project resources. Systems analysis is a demanding career, but, in compensation, an ever-changing and always challenging one.

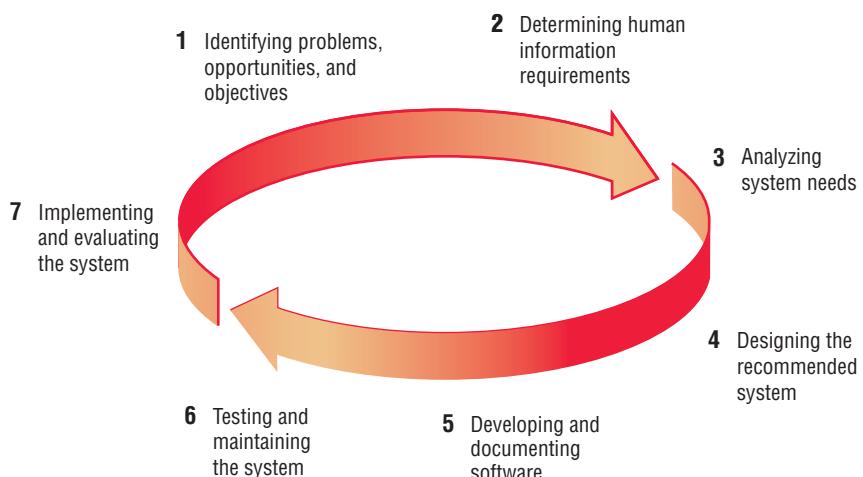
## THE SYSTEMS DEVELOPMENT LIFE CYCLE

Throughout this chapter we have referred to the systematic approach analysts take to the analysis and design of information systems. Much of this is embodied in what is called the systems development life cycle (SDLC). The SDLC is a phased approach to analysis and design that holds that systems are best developed through the use of a specific cycle of analyst and user activities.

Analysts disagree on exactly how many phases there are in the SDLC, but they generally laud its organized approach. Here we have divided the cycle into seven phases, as shown in Figure 1.3. Although each phase is presented discretely, it is never accomplished as a separate step. Instead, several activities can occur simultaneously, and activities may be repeated.

**FIGURE 1.3**

The seven phases of the systems development life cycle (SDLC).



## Incorporating Human–Computer Interaction Considerations

In recent years, the study of human–computer interaction (HCI) has become increasingly important for systems analysts. Although the definition is still evolving, researchers characterize HCI as the “aspect of a computer that enables communications and interactions between humans and the computer. It is the layer of the computer that is between humans and the computer” (Zhang, Carey, Te’eni, & Tremaine, 2005, p. 518). Analysts using an HCI approach are emphasizing people rather than the work to be done or the IT that is involved. Their approach to a problem is multifaceted, looking at the “human ergonomic, cognitive, affective, and behavioral factors involved in user tasks, problem solving processes and interaction context” (Zhang, Carey, Te’eni, & Tremaine, 2005, p. 518). Human computer interaction moves away from focusing first on organizational and system needs and instead concentrates on human needs. Analysts adopting HCI principles examine a variety of user needs in the context of humans interacting with information technology to complete tasks and solve problems. These include taking into account physical or ergonomic factors; usability factors that are often labeled cognitive matters; the pleasing, aesthetic, and enjoyable aspects of using the system; and behavioral aspects that center on the usefulness of the system.

Another way to think about HCI is to think of it as a human-centered approach that puts people ahead of organizational structure or culture when creating new systems. When analysts employ HCI as a lens to filter the world, their work will possess a different quality than the work of those who do not possess this perspective.

Your career can benefit from a strong grounding in HCI. The demand for analysts who are capable of incorporating HCI into the systems development process keeps rising, as companies increasingly realize that the quality of systems and the quality of work life can both be improved by taking a human-centered approach at the outset of a project.

The application of human–computer interaction principles tries to uncover and address the frustrations that users voice over their use of information technology. These concerns include a suspicion that systems analysts misunderstand the work being done, the tasks involved, and how they can best be supported; a feeling of helplessness or lack of control when working with the system; intentional breaches of privacy; trouble navigating through system screens and menus; and a general mismatch between the system designed and the way users themselves think of their work processes.

Misjudgments and errors in design that cause users to neglect new systems or that cause systems to fall into disuse soon after their implementation can be eradicated or minimized when systems analysts adopt an HCI approach.

Researchers in HCI see advantages to the inclusion of HCI in every phase of the SDLC. This is a worthwhile approach, and we will try to mirror this by bringing human concerns explicitly into each phase of the SDLC. As a person who is learning systems analysis, you can also bring a fresh eye to the SDLC to identify opportunities for designers to address HCI concerns and ways for users to become more central to each phase of the SDLC. Chapter 14 is devoted to examining the role of the systems analyst in designing human-centered systems and interfaces from an HCI perspective.

## Identifying Problems, Opportunities, and Objectives

In this first phase of the systems development life cycle, the analyst is concerned with correctly identifying problems, opportunities, and objectives. This stage is critical to the success of the rest of the project, because no one wants to waste subsequent time addressing the wrong problem.

The first phase requires that the analyst look honestly at what is occurring in a business. Then, together with other organizational members, the analyst pinpoints problems. Often others will bring up these problems, and they are the reason the analyst was initially called in. Opportunities are situations that the analyst believes can be improved through the use of computerized information systems. Seizing opportunities may allow the business to gain a competitive edge or set an industry standard.

Identifying objectives is also an important component of the first phase. The analyst must first discover what the business is trying to do. Then the analyst will be able to see whether some aspect of information systems applications can help the business reach its objectives by addressing specific problems or opportunities.

The people involved in the first phase are the users, analysts, and systems managers coordinating the project. Activities in this phase consist of interviewing user management, summarizing the

knowledge obtained, estimating the scope of the project, and documenting the results. The output of this phase is a feasibility report containing a problem definition and summarizing the objectives. Management must then make a decision on whether to proceed with the proposed project. If the user group does not have sufficient funds in its budget or wishes to tackle unrelated problems, or if the problems do not require a computer system, a different solution may be recommended, and the systems project does not proceed any further.

### Determining Human Information Requirements

The next phase the analyst enters is that of determining the human needs of the users involved, using a variety of tools to understand how users interact in the work context with their current information systems. The analyst will use interactive methods such as interviewing, sampling and investigating hard data, and questionnaires, along with unobtrusive methods, such as observing decision makers' behavior and their office environments, and all-encompassing methods, such as prototyping.

The analyst will use these methods to pose and answer many questions concerning human-computer interaction (HCI), including questions such as, "What are the users' physical strengths and limitations?" In other words, "What needs to be done to make the system audible, legible, and safe?" "How can the new system be designed to be easy to use, learn, and remember?" "How can the system be made pleasing or even fun to use?" "How can the system support a user's individual work tasks and make them more productive in new ways?"

In the information requirements phase of the SDLC, the analyst is striving to understand what information users need to perform their jobs. At this point the analyst is examining how to make the system useful to the people involved. How can the system better support individual tasks that need doing? What new tasks are enabled by the new system that users were unable to do without it? How can the new system be created to extend a user's capabilities beyond what the old system provided? How can the analyst create a system that is rewarding for workers to use?

The people involved in this phase are the analysts and users, typically operations managers and operations workers. The systems analyst needs to know the details of current system functions: the who (the people who are involved), what (the business activity), where (the environment in which the work takes place), when (the timing), and how (how the current procedures are performed) of the business under study. The analyst must then ask why the business uses the current system. There may be good reasons for doing business using the current methods, and these should be considered when designing any new system.

Agile development is an object-oriented approach (OOA) to systems development that includes a method of development (including generating information requirements) as well as software tools. In this text it is paired with prototyping in Chapter 6. (There is more about object-oriented approaches in Chapter 10.)

If the reason for current operations is that "it's always been done that way," however, the analyst may wish to improve on the procedures. At the completion of this phase, the analyst should understand how users accomplish their work when interacting with a computer and begin to know how to make the new system more useful and usable. The analyst should also know how the business functions and have complete information on the people, goals, data, and procedures involved.

### Analyzing System Needs

The next phase that the systems analyst undertakes involves analyzing system needs. Again, special tools and techniques help the analyst make requirement determinations. Tools such as data flow diagrams (DFD) to chart the input, processes, and output of the business's functions, or activity diagrams or sequence diagrams to show the sequence of events, illustrate systems in a structured, graphical form. From data flow, sequence, or other diagrams, a data dictionary is developed that lists all the data items used in the system, as well as their specifications.

During this phase the systems analyst also analyzes the structured decisions made. Structured decisions are those for which the conditions, condition alternatives, actions, and action rules can be determined. There are three major methods for analysis of structured decisions: structured English, decision tables, and decision trees.

At this point in the SDLC, the systems analyst prepares a systems proposal that summarizes what has been found out about the users, usability, and usefulness of current systems; provides cost-benefit analyses of alternatives; and makes recommendations on what (if anything) should be done. If one of the recommendations is acceptable to management, the analyst proceeds along

that course. Each systems problem is unique, and there is never just one correct solution. The manner in which a recommendation or solution is formulated depends on the individual qualities and professional training of each analyst and the analyst's interaction with users in the context of their work environment.

### Designing the Recommended System

In the design phase of the SDLC, the systems analyst uses the information collected earlier to accomplish the logical design of the information system. The analyst designs procedures for users to help them accurately enter data so that data going into the information system are correct. In addition, the analyst provides for users to complete effective input to the information system by using techniques of good form and Web page or screen design.

Part of the logical design of the information system is devising the HCI. The interface connects the user with the system and is thus extremely important. The user interface is designed with the help of users to make sure that the system is audible, legible, and safe, as well as attractive and enjoyable to use. Examples of physical user interfaces include a keyboard (to type in questions and answers), onscreen menus (to elicit user commands), and a variety of graphical user interfaces (GUIs) that use a mouse or touch screen.

The design phase also includes designing databases that will store much of the data needed by decision makers in the organization. Users benefit from a well-organized database that is logical to them and corresponds to the way they view their work. In this phase the analyst also works with users to design output (either onscreen or printed) that meets their information needs.

Finally, the analyst must design controls and backup procedures to protect the system and the data, and to produce program specification packets for programmers. Each packet should contain input and output layouts, file specifications, and processing details; it may also include decision trees or tables, UML or data flow diagrams, and the names and functions of any prewritten code that is either written in-house or using code or other class libraries.

### Developing and Documenting Software

In the fifth phase of the SDLC, the analyst works with programmers to develop any original software that is needed. During this phase the analyst works with users to develop effective documentation for software, including procedure manuals, online help, and Web sites featuring Frequently Asked Questions (FAQs), on Read Me files shipped with new software. Because users are involved from the beginning, phase documentation should address the questions they have raised and solved jointly with the analyst. Documentation tells users how to use software and what to do if software problems occur.

Programmers have a key role in this phase because they design, code, and remove syntactical errors from computer programs. To ensure quality, a programmer may conduct either a design or a code walkthrough, explaining complex portions of the program to a team of other programmers.

### Testing and Maintaining the System

Before the information system can be used, it must be tested. It is much less costly to catch problems before the system is signed over to users. Some of the testing is completed by programmers alone, some of it by systems analysts in conjunction with programmers. A series of tests to pinpoint problems is run first with sample data and eventually with actual data from the current system. Often test plans are created early in the SDLC and are refined as the project progresses.

Maintenance of the system and its documentation begins in this phase and is carried out routinely throughout the life of the information system. Much of the programmer's routine work consists of maintenance, and businesses spend a great deal of money on maintenance. Some maintenance, such as program updates, can be done automatically via a vendor site on the Web. Many of the systematic procedures the analyst employs throughout the SDLC can help ensure that maintenance is kept to a minimum.

### Implementing and Evaluating the System

In this last phase of systems development, the analyst helps implement the information system. This phase involves training users to handle the system. Vendors do some training, but oversight of training is the responsibility of the systems analyst. In addition, the analyst needs to plan for a smooth conversion from the old system to the new one. This process includes converting files from old formats to new ones, or building a database, installing equipment, and bringing the new system into production.

At home and in our visits to university campuses and businesses around the world, we've noticed that students and organizations are increasingly showing an interest in Macs. Therefore, we thought it would add a little bit of interest to show some Mac options that a systems designer has. At the time we're writing this book, about one out of seven personal computers purchased in the United States is a Mac. Macs are quality Intel-based machines that run under a competent operating system and can also run Windows, so in effect everything that can be done on a PC can be done on a Mac. One way to run Windows is to boot directly into Windows (once it's installed); another is to use virtualization using software such as VM Fusion, which is shown in Figure 1.MAC.

Adopters of Macs have cited many reasons for using Macs including better security built into the Mac operating system, intelligent backup using the built-in time machine, the multitude of applications already included, the reliability of setup and networking, and the ability to sync Macs with other Macs and iPhones. The most compelling reason, we think, is the design itself.

**FIGURE 1.MAC**

Running Windows on a Mac using Virtualization Software called VM Fusion.

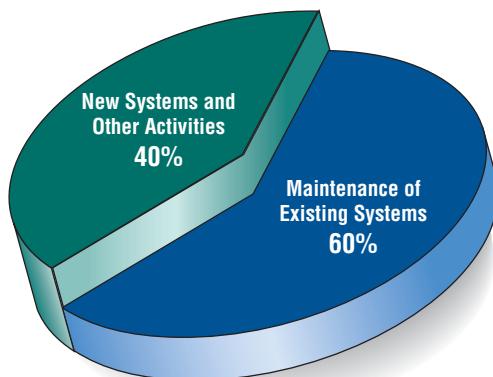
Evaluation is included as part of this final phase of the SDLC mostly for the sake of discussion. Actually, evaluation takes place during every phase. A key criterion that must be satisfied is whether the intended users are indeed using the system.

It should be noted that systems work is often cyclical. When an analyst finishes one phase of systems development and proceeds to the next, the discovery of a problem may force the analyst to return to the previous phase and modify the work done there.

### The Impact of Maintenance

After the system is installed, it must be maintained, meaning that the computer programs must be modified and kept up to date. Figure 1.4 illustrates the average amount of time spent on maintenance at a typical MIS installation. Estimates of the time spent by departments on maintenance have ranged from 48 to 60 percent of the total time spent developing systems. Very little time remains for new systems development. As the number of programs written increases, so does the amount of maintenance they require.

Maintenance is performed for two reasons. The first of these is to correct software errors. No matter how thoroughly the system is tested, bugs or errors creep into computer programs. Bugs

**FIGURE 1.4**

Some researchers estimate that the amount of time spent on system maintenance may be as much as 60 percent of the total time spent on systems projects.

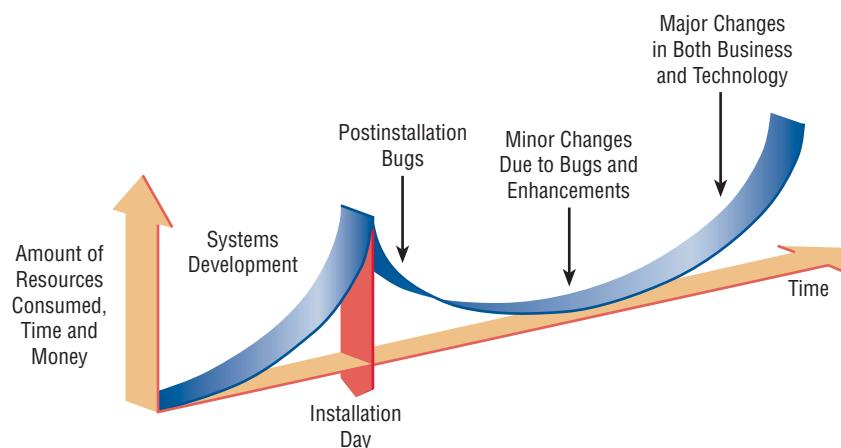
in commercial PC software are often documented as “known anomalies,” and are corrected when new versions of the software are released or in an interim release. In custom software (also called bespoke software), bugs must be corrected as they are detected.

The other reason for performing system maintenance is to enhance the software’s capabilities in response to changing organizational needs, generally involving one of the following three situations:

1. Users often request additional features after they become familiar with the computer system and its capabilities.
2. The business changes over time.
3. Hardware and software are changing at an accelerated pace.

Figure 1.5 illustrates the amount of resources—usually time and money—spent on systems development and maintenance. The area under the curve represents the total dollar amount spent. You can see that over time the total cost of maintenance is likely to exceed that of systems development. At a certain point it becomes more feasible to perform a new systems study, because the cost of continued maintenance is clearly greater than that of creating an entirely new information system.

In summary, maintenance is an ongoing process over the life cycle of an information system. After the information system is installed, maintenance usually takes the form of correcting previously undetected program errors. Once these are corrected, the system approaches a steady state, providing dependable service to its users. Maintenance during this period may consist of removing a few previously undetected bugs and updating the system with a few minor enhancements. As time goes on and the business and technology change, however, the maintenance effort increases dramatically.

**FIGURE 1.5**

Resource consumption over the system life.

## USING CASE TOOLS

Analysts who adopt the SDLC approach often benefit from productivity tools, called Computer-Aided Software Engineering (CASE) tools, that have been created explicitly to improve their routine work through the use of automated support. Analysts rely on CASE tools to increase productivity, communicate more effectively with users, and integrate the work that they do on the system from the beginning to the end of the life cycle.

Visible Analyst (VA) is one example of a CASE tool that enables systems analysts to do graphical planning, analysis, and design in order to build complex client/server applications and databases. Visible Analyst and another software product called Microsoft Visio allow users to draw and modify diagrams easily.

Analysts and users alike report that CASE tools afford them a means of communication about the system during its conceptualization. Through the use of automated support featuring onscreen output, clients can readily see how data flows and other system concepts are depicted, and they can then request corrections or changes that would have taken too much time with older tools.

Some analysts distinguish between upper and lower CASE tools. An upper CASE tool allows the analyst to create and modify the system design. All the information about the project is stored in an encyclopedia called the CASE repository, a large collection of records, elements, diagrams, screens, reports, and other information (see Figure 1.6). Analysis reports may be produced using the repository information to show where the design is incomplete or contains errors. Upper CASE tools can also help support the modeling of an organization's functional requirements, assist analysts and users in drawing the boundaries for a given project, and help them visualize how the project meshes with other parts of the organization.

Lower CASE tools are used to generate computer source code, eliminating the need for programming the system. Code generation has several advantages: (1) the system can be produced more quickly than by writing computer programs; (2) the amount of time spent on maintenance decreases with code generation; (3) code can be generated in more than one computer language, so it is easier to migrate systems from one platform to another; (4) code generation provides a cost-effective way of tailoring systems purchased from third-party vendors to the needs of the organization; and (5) generated code is free of computer program errors.

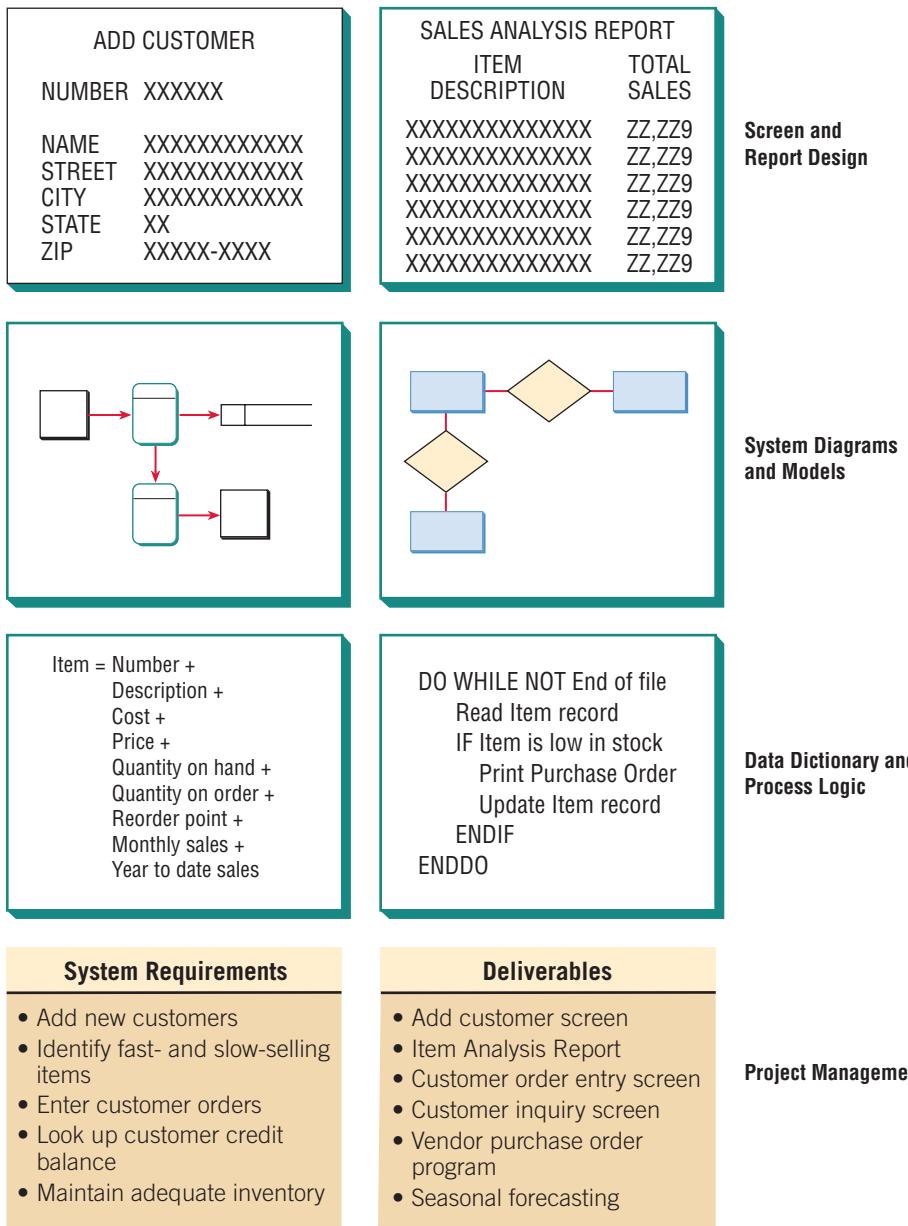
## THE AGILE APPROACH

Although this text tends to focus on SDLC, the most widely used approach in practice, at times the analyst will recognize that the organization could benefit from an alternative approach. Perhaps a systems project using a structured approach has recently failed, or perhaps the organizational subcultures, composed of several different user groups, seem more in step with an alternative method. We cannot do justice to these methods in a small space; each deserves and has inspired its own books and research. By mentioning these approaches here, however, we hope to help you become aware that under certain circumstances, your organization may want to consider an alternative or supplement to structured analysis and design and to the SDLC.

The agile approach is a software development approach based on values, principles, and core practices. The four values are communication, simplicity, feedback, and courage. We recommend that systems analysts adopt these values in all projects they undertake, not just when adopting the agile approach.

In order to finish a project, adjustments often need to be made in project management. In Chapter 6 we will see that agile methods can ensure successful completion of a project by adjusting the important resources of time, cost, quality, and scope. When these four control variables are properly included in the planning, there is a state of balance between the resources and the activities needed to complete the project.

Taking development practices to the extreme is most noticeable when one pursues practices that are unique to agile development. In Chapter 6 we discuss four core agile practices: short releases, the 40-hour workweek, hosting an onsite customer, and using pair programming. At first glance these practices appear extreme, but as you will see, we can learn some important lessons from incorporating many of the values and practices of the agile approach into systems analysis and design projects.

**FIGURE 1.6**

The repository concept.

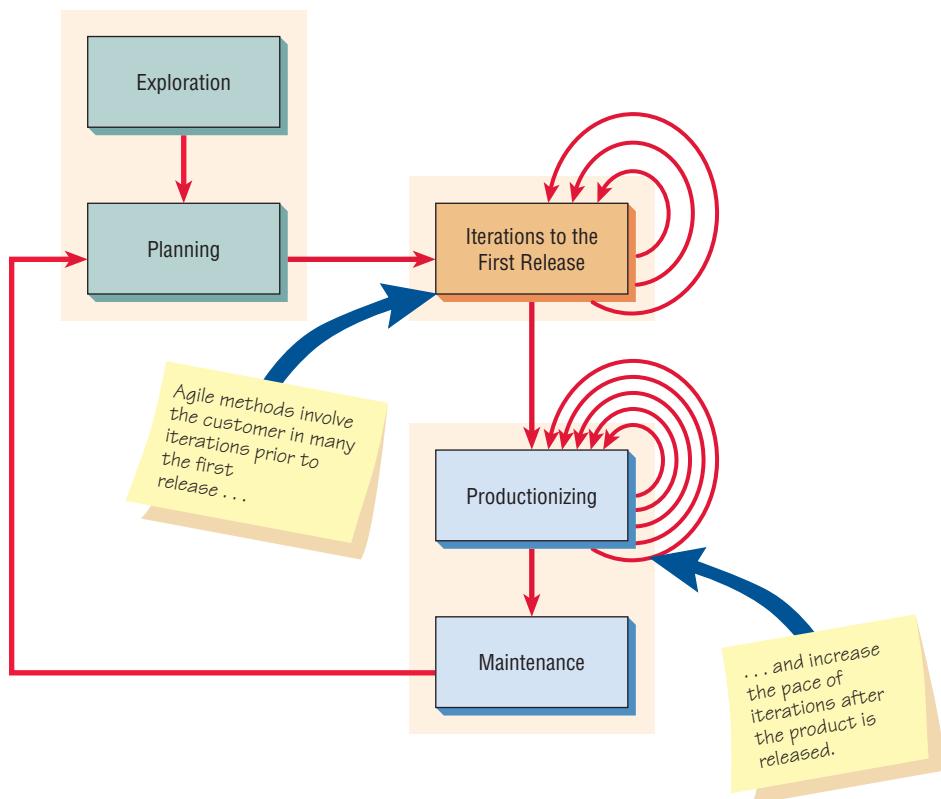
## Developmental Process for an Agile Project

There are activities and behaviors that shape the way development team members and customers act during the development of an agile project. Two words that characterize a project done with an agile approach are interactive and incremental. By examining Figure 1.7 we can see that there are five distinct stages: exploration, planning, iterations to the first release, productionizing, and maintenance. Notice that the three red arrows that loop back into the “Iterations” box symbolize incremental changes created through repeated testing and feedback that eventually lead to a stable but evolving system. Also note that there are multiple looping arrows that feed back into the productionizing phase. These symbolize that the pace of iterations is increased after a product is released. The red arrow is shown leaving the maintenance stage and returning to the planning stage, so that there is a continuous feedback loop involving customers and the development team as they agree to alter the evolving system.

**EXPLORATION.** During exploration, you will explore your environment, asserting your conviction that the problem can and should be approached with agile development, assemble the team, and assess team member skills. This stage will take anywhere from a few weeks (if you already know

**FIGURE 1.7**

The five stages of the agile modeling development process show that frequent iterations are essential to successful system development.



your team members and technology) to a few months (if everything is new). You also will be actively examining potential technologies needed to build the new system. During this stage you should practice estimating the time needed for a variety of tasks. In exploration, customers also are experimenting with writing user stories. The point is to get the customer to refine a story enough so that you can competently estimate the amount of time it will take to build the solution into the system you are planning. This stage is all about adopting a playful and curious attitude toward the work environment, its problems, technologies, and people.

**PLANNING.** The next stage of the agile development process is called planning. In contrast to the first stage, planning may only take a few days to accomplish. In this stage you and your customers agree on a date anywhere from two months to half a year from the current date to deliver solutions to their most pressing business problems (you will be addressing the smallest, most valuable set of stories). If your exploration activities were sufficient, this stage should be very short.

The entire agile planning process has been characterized using the idea of a *planning game* as devised by Beck. The planning game spells out rules that can help formulate the agile development team's relationship with their business customers. Although the rules form an idea of how you want each party to act during development, they are not meant as a replacement for a relationship. They are a basis for building and maintaining a relationship.

So, we use the metaphor of a game. To that end we talk in terms of the goal of the game, the strategy to pursue, the pieces to move, and the players involved. The goal of the game is to maximize the value of the system produced by the agile team. In order to figure the value, you have to deduct costs of development, and the time, expense, and uncertainty taken on so that the development project could go forward.

The strategy pursued by the agile development team is always one of limiting uncertainty (downplaying risk). To do that they design the simplest solution possible, put the system into production as soon as possible, get feedback from the business customer about what's working, and adapt their design from there.

Story cards become the pieces in the planning game that briefly describe the task, provide notes, and provide an area for task tracking.

There are two main players in the planning game: the development team and the business customer. Deciding which business group in particular will be the business customer is not always

easy, because the agile process is an unusually demanding role for the customer to play. Customers decide what the development team should tackle first. Their decisions will set priorities and check functionalities throughout the process.

**ITERATIONS TO THE FIRST RELEASE.** The third stage in the agile development process is composed of iterations to the first release. Typically these are iterations (cycles of testing, feedback, and change) of about three weeks in duration. You will be pushing yourself to sketch out the entire architecture of the system, even though it is just in outline or skeletal form. One goal is to run customer-written functional tests at the end of each iteration. During the iterations stage you should also question whether the schedule needs to be altered or whether you are tackling too many stories. Make small rituals out of each successful iteration, involving customers as well as developers. Always celebrate your progress, even if it is small, because this is part of the culture of motivating everyone to work extremely hard on the project.

**PRODUCTIONIZING.** Several activities occur during this phase. In this phase the feedback cycle speeds up so that rather than receiving feedback for an iteration every three weeks, software revisions are being turned around in one week. You may institute daily briefings so everyone knows what everyone else is doing. The product is released in this phase, but may be improved by adding other features. Getting a system into production is an exciting event. Make time to celebrate with your teammates and mark the occasion. One of the watchwords of the agile approach, with which we heartily agree, is that it is supposed to be fun to develop systems!

**MAINTENANCE.** Once the system has been released, it needs to be kept running smoothly. New features may be added, riskier customer suggestions may be considered, and team members may be rotated on or off the team. The attitude you take at this point in the developmental process is more conservative than at any other time. You are now in a “keeper of the flame” mode rather than the playful one you experienced during exploration.

## OBJECT-ORIENTED SYSTEMS ANALYSIS AND DESIGN

Object-oriented (O-O) analysis and design is an approach that is intended to facilitate the development of systems that must change rapidly in response to dynamic business environments. Chapter 10 helps you understand what object-oriented systems analysis and design is, how it differs from the structured approach of the SDLC, and when it may be appropriate to use an object-oriented approach.

Object-oriented techniques are thought to work well in situations in which complicated information systems are undergoing continuous maintenance, adaptation, and redesign. Object-oriented approaches use the industry standard for modeling object-oriented systems, called the unified modeling language (UML), to break down a system into a use case model.

Object-oriented programming differs from traditional procedural programming by examining objects that are part of a system. Each object is a computer representation of some actual thing or event. Objects may be customers, items, orders, and so on. Objects are represented by and grouped into classes that are optimal for reuse and maintainability. A class defines the set of shared attributes and behaviors found in each object in the class.

The phases in UML are similar to those in the SDLC. Since those two methods share rigid and exacting modeling, they happen in a slower, more deliberate pace than the phases of agile modeling. The analyst goes through problem and identification phases, an analysis phase, and a design phase as shown in Figure 1.8. Although much of the specifics are discussed in Chapters 2 and 10, the following steps give a brief description of the UML process.

### 1. Define the use case model.

In this phase the analyst identifies the actors and the major events initiated by the actors.

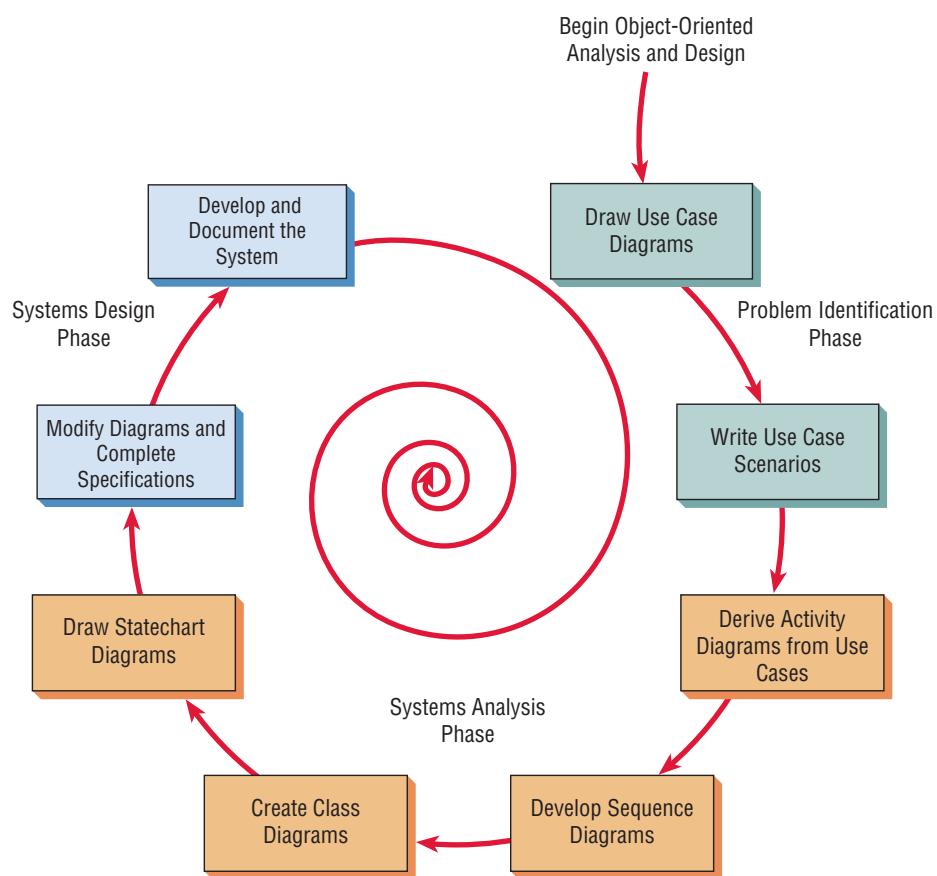
Often the analyst will start by drawing a diagram with stick figures representing the actors and arrows showing how the actors relate. This is called a use case diagram (Chapter 2) and it represents the standard flow of events in the system. Then an analyst typically writes up a use case scenario (Chapter 2), which describes in words the steps that are normally performed.

### 2. During the systems analysis phase, begin drawing UML diagrams.

In the second phase (Chapter 10), the analyst will draw Activity Diagrams, which illustrate all the major activities in the use case. In addition, the analyst will create one or

**FIGURE 1.8**

The steps in the UML development process.



more sequence diagrams for each use case, which show the sequence of activities and their timing. This is an opportunity to go back and review the use cases, rethink them, and modify them if necessary.

**3. Continuing in the analysis phase, develop class diagrams.**

The nouns in the use cases are objects that can potentially be grouped into classes. For example, every automobile is an object that shares characteristics with other automobiles. Together they make up a class.

**4. Still in the analysis phase, draw statechart diagrams.**

The class diagrams are used to draw statechart diagrams, which help in understanding complex processes that cannot be fully derived by the sequence diagrams. The statechart diagrams are extremely useful in modifying class diagrams, so the iterative process of UML modeling continues.

**5. Begin systems design by modifying the UML diagrams. Then complete the specifications.**

Systems design means modifying the existing system and that implies modifying the diagrams drawn in the previous phase. These diagrams can be used to derive classes, their attributes, and methods (methods are simply operations). The analyst will need to write class specifications for each class including the attributes, methods, and their descriptions. They will also develop methods specifications that detail the input and output requirements for the method, along with a detailed description of the internal processing of the method.

**6. Develop and document the system.**

UML is, of course, a modeling language. An analyst may create wonderful models, but if the system isn't developed there is not much point in building models. Documentation is critical. The more complete the information you provide the development team through documentation and UML diagrams, the faster the development and the more solid the final production system.

Object-oriented methodologies often focus on small, quick iterations of development, sometimes called the spiral model. Analysis is performed on a small part of the system, usually starting

Choose	When
<b>The Systems Development Life Cycle (SDLC) Approach</b>	<ul style="list-style-type: none"> <li>systems have been developed and documented using SDLC</li> <li>it is important to document each step of the way</li> <li>upper-level management feels more comfortable or safe using SDLC</li> <li>there are adequate resources and time to complete the full SDLC</li> <li>communication of how new systems work is important</li> </ul>
<b>Agile Methodologies</b>	<ul style="list-style-type: none"> <li>there is a project champion of agile methods in the organization</li> <li>applications need to be developed quickly in response to a dynamic environment</li> <li>a rescue takes place (the system failed and there is no time to figure out what went wrong)</li> <li>the customer is satisfied with incremental improvements</li> <li>executives and analysts agree with the principles of agile methodologies</li> </ul>
<b>Object-Oriented Methodologies</b>	<ul style="list-style-type: none"> <li>the problems modeled lend themselves to classes</li> <li>an organization supports the UML learning</li> <li>systems can be added gradually, one subsystem at a time</li> <li>reuse of previously written software is a possibility</li> <li>it is acceptable to tackle the difficult problems first</li> </ul>

**FIGURE 1.9**

How to decide which development method to use.

with a high-priority item or perhaps one that has the greatest risk. This is followed by design and implementation. The cycle is repeated with analysis of the next part, design, and some implementation, and it is repeated until the project is completed. Reworking diagrams and the components themselves is normal. UML is a powerful modeling tool that can greatly improve the quality of your systems analysis and design and the final product.

## CHOOSING WHICH SYSTEMS DEVELOPMENT METHOD TO USE

The differences among the three approaches described earlier are not as big as they seem at the outset. In all three approaches, the analyst needs to understand the organization first (Chapter 2). Then the analyst or project team needs to budget their time and resources and develop a project proposal (Chapter 3). Next they need to interview organizational members and gather detailed data by using questionnaires (Chapter 4) and sample data from existing reports and observe how business is currently transacted (Chapter 5). The three approaches have all of these activities in common.

Even the methods themselves have similarities. The SDLC and object-oriented approaches both require extensive planning and diagramming. The agile approach and the object-oriented approach both allow subsystems to be built one at a time until the entire system is complete. The agile and SDLC approaches are both concerned about the way data logically moves through the system.

So given a choice to develop a system using an SDLC approach, an agile approach, or an object-oriented approach, which would you choose? Figure 1.9 provides a set of guidelines to help you choose which method to use when developing your next system.

## SUMMARY

Information can be viewed as an organizational resource just as humans are. As such, it must be managed carefully, just as other resources are. The availability of affordable computer power to organizations has meant an explosion of information, and consequently, more attention must be paid to coping with the information generated.

Systems analysts recommend, design, and maintain many types of systems for users, including transaction processing systems (TPS), office automation systems (OAS), knowledge work systems (KWS), and management information systems (MIS). They also create decision-oriented systems for specific users. These



## HYPERCASE® EXPERIENCE 1

**W**elcome to Maple Ridge Engineering, what we call MRE. We hope you'll enjoy serving as a systems consultant for us. Although I've worked here five years in different capacities, I've just been reassigned to serve as an administrative aide to Snowden Evans, the head of the new Training and Management Systems Department. We're certainly a diverse group. As you make your way through the company, be sure to use all your skills, both technical and people oriented, to understand who we are and to identify the problems and conflicts that you think should be solved regarding our information systems."

"To bring you up to date, let me say that Maple Ridge Engineering is a medium-sized medical engineering company. Last year, our revenues exceeded \$287 million. We employ about 335 people. There are about 150 administrative employees as well as management and clerical staff like myself; approximately 75 professional employees, including engineers, physicians, and systems analysts; and about 110 trade employees, such as drafters and technicians."

"There are four offices. You will visit us through HyperCase in our home office in Maple Ridge, Tennessee. We have three other branches in the southern United States as well: Atlanta, Georgia;

Charlotte, North Carolina; and New Orleans, Louisiana. We'd love to have you visit when you're in the area."

"For now, you should explore HyperCase using either Firefox, Safari, or Microsoft Internet Explorer."

"To learn more about Maple Ridge Engineering as a company or to find out how to interview our employees, who will use the systems you design, and how to observe their offices in our company, you may want to start by going to the Web site found at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Then click on the link labeled **HyperCase**. At the HyperCase display screen, click on **Start** and you will be in the reception room for Maple Ridge Engineering. From this point, you can start consulting right away."

This Web site contains useful information about the project as well as files that can be downloaded to your computer. There is a set of Visible Analyst data files, and another set of Visio data files that match HyperCase. They contain a partially constructed series of data flow diagrams, entity-relationship diagrams, UML diagrams, and repository information. The HyperCase Web site also contains additional exercises that may be assigned. HyperCase is designed to be explored, and you should not overlook any object or clue on a Web page.

include decision support systems (DSS), expert systems (ES), group decision support systems (GDSS), computer-supported collaborative work systems (CSCWS), and executive support systems (ESS). Many applications are either originating on, or moving to, the Web to support ecommerce and many other business functions.

Systems analysis and design is a systematic approach to identifying problems, opportunities, and objectives; to analyzing human and computer-generated information flows in organizations; and to designing computerized information systems to solve a problem. Systems analysts are required to take on many roles in the course of their work. Some of these roles are (1) an outside consultant to business, (2) a supporting expert within a business, and (3) an agent of change in both internal and external situations.

Analysts possess a wide range of skills. First and foremost, the analyst is a problem solver, someone who enjoys the challenge of analyzing a problem and devising a workable solution. Systems analysts require communication skills that allow them to relate meaningfully to many different kinds of people on a daily basis, as well as computer skills. Understanding and relating well to users is critical to their success.

Analysts proceed systematically. The framework for their systematic approach is provided in what is called the systems development life cycle (SDLC). This life cycle can be divided into seven sequential phases, although in reality the phases are interrelated and are often accomplished simultaneously. The seven phases are identifying problems, opportunities, and objectives; determining human information requirements; analyzing system needs; designing the recommended system; developing and documenting software; testing and maintaining the system; and implementing and evaluating the system.

The agile approach is a software development approach based on values, principles, and core practices. Systems that are designed using agile methods can be developed rapidly. Stages in the agile development process are exploration, planning, iterations to the first release, productionizing, and maintenance.

A third approach to systems development is called object-oriented analysis design. These techniques are based on object-oriented programming concepts that have become codified in UML, a standardized modeling language in which objects that are created include not only code about data but also instructions about the operations to be performed on the data. Key diagrams help analyze, design, and communicate UML-developed systems. These systems are usually developed as components and reworking the components many times is a normal activity in object-oriented analysis and design.

## KEYWORDS AND PHRASES

agent of change  
agile approach  
agile methods  
Ajax  
artificial intelligence (AI)  
bespoke software  
Computer-Assisted Software Engineering (CASE)  
CASE tools  
computer-supported collaborative work systems (CSCWS)  
decision support systems (DSS)  
ecommerce applications  
enterprise resource planning (ERP) systems  
executive support systems (ESS)  
expert systems  
exploration phase  
group decision support systems (GDSS)  
human-computer interaction (HCI)  
iterations to the first release phase  
knowledge work systems (KWS)  
maintenance phase  
management information systems (MIS)  
mcommerce (mobile commerce)  
migrate systems  
object-oriented (O-O) systems analysis and design  
office automation systems (OAS)  
open source software (OSS)  
planning game  
planning phase  
productionizing phase  
prototyping  
rapid application development (RAD)  
service-oriented architecture (SOA)  
systems analysis and design  
systems analyst  
systems consultant  
systems development life cycle (SDLC)  
transaction processing systems (TPS)  
unified modeling language (UML)

## REVIEW QUESTIONS

1. Compare treating information as a resource to treating humans as a resource.
2. List the differences between OAS and KWS.
3. Define what is meant by MIS.
4. How does MIS differ from DSS?
5. Define the term *expert systems*. How do expert systems differ from decision support systems?
6. List the problems of group interaction that group decision support systems (GDSS) and computer-supported collaborative work systems (CSCWS) were designed to address.
7. Which is the more general term, CSCWS or GDSS? Explain.
8. Define the term *mcommerce*.
9. List the advantages of mounting applications on the Web.
10. What is the overarching reason for designing enterprise (or ERP) systems?
11. Provide an example of an open source software project.
12. List the advantages of using systems analysis and design techniques in approaching computerized information systems for business.
13. List three roles that the systems analyst is called upon to play. Provide a definition for each one.
14. What personal qualities are helpful to the systems analyst? List them.
15. List and briefly define the seven phases of the systems development life cycle (SDLC).
16. What are CASE tools used for?
17. What is the difference between upper and lower CASE tools?
18. Define what is meant by the agile approach.
19. What is the meaning of the phrase “the planning game”?
20. What are the stages in agile development?
21. Define the term *object-oriented analysis and design*.
22. What is UML?

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## EPISODE 1

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# The Case Opens

On a warm, sunny day in late October, Chip Puller parks his car and walks into his office at Central Pacific University. It felt good to be starting as a systems analyst, and he was looking forward to meeting the other staff.

In the office, Anna Liszt introduces herself. “We’ve been assigned to work as a team on a new project. Why don’t I fill you in with the details, and then we can take a tour of the facilities?”

“That sounds good to me,” Chip replies. “How long have you been working here?”

“About five years,” answers Anna. “I started as a programmer analyst, but the last few years have been dedicated to analysis and design. I’m hoping we’ll find some ways to increase our productivity,” Anna continues.

“Tell me about the new project,” Chip says.

“Well,” Anna replies, “like so many organizations, we have a large number of microcomputers with different software packages installed on them. From what I understand, in the 1980s there were few personal computers and a scattered collection of software. This expanded rapidly in the 1990s, and now everyone uses computers. Some faculty members use more than one computer. The current system that is used to maintain software and hardware, which was originally quite useful, is now very outdated and quite overwhelmed.”

“What about the users? Who should I know? Who do you think will be important in helping us with the new system?” Chip asks.

“You’ll meet everyone, but there are key people I’ve recently met, and I’ll tell you what I’ve learned so you’ll remember them when you meet them.

“Dot Matrix is manager of all microcomputer systems at Central Pacific. We seem to be able to work together well. She’s very competent. She’d really like to be able to improve communication among users and analysts.”

“It will be a pleasure to meet her,” Chip speculates.

“Then there’s Mike Crowe, computer maintenance expert. He really seems to be the nicest guy, but way too busy. We need to help lighten his load. The software counterpart to Mike is Cher Ware. She’s a free spirit, but don’t get me wrong, she knows her job,” Anna says.

“She could be fun to work with,” Chip muses.

“Could be,” Anna agrees. “You’ll meet the financial analyst, Paige Prynter, too. I haven’t figured her out yet.”

“Maybe I can help,” Chip says.

“Last, you should—I mean, you will—meet Hy Perteks, who does a great job running the Information Center. He’d like to see us be able to integrate our life cycle activities.”

“It sounds promising,” Chip says. “I think I’m going to like it here.”

### EXERCISES

- E-1. From the introductory conversation Chip and Anna shared, which elements mentioned might suggest the use of CASE tools?

# Understanding and Modeling Organizational Systems

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand that organizations and their members are systems and that analysts need to take a systems perspective.
2. Depict systems graphically using context-level data flow diagrams, entity-relationship models, and use cases and use case scenarios.
3. Recognize that different levels of management require different systems.
4. Comprehend that organizational culture impacts the design of information systems.



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To analyze and design appropriate information systems, systems analysts need to comprehend the organizations they work in as systems shaped through the interactions of three main forces: the levels of management, design of organizations, and organizational cultures.

Organizations are large systems composed of interrelated subsystems. The subsystems are influenced by three broad levels of management decision makers (operations, middle management, and strategic management) that cut horizontally across the organizational system. Organizational cultures and subcultures all influence the way people in subsystems interrelate. These topics and their implications for information systems development are considered in this chapter.



## ORGANIZATIONS AS SYSTEMS

Organizations and their members are usefully conceptualized as systems designed to accomplish predetermined goals and objectives through people and other resources that they employ. Organizations are composed of smaller, interrelated systems (departments, units, divisions, etc.) serving specialized functions. Typical functions include accounting, marketing, production, data processing, and management. Specialized functions (smaller systems) are eventually reintegrated through various ways to form an effective organizational whole.

The significance of conceptualizing organizations as complex systems is that systems principles allow insight into how organizations work. To ascertain information requirements properly and to design appropriate information systems, it is of primary importance to understand the organization as a whole. All systems are composed of subsystems (which include information systems); therefore, when studying an organization, we also examine how smaller systems are involved and how they function.

## Interrelatedness and Interdependence of Systems

All systems and subsystems are interrelated and interdependent. This fact has important implications both for organizations and for those systems analysts who seek to help them better achieve their goals. When any element of a system is changed or eliminated, the rest of the system's elements and subsystems are also significantly affected.

For example, suppose that the managers of an organization decide not to hire administrative assistants any longer and to replace their functions with networked PCs. This decision has the potential to significantly affect not only the administrative assistants and the managers but also all the organizational members who built up communications networks with the now departed assistants.

All systems process inputs from their environments. By definition, processes change or transform inputs into outputs. Whenever you examine a system, check to see what is being changed or processed. If nothing is changed, you may not be identifying a process. Typical processes in systems include verifying, updating, and printing.

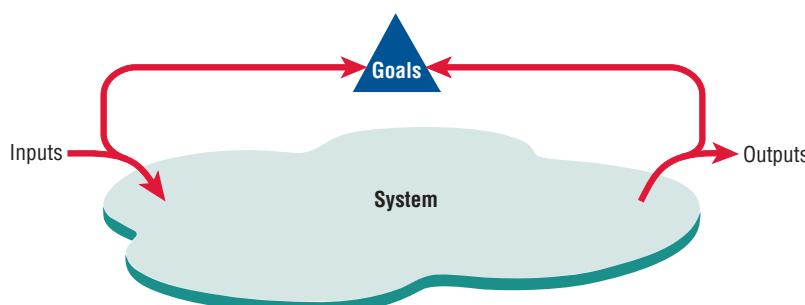
Another aspect of organizations as systems is that all systems are contained by boundaries separating them from their environments. Organizational boundaries exist on a continuum ranging from extremely permeable to almost impermeable. To continue to adapt and survive, organizations must be able first to import people, raw materials, and information through their boundaries (inputs), and then to exchange their finished products, services, or information with the outside world (outputs).

Feedback is one form of system control. As systems, all organizations use planning and control to manage their resources effectively. Figure 2.1 shows how system outputs are used as feedback that compares performance with goals. This comparison in turn helps managers formulate more specific goals as inputs. An example is a U.S. manufacturing company that produces red-white-and-blue weight-training sets as well as gun-metal gray sets. The company finds that one year after the Olympics, very few red-white-and-blue sets are purchased. Production managers use that information as feedback to make decisions about what quantities of each color to produce. Feedback in this instance is useful for planning and control.

The ideal system, however, is one that self-corrects or self-regulates in such a way that decisions on typical occurrences are not required. An example is a supply chain system for production planning that takes into account current and projected demand and formulates a proposed solution as output. An Italian knitwear manufacturer that markets its clothing in the United States has just such a system. This company produces most of its sweaters in white, uses its computerized inventory information system to find out what colors are selling best, and then dyes sweaters in hot-selling colors immediately before shipping them.

Feedback is received from within the organization and from the outside environments around it. Anything external to an organization's boundaries is considered to be an environment. Numerous environments, with varying degrees of stability, constitute the milieu in which organizations exist.

Among these environments are (1) the environment of the community in which the organization is physically located, which is shaped by the size of its population and its demographic profile, including factors such as education and average income; (2) the economic environment, influenced by market factors, including competition; (3) the political environment, controlled through state and local governments; and (4) the legal environment, issuing federal, state, regional, and local laws and guidelines. Although changes in environmental status can be planned for, they often cannot be directly controlled by the organization.



**FIGURE 2.1**

System outputs serve as feedback that compares performance with goals.



## CONSULTING OPPORTUNITY 2.1

### The E in Vitamin E Stands for Ecommerce

**O**ur retail shops and mail-order division are quite healthy,” says Bill Berry, one of the owners of Marathon Vitamin Shops, “but to be competitive, we must establish an ecommerce Web site.” His father, a co-owner, exclaims, “I agree, but where do we start?” The elder Berry knew, of course, that it wasn’t a case of setting up a Web site and asking customers to email their orders to the retail store. He identified eight different parts to ecommerce and realized that they were all part of a larger system. In other words, all the parts had to work together to create a strong package. His list of elements essential to ecommerce included the following:

1. Attracting customers to an ecommerce Web site.
2. Informing customers about products and services offered.
3. Allowing customers to customize products online.
4. Completing transactions with customers.
5. Accepting payment from customers in a variety of forms.
6. Supporting customers after the sale via the Web site.
7. Arranging for the delivery of goods and services.

8. Personalizing the look and feel of the Web site for different customers.

Bill Berry read the list and contemplated it for a while. “It is obvious that ecommerce is more complex than I thought,” he says. You can help the owners of Marathon Vitamin Shops in the following ways:

1. Make a list of the elements that are interrelated or interdependent. Then write a paragraph stating why it is critical to monitor these elements closely.
2. Decide on the boundaries and ultimate scope of the system. That is, write a paragraph expressing an opinion on which elements are critical for Marathon Vitamin Shops and which elements can be explored at a later date.
3. Suggest which elements should be handled in-house and which should be outsourced to another company that may be better able to handle the job. Justify your suggestions in two paragraphs, one for the in-house jobs and one for the outsourced tasks.

Related and similar to the concept of external boundary permeability is the concept of internal openness or closedness of organizations. Openness and closedness also exist on a continuum, because there is no such thing as an absolutely open or completely closed organization.

Openness refers to the free flow of information within the organization. Subsystems such as creative or art departments often are characterized as open, with a free flow of ideas among participants and very few restrictions on who gets what information at what time when a creative project is in its infancy.

At the opposite end of the continuum might be a defense department unit assigned to work on top-secret defense planning affecting national security. Each person needs to receive clearance, timely information is a necessity, and access to information is only on a “need to know” basis. This sort of unit is constrained by numerous rules.

Using a systems overlay to understand organizations allows us to acknowledge the idea of systems composed of subsystems; their interrelatedness and their interdependence; the existence of boundaries that allow or prevent interaction between various departments and elements of other subsystems and environments; and the existence of internal environments characterized by degrees of openness and closedness, which might differ across departments, units, or even systems projects.

### Virtual Organizations and Virtual Teams

Not all organizations or parts of organizations are visible in a physical location. Entire organizations or units of organizations can now possess virtual components that permit them to change configurations to adapt to changing project or marketplace demands. Virtual enterprises use networks of computers and communications technology to bring people with specific skills together electronically to work on projects that are not physically located in the same place. Information technology enables coordination of these remote team members. Often virtual teams spring up in already-established organizations; in some instances, however, organizations of remote workers have been able to succeed without the traditional investment in a physical facility.

There are several potential benefits to virtual organizations, such as the possibility of reducing costs of physical facilities, more rapid response to customer needs, and helping virtual employees to fulfill their familial obligations to growing children or aging parents. Just how important it will be to meet the social needs of virtual workers is still open to research and debate. One example of a need for tangible identification with a culture arose when students who were enrolled in an online virtual university, with no physical campus (or sports teams), kept requesting items such as sweatshirts, coffee mugs, and pennants with the virtual university's logo imprinted on them. These items are meaningful cultural artifacts that traditional brick-and-mortar schools have long provided.

Many systems analysis and design teams are now able to work virtually, and in fact, many of them marked the path for other types of employees to follow in accomplishing work virtually. Some applications permit analysts who are providing technical assistance over the Web to "see" the software and hardware configuration of the user requesting help, in this way creating an ad hoc virtual team composed of the analyst and user.

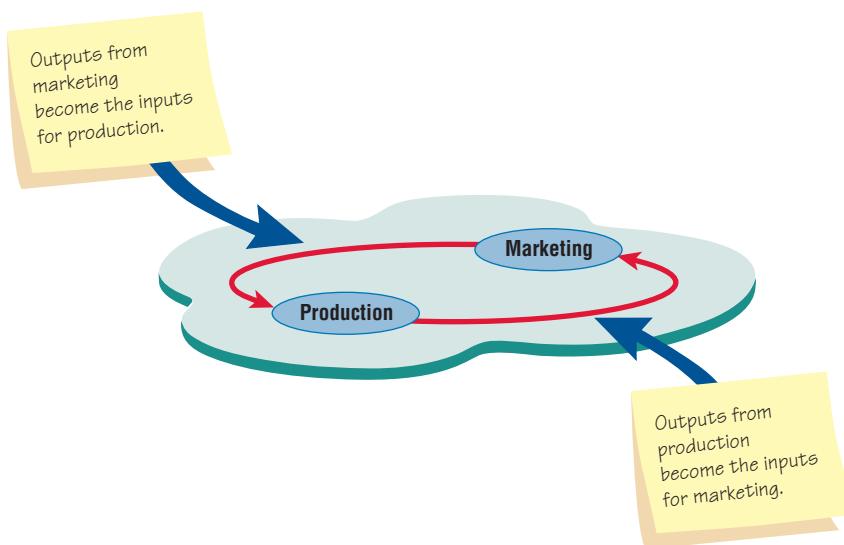
### Taking a Systems Perspective

Taking a systems perspective allows systems analysts to start broadly clarifying and understanding the various businesses with which they will come into contact. It is important that members of subsystems realize that their work is interrelated. Notice in Figure 2.2 that the outputs from the production subsystems serve as inputs for marketing and that the outputs of marketing serve as new inputs for production. Neither subsystem can properly accomplish its goals without the other.

Problems occur when each manager possesses a different picture of the importance of his or her own functional subsystem. In Figure 2.3 you can see that the marketing manager's personal perspective shows the business as driven by marketing, with all other functional areas interrelated but not of central importance. By the same token, the perspective of a production manager positions production at the center of the business, with all other functional areas driven by it.

The relative importance of functional areas as revealed in the personal perspectives of managers takes on added significance when managers rise to the top through the ranks, becoming strategic managers. They can create problems if they overemphasize their prior functional information requirements in relation to the broader needs of the organization.

For example, if a production manager is promoted but continues to stress production scheduling and performance of line workers, the broader aspects of forecasting and policy making may suffer. This tendency is a danger in all sorts of businesses: where engineers work their way up to become administrators of aerospace firms, college professors move from their departments to become deans, or programmers advance to become executives of software firms. Their tunnel vision often creates problems for the systems analyst trying to separate actual information requirements from desires for a particular kind of information.

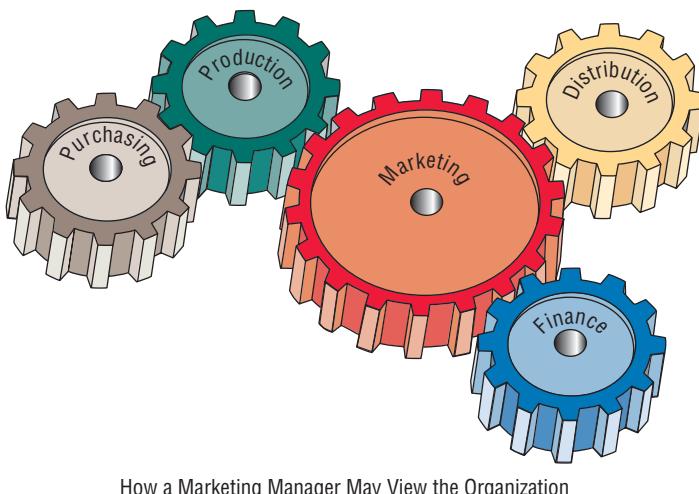


**FIGURE 2.2**

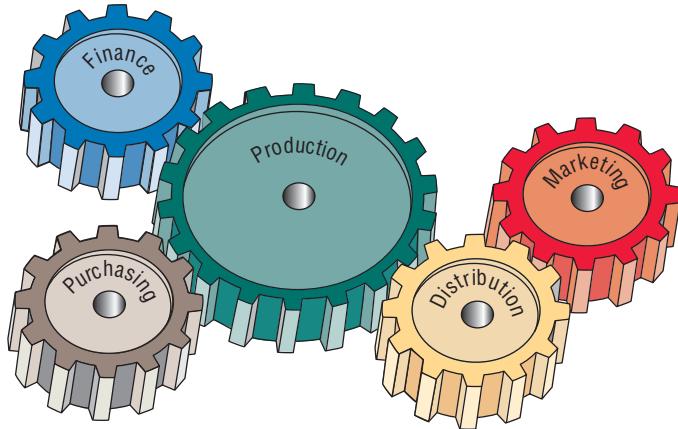
Outputs from one department serve as inputs for another such that subsystems are interrelated.

**FIGURE 2.3**

A depiction of the personal perspective of functional managers shows that they feature their own functional area as central to the organization.



How a Marketing Manager May View the Organization



How a Production Manager May See the Organization

### Enterprise Systems: Viewing the Organization as a System

Enterprise systems, often referred to as enterprise resource planning (ERP) systems, is a term used to describe an integrated organizational (enterprise) information system. Specifically, ERP is software that helps the flow of information between the functional areas in the organization. It is a customized system that, rather than being developed in-house, is usually purchased from one of the software development companies well-known for its ERP packages, such as SAP or Oracle. The product is then customized to fit the requirements of a particular company. Typically, the vendor requires an organizational commitment in terms of specialized user or analyst training. Many ERP packages are designed to run on the Web. ERP, although growing in popularity, is also being viewed with some skepticism.

ERP evolved from materials requirements planning (MRP), the information systems designed to improve manufacturing in general and assembly in particular. ERP systems now include manufacturing components and thus help with capacity planning, material production scheduling, and forecasting. Beyond manufacturing (and its service counterpart), ERP includes sales and operations planning, distribution, procurement, and managing the supply chain. It therefore significantly affects all the areas in the organization, including accounting, finance, management, marketing, and information systems.

Implementing an ERP solution may be frustrating because it is difficult to analyze a system currently in use and then fit the ERP model to that system. Furthermore, companies tend to design their business processes before ERP is implemented. Unfortunately, this process is often rushed and the proposed business model does not always match the ERP functionality. The result is further customizations, extended implementation time frames, higher costs, and often the loss

of user confidence. Analysts need to be aware of the magnitude of the problem they are tackling when trying to implement ERP packages.

## DEPICTING SYSTEMS GRAPHICALLY

A system or subsystem as it exists within the corporate organization may be graphically depicted in several ways. The various graphical models show the boundaries of the system and the information used in the system.

### Systems and the Context-Level Data Flow Diagram

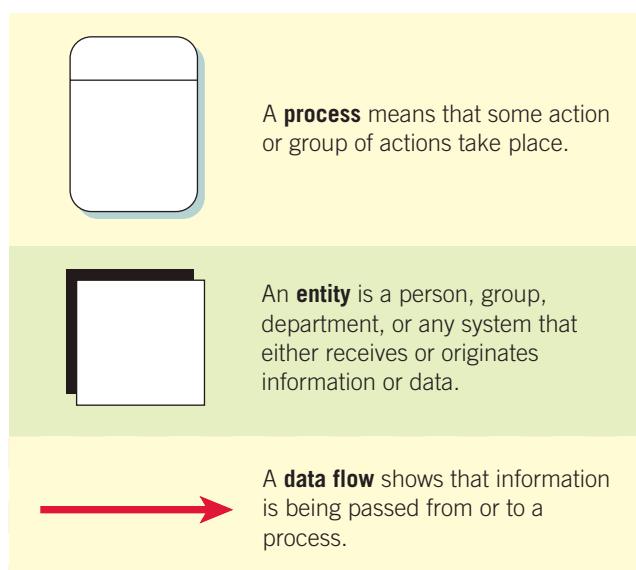
The first model is the context-level data flow diagram (also called an environmental model). Data flow diagrams focus on the data flowing into and out of the system and the processing of the data. These basic components of every computer program can be described in detail and used to analyze the system for accuracy and completeness.

As shown in Figure 2.4, the context-level data flow diagram employs only three symbols: (1) a rectangle with rounded corners, (2) a square with two shaded edges, and (3) an arrow. Processes transform incoming data into outgoing information, and the content level has only one process, representing the entire system. The external entity represents any entity that supplies or receives information from the system but is not a part of the system. This entity may be a person, a group of people, a corporate position or department, or other systems. The lines that connect the external entities to the process are called data flows, and they represent data.

An example of a context-level data flow diagram is found in Figure 2.5. In this example, the most basic elements of an airline reservation system are represented. The passenger (an entity) initiates a travel request (data flow). The context-level diagram doesn't show enough detail to indicate exactly what happens (it isn't supposed to), but we can see that the passenger's preferences and the available flights are sent to the travel agent, who sends ticketing information back to the process. We can also see that the passenger reservation is sent to the airline. The context-level data flow diagram serves as a good starting point for drawing the use case diagram (discussed later in this chapter).

In Chapter 7 we see that a data flow contains much information. For example, the passenger reservation contains the passenger's name, airline, flight number(s), date(s) of travel, price, seating preference, and so on. For now, however, we are concerned mainly with how a context level defines the boundaries of the system. In the preceding example, only reservations are part of the process. Other decisions that the airline would make (for example, purchasing airplanes, changing schedules, pricing) are not part of this system.

The context-level data flow diagram is one way to show the scope of the system, or what is to be included in the system. The external entities are outside of the scope and something over which the system has no control.

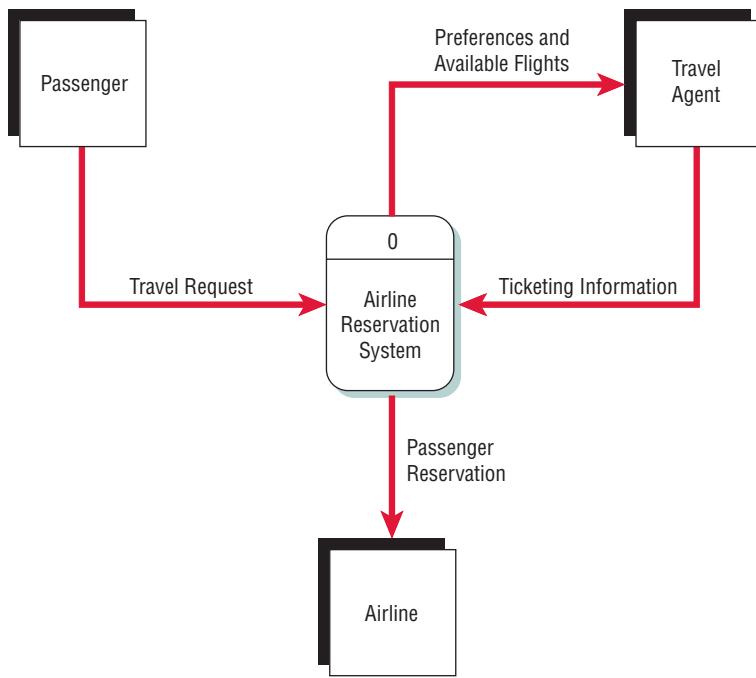


**FIGURE 2.4**

The basic symbols of a data flow diagram.

**FIGURE 2.5**

A context-level data flow diagram for an airline reservation system.



### Systems and the Entity-Relationship Model

Another way a systems analyst can show the scope of the system and define proper system boundaries is to use an entity-relationship model. The elements that make up an organizational system can be referred to as entities. An entity may be a person, a place, or a thing, such as a passenger on an airline, a destination, or a plane. Alternatively, an entity may be an event, such as the end of the month, a sales period, or a machine breakdown. A relationship is the association that describes the interaction among the entities.

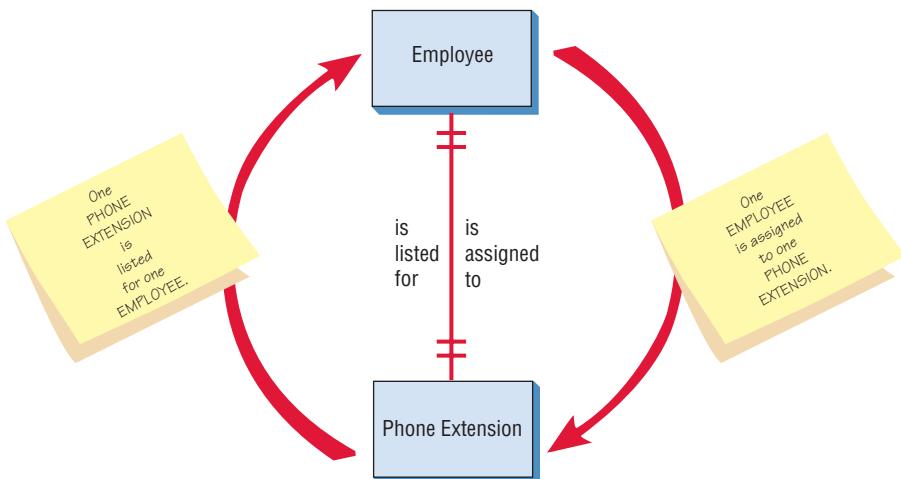
There are many different conventions for drawing entity-relationship (E-R) diagrams (with names like crow's foot, Arrow, or Bachman notation). In this book, we use crow's foot notation. For now, we assume that an entity is a plain rectangular box.

Figure 2.6 shows a simple entity-relationship diagram. Two entities are linked together by a line. In this example, the end of the line is marked with two short parallel marks (||), signifying that this relationship is one-to-one. Thus, exactly one employee is assigned to one phone extension. No one shares the same phone extension in this office.

The red arrows are not part of the entity-relationship diagram. They are present to demonstrate how to read the entity-relationship diagram. The phrase on the right side of the line is read from top to bottom as follows: “One EMPLOYEE is assigned to one PHONE EXTENSION.” On

**FIGURE 2.6**

An entity-relationship diagram showing a one-to-one relationship.



the left side, as you read from bottom to top, the arrow says, “One PHONE EXTENSION is listed for one EMPLOYEE.”

Similarly, Figure 2.7 shows another relationship. The crow’s foot notation ( $\Rightarrow+$ ) is obvious on this diagram, and this particular example is a many-to-one example. As you read from left to right, the arrow signifies, “Many EMPLOYEES are members of a DEPARTMENT.” As you read from right to left, it implies, “One DEPARTMENT contains many EMPLOYEES.”

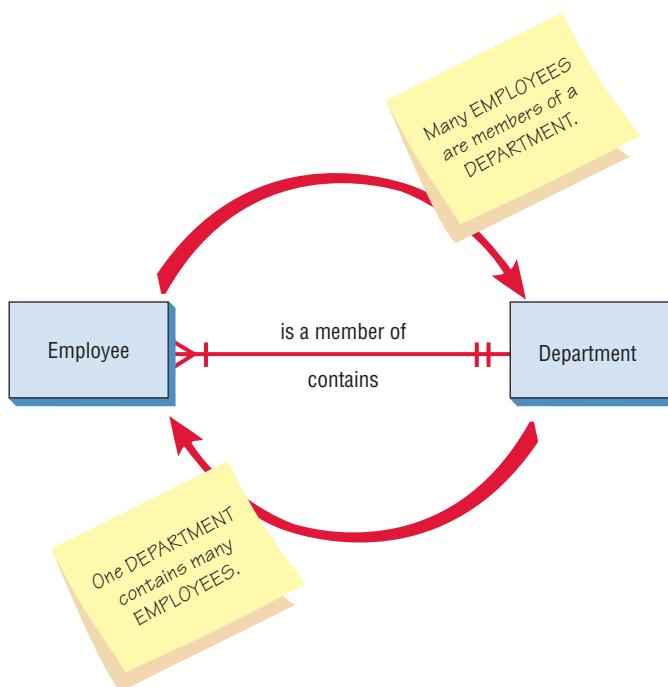
Notice that when a many-to-one relationship is present, the grammar changes from “is” to “are” even though the singular “is” is written on the line. The crow’s foot and the single mark do not literally mean that this end of the relationship must be a mandatory “many.” Instead, they imply that this end could be anything from one to many.

Figure 2.8 elaborates on this scheme. Here we have listed a number of typical entity relationships. The first, “An EMPLOYEE is assigned to an OFFICE,” is a one-to-one relationship. The second one is a one-to-many relationship: “One CARGO AIRCRAFT will serve one or more DISTRIBUTION CENTERS.” The third one is slightly different because it has a circle at one end. It can be read as “A SYSTEMS ANALYST may be assigned to MANY PROJECTS,” meaning that the analyst can be assigned to no projects [that is what the circle (O), for zero, is for], one, or many projects. Likewise, the circle (O) indicates that none is possible in the next relationship. Recall that the short mark means one. Therefore, we can read it as follows: “A MACHINE may or may not be undergoing SCHEDULED MAINTENANCE.” Notice that the line is written as “is undergoing,” but the end marks on the line indicate that either no maintenance (O) or maintenance (I) is actually going on.

The next relationship states, “One or many SALESPEOPLE (plural of SALESPERSON) are assigned to one or more CUSTOMERS.” It is the classic many-to-many relationship. The next relationship can be read as follows: “The HOME OFFICE can have one or many EMPLOYEES,” or “One or more EMPLOYEES may or may not be assigned to the HOME OFFICE.” Once again, the I and O together imply a Boolean situation; in other words, one or zero.

The final relationship shown here can be read as, “Many PASSENGERS are flying to many DESTINATIONS.” This symbol [ $\Rightarrow+$ ] is preferred by some to indicate a mandatory “many” condition. (Would it ever be possible to have only one passenger or only one destination?) Even so, some CASE tools such as Visible Analyst do not offer this possibility, because the optional one-or-many condition as shown in the SALESPERSON-CUSTOMER relationship will do.

Up to now we have modeled all our relationships using just one simple rectangle and a line. This method works well when we are examining the relationships of real things such as real people, places, and things. Sometimes, though, we create new items in the process of developing an information system. Some examples are invoices, receipts, files, and databases. When we want

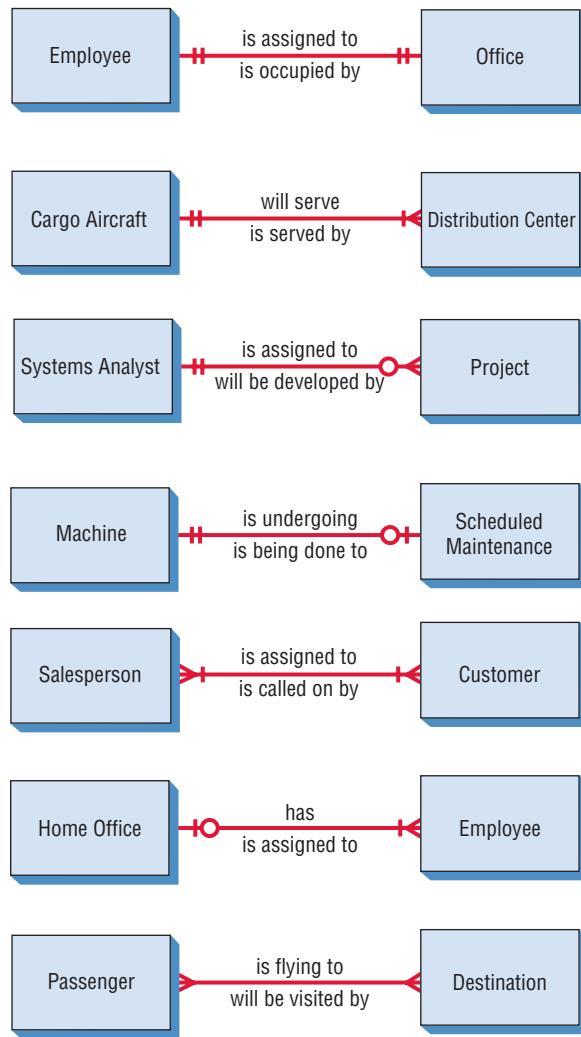


**FIGURE 2.7**

An entity-relationship diagram showing a many-to-one relationship.

**FIGURE 2.8**

Examples of different types of relationships in E-R diagrams.



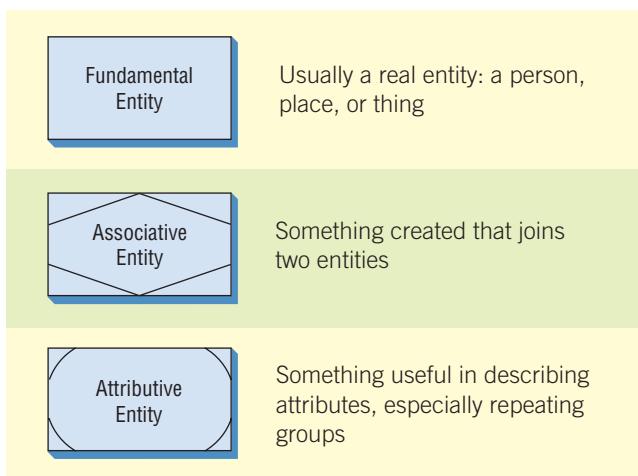
to describe how a person relates to a receipt, for example, it becomes convenient to indicate the receipt in a different way, as shown in Figure 2.9 as an associative entity.

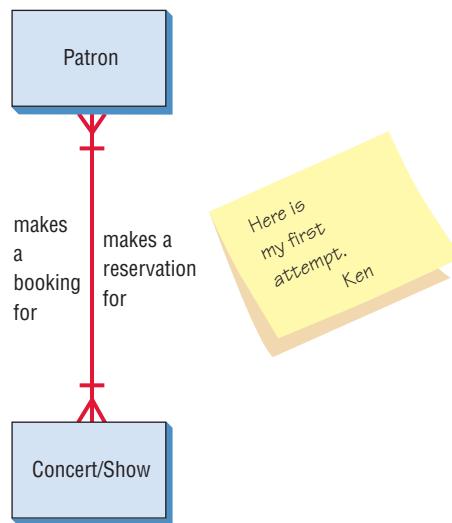
An associative entity can only exist if it is connected to at least two other entities. For that reason, some call it a gerund, a junction, an intersection, or a concatenated entity. This wording makes sense because a receipt wouldn't be necessary unless there were a customer and a salesperson making the transaction.

Another type of entity is the attributive. When an analyst wants to show data that are completely dependent on the existence of a fundamental entity, an attributive entity should be used.

**FIGURE 2.9**

Three different types of entities used in E-R diagrams.

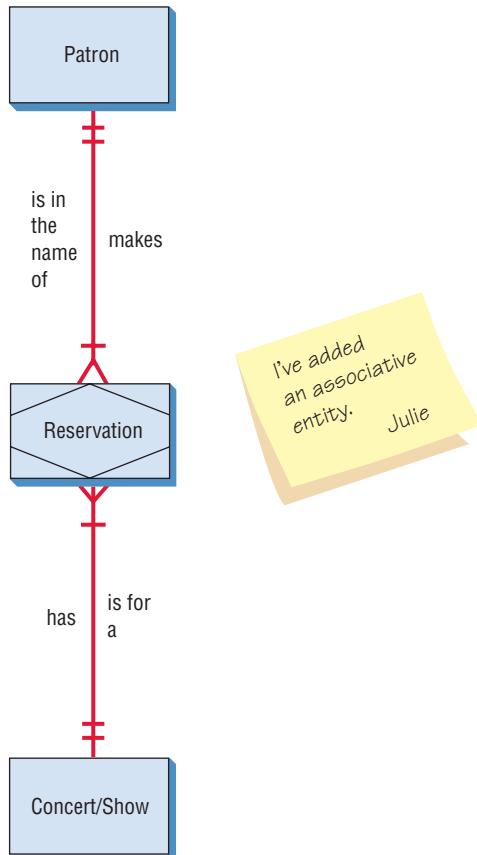


**FIGURE 2.10**

The first attempt at drawing an E-R diagram.

For example, when a library had multiple copies of the same book, an attributive entity could be used to designate which copy of the book is being checked out. The attributive entity is useful for showing repeating groups of data. For example, suppose we are going to model the relationships that exist when a patron gets tickets to a concert or show. The entities seem obvious at first: “a PATRON and a CONCERT/SHOW,” as shown in Figure 2.10. What sort of relationship exists? At first glance the PATRON gets a reservation for a CONCERT/SHOW, and the CONCERT/SHOW can be said to have made a booking for a PATRON.

The process isn’t that simple, of course, and the E-R diagram need not be that simple either. The PATRON actually makes a RESERVATION, as shown in Figure 2.11. The RESERVATION is for a CONCERT/SHOW. The CONCERT/SHOW holds the RESERVATION, and the RESERVATION is in the name of the PATRON. We added an associative entity here because a RESERVATION was created due to the information system required to relate the PATRON and the CONCERT/SHOW.

**FIGURE 2.11**

Improving the E-R diagram by adding an associative entry called RESERVATION.

Again this process is quite simple, but because concerts and shows have many performances, the E-R diagram is drawn once more in Figure 2.12. Here we add an attributive entity to handle the many performances of the CONCERT/SHOW. In this case the RESERVATION is made for a particular PERFORMANCE, and the PERFORMANCE is one of many that belong to a specific CONCERT/SHOW. In turn the CONCERT/SHOW has many performances, and one PERFORMANCE has a RESERVATION that is in the name of a particular PATRON.

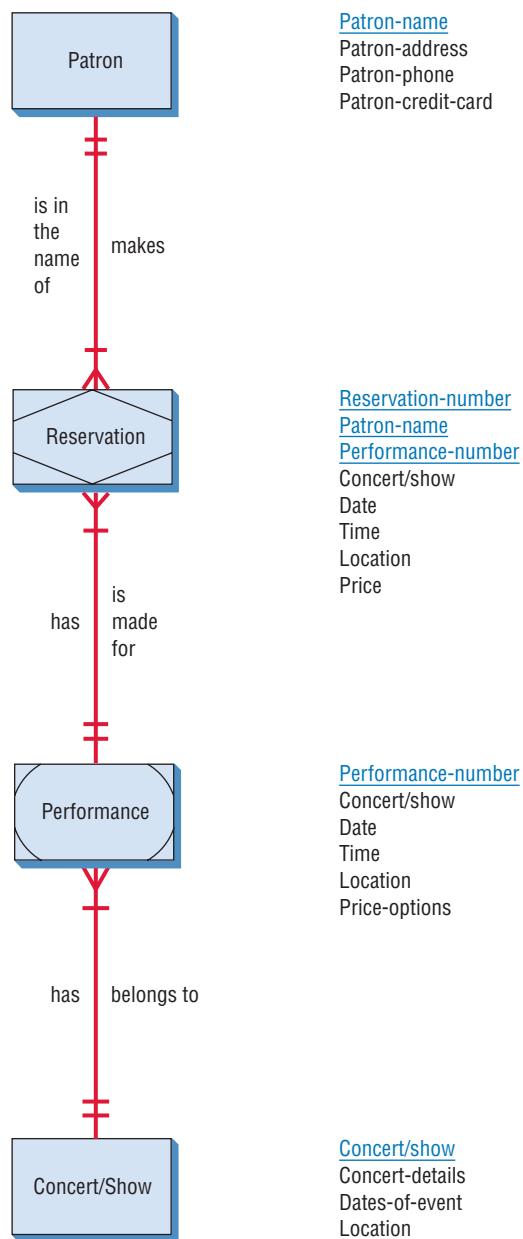
To the right of this E-R diagram is a set of data attributes that make up each of the entities. Some entities may have attributes in common. The attributes that are underlined can be searched for. The attributes are referred to as keys and are discussed in Chapter 13.

E-R diagrams are often used by systems designers to help model the file or database. It is even more important, however, that the systems analyst understand early both the entities and relationships in the organizational system. In sketching out some basic E-R diagrams, the analyst needs to:

1. List the entities in the organization to gain a better understanding of the organization.
2. Choose key entities to narrow the scope of the problem to a manageable and meaningful dimension.

**FIGURE 2.12**

A more complete E-R diagram showing data attributes of the entities.



**MAC APPEAL**

Microsoft Visio makes it easy for a systems analyst to draw E-R diagrams as well as most of the diagrams found in this book, but it is available only for PCs. Mac users have an alternative, OmniGraffle Professional. OmniGraffle is easier to use than Microsoft Visio because its drag-and-drop interface is smoother and more intuitive.

It also features a “smart guide” that uses pop-up distance markers to help position the symbols in the correct places. Many symbols like those used in E-R diagrams are built in, but OmniGraffle also lets the user search a third-party library called Graffletopia to find UML and other specialized symbols.

**FIGURE 2.MAC**

OmniGraffle from The Omni Group is an easy and powerful drawing package.

3. Identify what the primary entity should be.
4. Confirm the results of steps 1 through 3 through other data-gathering methods (investigation, interviewing, administering questionnaires, observation, and prototyping), as discussed in Chapters 4 through 6.

It is critical that the systems analyst begin to draw E-R diagrams upon entering the organization rather than waiting until the database needs to be designed, because E-R diagrams help the analyst understand what business the organization is actually in, determine the size and scope of the problem, and discern whether the right problem is being addressed. The E-R diagrams need to be confirmed or revised as the data-gathering process takes place.

## USE CASE MODELING

Originally introduced as a diagram for use in object-oriented UML, use cases are now being used regardless of the approach to systems development. It can be used as part of the SDLC or in agile modeling. The word *use* is pronounced as a noun (yoos) rather than a verb (yooz). A

use case model describes *what* a system does without describing *how* the system does it; that is, it is a logical model of the system. (Logical or conceptual models will be further discussed in Chapter 7.) The use case model reflects the view of the system from the perspective of a user outside of the system (i.e., the system requirements).

An analyst develops use cases in a cooperative effort with the business experts who help define the requirements of the system. The use case model provides an effective means of communication between the business team and the development team. A use case model partitions the way the system works into behaviors, services, and responses (the use cases) that are significant to the users of the system.

From the perspective of an actor (or user), a use case should produce something that is of value. Therefore, the analyst must determine what is important to the user, and remember to include it in the use case diagram. For example, is entering a password something of value to the user? It may be included if the user has a concern about security or if it is critical to the success of the project.

### Use Case Symbols

A use case diagram contains the actor and use case symbols, along with connecting lines. Actors are similar to external entities; they exist outside of the system. The term *actor* refers to a particular role of a user of the system. For example, an actor may be an employee, but also may be a customer at the company store. Even though it is the same person in the real world, it is represented as two different symbols on a use case diagram, because the person interacts with the system in different roles. The actor exists outside of the system and interacts with the system in a specific way. An actor can be a human, another system, or a device such as a keyboard or Web connection. Actors can initiate an instance of a use case. An actor may interact with one or more use cases, and a use case may involve one or more actors.

Actors may be divided into two groups. Primary actors supply data or receive information from the system. Some users directly interact with the system (system actors), but primary actors may also be businesspeople who do not directly interact with the system but have a stake in it. Primary actors are important because they are the people who use the system and can provide details on what the use case should do. They can also provide a list of goals and priorities. Supporting actors (also called secondary actors) help to keep the system running or provide other services. These are the people who run the help desk, the analysts, programmers, and so on.

Sometimes it is useful to create an actor profile that lists the actors, their background, and their skills in a simple table format. This may be useful to understand how the actor interacts with the system. An example is an Order Processing Specialist. The profile would be, “A routine user of the software, familiar with minor features, order exceptions, and order customization.” It is also useful to list the actors and their goals and priorities. Each goal may become a use case.

A use case provides developers with a view of what the users want. It is free of technical or implementation details. We can think of a use case as a sequence of transactions in a system. The use case model is based on the interactions and relationships of individual use cases.

A use case always describes three things: an actor that initiates an event; the event that triggers a use case; and the use case that performs the actions triggered by the event. In a use case, an actor using the system initiates an event that begins a related series of interactions in the system. Use cases are used to document a single transaction or event. An event is an input to the system that happens at a specific time and place and causes the system to do something.

It is better to create fewer use cases rather than more. Often queries and reports are not included; 20 use cases (and no more than 40 or 50) are sufficient for a large system. Use cases may also be nested, if needed. Some use cases use the verb *manage* to group use cases for adding, deleting, and changing into another, lower-level, use case diagram. You can include a use case on several diagrams, but the actual use case is defined only once in the repository. A use case is named with a verb and a noun.

### Use Case Relationships

Active relationships are referred to as behavioral relationships and are used primarily in use case diagrams. There are four basic types of behavioral relationships: communicates, includes, extends, and generalizes. Notice that all these terms are action verbs. Figure 2.13 shows the arrows

Relationship	Symbol	Meaning
Communicates	—	An actor is connected to a use case using a line with no arrowheads.
Includes	← << include >>	A use case contains a behavior that is common to more than one other use case. The arrow points to the common use case.
Extends	— << extend >> —	A different use case handles exceptions from the basic use case. The arrow points from the extended to the basic use case.
Generalizes	→	One UML “thing” is more general than another “thing.” The arrow points to the general “thing.”

and lines used to diagram each of the four types of behavioral relationships. The four relationships are described next.

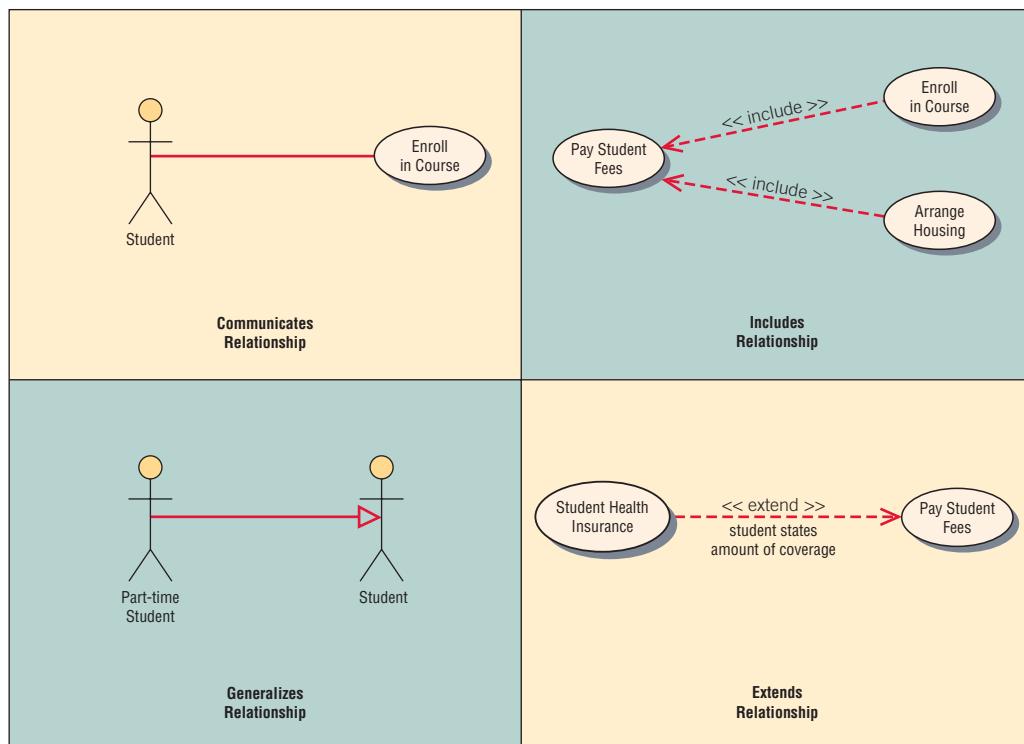
**COMMUNICATES.** The behavioral relationship communicates is used to connect an actor to a use case. Remember that the task of the use case is to give some sort of result that is beneficial to the actor in the system. Therefore, it is important to document these relationships between actors and use cases. In our first example, a **Student** communicates with **Enroll in Course**. Examples of some components of a student enrollment example are shown in the use case diagrams in Figure 2.14.

**INCLUDES.** The includes relationship (also called uses relationship) describes the situation in which a use case contains behavior that is common to more than one use case. In other words, the common use case is included in the other use cases. A dotted arrow that points to the common use case indicates the includes relationship. An example would be a use case **Pay Student Fees** that is included in **Enroll in Course** and **Arrange Housing**, because in both cases students must pay their fees. This may be used by several use cases. The arrow points toward the common use case.

**EXTENDS.** The extends relationship describes the situation in which one use case possesses the behavior that allows the new use case to handle a variation or exception from the basic use case.

**FIGURE 2.13**

Some components of use case diagrams showing actors, use cases, and relationships for a student enrollment example.



**FIGURE 2.14**

Examples of use cases and behavioral relationships for student enrollment.

For example, the extended use case **Student Health Insurance** extends the basic use case **Pay Student Fees**. The arrow goes from the extended to the basic use case.

**GENERALIZES.** The generalizes relationship implies that one thing is more typical than the other thing. This relationship may exist between two actors or two use cases. For example, a **Part-Time Student** generalizes a **Student**. Similarly, some of the university employees are professors. The arrow points to the general thing.

### Developing System Scope

The scope of a system defines its boundaries, what is in scope—or inside the system—and what is out of scope. The project usually has a budget that helps to define scope, and a start and end time. Actors are always outside the scope of the system. The communicates lines that connect actors to the use cases are the boundaries, and define the scope. Since a use case diagram is created early in the systems life cycle, the budget, starting time, and ending time may change as the project progresses; as the analyst learns more about the system, the use case diagrams, use case, and scope may change.

### Developing Use Case Diagrams

The primary use case consists of a standard flow of events in the system that describes a standard system behavior. The primary use case represents the normal, expected, and successful completion of the use case.

When diagramming a use case, start by asking the users to list everything the system should do for them. This can be done using interviews, in a joint application design session (as described in Chapter 4), or through other facilitated team sessions. The analyst may also use agile stories sessions (described in Chapter 6) to develop use cases. Write down who is involved with each use case, and the responsibilities or services the use case must provide to actors or other systems. In the initial phases, this may be a partial list that is expanded in the later analysis phases. Use the following guidelines:

1. Review the business specifications and identify the actors involved.
2. Identify the high-level events and develop the primary use cases that describe those events and how the actors initiate them. Carefully examine the roles played by the actors to identify all the possible primary use cases initiated by each actor. Use cases with little or no user interaction do not have to be shown.
3. Review each primary use case to determine the possible variations of flow through the use case. From this analysis, establish the alternative paths. Because the flow of events is usually different in each case, look for activities that could succeed or fail. Also look for any branches in the use case logic in which different outcomes are possible.

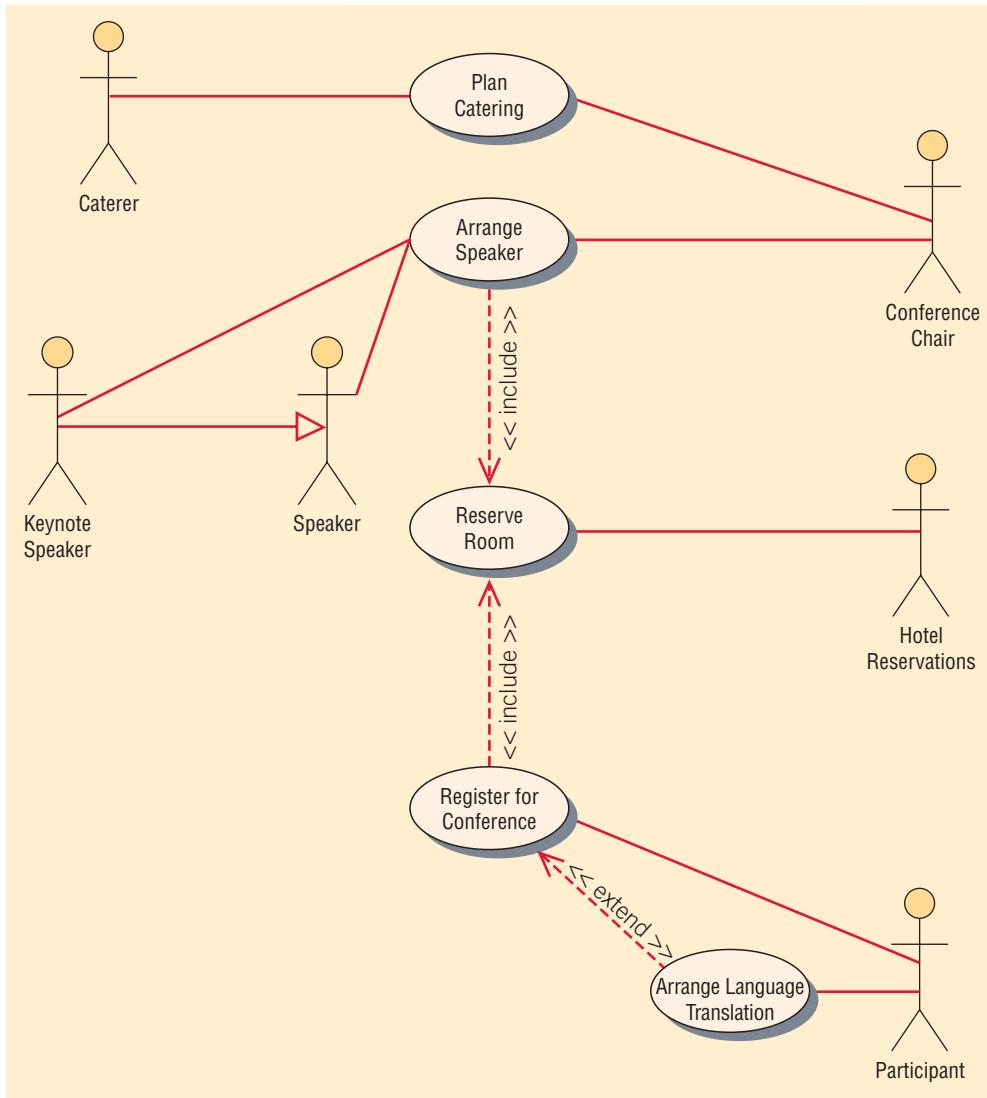
If a context-level data flow diagram has been created, it can be a starting point for creating a use case. The external entities are potential actors. Then examine the data flow to determine if it would initiate a use case or be produced by a use case.

Figure 2.15 is an example of a use case diagram representing a system used to plan a conference. The actors are the **Conference Chair**, responsible for planning and managing the conference, the conference **Participant**, **Speakers**, a **Keynote Speaker**, **Hotel Reservations**, and a **Caterer**. Actors represent the *role* the user plays, and the **Caterer** may be either a hotel employee or an external catering service.

Both the **Conference Chair** and the **Caterer** are involved in planning meals and banquets. The **Conference Chair** is also responsible for arranging speakers. The **Participant** registers for the conference. Notice that the **Reserve Room** use case is involved in an *includes* relationship with the **Arrange Speaker** and **Register for Conference** use cases, since both speakers and participants will need lodging. The **Arrange Language Translation** use case extends the **Register for Conference** use case because not all participants will require language translation services. The **Speaker** actor is a generalization of **Keynote Speaker**.

### Developing Use Case Scenarios

Each use case has a description. We will refer to the description as a use case scenario. As mentioned, the primary use case represents the standard flow of events in the system, and alternative

**FIGURE 2.15**

A use case diagram representing a system used to plan a conference.

paths describe variations to the behavior. Use case scenarios may describe what happens if an item purchased is out of stock, or if a credit card company rejects a customer's requested purchase.

There is no standardized use case scenario format, so each organization is faced with specifying what standards should be included. Often the use cases are documented using a use case document template predetermined by the organization, which makes the use cases easier to read and provides standardized information for each use case in the model.

### Use Case Levels

You may want to create use cases for different levels. One method (defined by Alistair Cockburn) uses the following altitude metaphors:

1. White is the highest level, like clouds. This is the enterprise level, and there may only be four to five for the entire organization. Examples might be to advertise goods, sell goods to customers, manage inventory, manage the supply chain, and optimize shipping.
2. Kite is lower than white but still a high level, providing an overview. The kite use case may be at the business unit or department level and is a summary of goals. Examples would be to register students, or if working with a travel company: make an airline, hotel, car, or cruise reservation.
3. Blue is at sea level, and is usually created for user goals. This often has the greatest interest for users and is easiest for a business to understand. It is usually written for a business activity and each person should be able to do one blue level activity in anywhere from 2 to

20 minutes. Examples are register a continuing student, add a new customer, place an item in a shopping cart, and order checkout.

4. Indigo or fish is a use case that shows lots of detail, often at a functional or subfunctional level. Examples are choose a class, pay academic fees, look up the airport code for a given city, and produce a list of customers after entering a name.
5. Black or clam, like the bottom of the ocean, are the most detailed use cases, at a subfunction level. Examples might be a secure logon validation, adding a new field using dynamic HTML, or using Ajax to update a Web page in a small way.

A use case scenario example is shown in Figure 2.16. Some of the areas included are optional, and may not be used by all organizations. The three main areas are:

1. An area header containing case identifiers and initiators.
2. Steps performed.
3. A footer area containing preconditions, assumptions, questions, and other information.

**FIGURE 2.16**

A use case scenario is divided into three sections: identification and initiation; steps performed; and conditions, assumptions, and questions.

The screenshot shows a use case scenario template with the following details:

<b>Use case name:</b>	Register for Conference	<b>UniqueID:</b> Conf RG 003
<b>Area:</b>	Conference Planning	
<b>Actor(s):</b>	Participant	
<b>Stakeholder:</b>	Conference Sponsor, Conference Speakers	
<b>Level:</b>	Blue	
<b>Description:</b>	Allow conference participant to register online for the conference using a secure Web site.	
<b>Triggering Event:</b>	Participant uses Conference Registration Web site, enters userID and password, and clicks the logon button.	
<b>Trigger type:</b>	<input checked="" type="checkbox"/> External <input type="checkbox"/> Temporal	
<b>Steps Performed (Main Path)</b>		<b>Information for Steps</b>
1. Participant logs in using the secure Web server.		userID, Password
2. Participant record is read and password is verified.		Participant Record, userID, Password
3. Participant and session information is displayed on the Registration Web page.		Participant Record, Session Record
4. Participant enters information on the Registration Web form and clicks <b>Submit</b> button.		Registration Web Form
5. Registration information is validated on the Web server.		Registration Web Form
6. Registration Confirmation page is displayed to confirm registration information.		Confirmation Web Page
7. Credit card is charged for registration fees.		Secure Credit Card Web Page
8. Add Registration Journal record is written.		Confirmation Web Page
9. Registration record is updated on the Registration Master.		Confirmation Web Page, Registration Record
10. Session record is updated for each selected session on the Session Master.		Confirmation Web Page, Session Record
11. Participant record is updated for the participant on the Participant Master.		Confirmation Web Page, Participant Record
12. Successful Registration Confirmation Web page is sent to the participant.		Registration Record Confirmation Number
<b>Preconditions:</b>	Participant has already registered and has created a user account.	
<b>Postconditions:</b>	Participant has successfully registered for the conference.	
<b>Assumptions:</b>	Participant has a browser and a valid userID and password.	
<b>Success Guarantee:</b>	Participant has registered for the conference and is enrolled in all selected sessions.	
<b>Minimum Guarantee:</b>	Participant was able to logon.	
<b>Requirements Met:</b>	Allow conference participants to be able to register for the conference using a secure Web site.	
<b>Outstanding Issues:</b>	How should a rejected credit card be handled?	
<b>Priority:</b>	High	
<b>Risk:</b>	Medium	

The first area, use case identifiers and initiators, orients the reader and contains the use case name and a unique ID; the application area or system that this use case belongs to; the actors involved in the use case; and the stakeholders that have a high level of interest in the use case. Some stakeholders never interact directly with the system, such as the stockholders, the board of directors, or the sales manager. Each primary actor is a stakeholder, but not listed in the stakeholder area. Include the level (blue, kite, and so on) and a brief description of what the use case accomplishes.

The header concludes with the initiating (triggering) event, that is, what caused the use case to start, and the type of trigger, either external or temporal. External events are those started by an actor, either a person or another system requesting information, such as an airline reservation system requesting flight information from an airline system. Temporal events are those that are triggered or started by time. Events occur at a specific time, such as sending an email about special offers once a week on a Sunday evening, sending bills on a specific day, or generating government statistics on a specified date every quarter.

The second area of the use case includes the steps performed, and the information required for each of the steps. These statements represent the standard flow of events and the steps taken for the successful completion of the use case. It is desirable to write up a use case for the main path, and then to write up one for each of the alternative paths separately, rather than using IF . . . THEN . . . statements. Steps are numbered with an integer. The steps may come from a detailed interview with users or may be derived from agile modeling stories (as described in Chapter 6). These steps should be reviewed with the users for clarification.

The analyst should examine each of the steps and determine the information required for each step. If the analyst cannot determine the information, he or she should schedule a follow-up interview with the user. Some use case descriptions include extensions or alternative scenarios, with the exceptions as additional sections following the standard flow of events. These are numbered with an integer, decimal point, and another integer, such as 3.1, 3.2, 3.3, and so on. These are steps that may or may not be used. Analysts and users can brainstorm what can go wrong with the main path, and may uncover important details and conditions. It is necessary to work with the users to determine what to do when these conditions occur. This helps to detect errors earlier in the life cycle.

Figure 2.17 illustrates how logic and alternative scenarios can be included in the middle section of a use case. In this airline example, notice that step 1 is made up of smaller steps, many of which are preceded by an “if.” These are still on the main path, but only occur if the condition is met. For example, if there are many airports that serve a city, then all the airports will be displayed. Extensions or alternate scenarios can also appear here. For this airline, other scenarios include flight selection, seat selection, and meal selection. Use cases may even include iterative or looping steps.

The third area of the use case includes:

- Preconditions, or the condition of the system before the use case may be performed, which may be another use case. An example might be, “The viewer has successfully logged into the system,” or it might be the successful completion of another use case.
- Postconditions, or the state of the system after the use case has finished, including output people have received, transmissions to other systems, and data that have been created or updated. These relate to the goals or user requirements from a problem definition (described in Chapter 3) or to agile stories (described in Chapter 6).
- Assumptions made that would affect the method of the use case and that could stipulate required technology, such as the minimum technology requirements in a browser or even a specific or higher version of a browser. An assumption might be that cookies or JavaScript are enabled. The analyst must determine what to do if the assumptions are not met. When using Google Maps, JavaScript must be enabled. If it is not enabled, the map will not display. Cookies are required by Netflix. Good Web pages will detect that an assumption has not been met and notify the viewer with a message, including information on how to turn on cookies or JavaScript for different browsers.
- Minimal guarantee is the minimum promised to the users. They may not be happy with this result and it may be that nothing happens.
- Success guarantee is what would satisfy the users, and it is usually that the goal of the use case has been met.
- Any outstanding issues or questions must be answered before implementation of the use case.

Steps Performed (Main Path)	Information for Steps
1. Enter departing and arriving airports, dates of travel.	Airport Locations
1.1. If an airport code is entered, display matching name, city, country	
1.2. If a city is entered, find all matching cities	
1.3. Customer selects a city	
1.4. If there is more than one airport for the city, display airports	
1.5. Client selects an airport	
1.6. Insert the airport code (3 characters)	
1.7. Display the matching airport country, city, and airport name	
2. Find all matching flights with available seats	Flight Information
3. Customer selects flight	
4. Customer logs on	Customer Logon
5. Customer selects passenger names	Passenger Records
6. Seating chart is displayed showing all available seats	Plane Number, Seating Chart, Available Seats
7. Customer selects seat(s) for each passenger	
8. Display confirmation and credit card page	
9. Credit card verified	
10. Email confirmation sent	
11. Airline reservation made	
Extensions or Alternative Scenarios	
Flight Selection	
1. A list of flights displays	
2. Customer selects a flight	
3. Request is sent to airline	
4. Flight is already full	
Seat Selection	
1. A list of flights displays	
2. Customer selects a flight	
3. Request is sent to airline	
4. Seat reservations are retrieved	
5. Seating chart is displayed	
6. Customer cannot find an acceptable seat	
Meal Selection for International Flights	
1. Customer selects meal from drop-down list	Available Airline Meal List
2. Record is updated with meal selection	Customer Meal Record

**FIGURE 2.17**

Use cases can include conditional steps as well as extensions or alternative scenarios.

- An optional statement of priority of the use case, which may come from a problem definition or user requirements.
- An optional statement of risk involved in creating the use case.

The “requirements met” area links the use case to user requirements or objectives from a problem definition. Once you develop the use case scenarios, be sure to review your results with the business experts to verify and refine the use cases if needed.

In this particular use case scenario, called **Register for Conference**, the only actor involved is the **Participant**. The overall area is **Conference Planning**, and the use case is triggered by the participant logging on to the **Registration Web page**. The **Steps Performed** area lists the sequence of events that must occur for a successful conference registration. Notice that the information needed to perform each of the steps is listed on the right. This may include Web pages and forms, as well as database tables and records.

The **Preconditions** area in the footer section of the use case scenario lists what must occur before the participant can register for a conference. In this example, the participant must have already signed up as a member of the society and have a valid userID and password. The **Postconditions** area lists what has been accomplished by the use case. The **Assumptions** area lists any basic premises the analyst assumes are fulfilled by the actor beforehand. The **Requirements Met** area shows why this use case is important and necessary for the business area to be successful. **Priority** is an indication of which use cases should be developed first and which may be delayed. **Risk** is a rough assessment of whether there may be problems or difficulties developing the use case. In this case, the risk is medium because the registration use case requires a secure server and is accepting credit card information.

## Creating Use Case Descriptions

Use the following four steps to create use case descriptions:

1. Use agile stories, problem definition objectives, user requirements, or a features list as a starting point.
2. Ask about the tasks that must be done to accomplish the transaction. Ask if the use case reads any data or updates any tables.
3. Find out if there are any iterative or looping actions.
4. The use case ends when the customer goal is complete.

## Why Use Case Diagrams Are Helpful

No matter what method you use to develop your system (traditional SDLC methods, agile methods, or object-oriented methods), you will find that use cases are very valuable. The use case diagrams identify all the actors in the problem domain, and a systems analyst can concentrate on what humans want and need to use the system, extend their capabilities, and enjoy their interaction with technology.

The actions that need to be completed are also clearly shown on the use case diagram. This not only makes it easy for the analyst to identify processes, but it also aids in communication with other analysts on the team and business executives.

The use case scenario is also worthwhile. Since a lot of the information the users impart to the analyst already takes the form of stories, it is easy to capture the stories on a use case scenario form. The use case scenario always documents the triggering event so that an analyst can always trace the steps that led to other use cases. Since the steps performed are noted, it is possible to employ use case scenarios to write logical processes.

Use case diagrams are becoming popular because of their simplicity and lack of technical detail. They are used to show the scope of a system, along with the major features of the system and the actors who work with those major features. The users see the system and they can react to it and provide feedback. They may also help to determine whether to build or buy the software.

The main reasons for writing use cases are shown in Figure 2.18.

## LEVELS OF MANAGEMENT

Management in organizations exists on three broad, horizontal levels: operational control, managerial planning and control (middle management), and strategic management, as shown in

- Use cases effectively communicate systems requirements because the diagrams are kept simple.
- Use cases allow people to tell stories.
- Use case stories make sense to nontechnical people.
- Use cases do not depend on a special language.
- Use cases can describe most functional requirements (such as interactions between actors and applications).
- Use cases can describe nonfunctional requirements (such as performance and maintainability) through the use of stereotypes.
- Use cases help analysts define boundaries.
- Use cases can be traceable, allowing analysts to identify links between use cases and other design and documentation tools.

**FIGURE 2.18**

The main reasons for writing use cases are their effectiveness in communicating with users and their capturing of user stories.



## CONSULTING OPPORTUNITY 2.2

### Where There's Carbon, There's a Copy

**I** don't know what we do with the pink ones yet," Richard Russell admitted. "They're part of a quadruplicate form that rips apart. All I know is that we keep them for the filing clerk, and he files them when he has time."

Richard is a newly hired junior account executive for Carbon, Carbon & Rippy, a brokerage house. You are walking through the steps he takes in making a stock purchase "official" because his boss has asked you to streamline the process whereby stock purchase information is stored in the computer system and retrieved.

After you leave, Richard continues thinking about the pink forms. He tells his clerk, Harry Schultz, "In my two months here, I haven't seen anyone use those. They take up my time and yours, not to mention all the filing space. Let's pitch them."

Richard and Harry proceed to open all the old files kept by Richard's predecessor and throw out the filed pink forms, along with those accumulated but not yet filed. It takes hours, but they make a lot of room. "Definitely worth the time," Richard reassures Harry.

Three weeks later, an assistant to Richard's boss, Carol Vaness, appears. Richard is happy to see a familiar face, greeting her with, "Hi, Carol. What's new?"

"Same old thing," Carol sighs. "Well, I guess it isn't old to you, because you're the newcomer. But I need all those pesky pink forms."

Almost in shock, Richard exchanges looks with Harry, then mumbles, "You're kidding, of course."

Carol looks more serious than Richard ever thought possible, replying, "No joke. I summarize all the pink forms from all the brokers, and then my totals are compared with computerized stock purchase information. It's part of our routine, three-month audit for transaction accuracy. My work depends on yours. Didn't Ms. McCue explain that to you when you started?"

What systems concept did Richard and Harry ignore when tossing out the pink forms? What are the possible ramifications for systems analysts if general systems concepts are ignored?

Figure 2.19. Each level carries its own responsibilities, and all work toward achieving organizational goals and objectives in their own ways.

Operational control forms the bottom tier of three-tiered management. Operations managers make decisions using predetermined rules that have predictable outcomes when implemented correctly.

They make decisions that affect implementation in work scheduling, inventory control, shipping, receiving, and control of processes such as production. Operations managers oversee the operating details of the organization.

Middle management forms the second, or intermediate, tier of the three-tiered management system. Middle managers make short-term planning and control decisions about how resources may best be allocated to meet organizational objectives.

Their decisions range all the way from forecasting future resource requirements to solving employee problems that threaten productivity. The decision-making domain of middle managers can usefully be characterized as partly operational and partly strategic, with constant fluctuations.

#### FIGURE 2.19

Management in organizations exists on three horizontal levels: operational control, managerial planning and control, and strategic management.



Strategic management is the third level of three-tiered management control. Strategic managers look outward from the organization to the future, making decisions that will guide middle and operations managers in the months and years ahead.

Strategic managers work in a highly uncertain decision-making environment. Through statements of goals and the determination of strategies and policies to achieve them, strategic managers actually define the organization as a whole. Theirs is the broad picture, wherein the company decides to develop new product lines, divest itself of unprofitable ventures, acquire other compatible companies, or even allow itself to be acquired or merged.

There are sharp contrasts among the decision makers on many dimensions. For instance, strategic managers have multiple decision objectives, whereas operations managers have single ones. It is often difficult for high-level managers to identify problems, but it is easy for operations managers to do so. Strategic managers are faced with semistructured problems, whereas lower-level managers deal mostly with structured problems.

The alternative solutions to a problem facing the strategic managers are often difficult to articulate, but the alternatives that operations managers work with are usually easy to enumerate. Strategic managers most often make one-time decisions, whereas the decisions made by operations managers tend to be repetitive.

### Implications for Information Systems Development

Each of the three management levels holds differing implications for developing information systems. Some of the information requirements for managers are clear-cut, whereas others are fuzzy and overlapping.

Operations managers need internal information that is of a repetitive, low-level nature. They are highly dependent on information that captures current performance, and they are large users of online, real-time information resources. The need of operations managers for past performance information and periodic information is only moderate. They have little use for external information that allows future projections.

On the next management level, middle managers are in need of both short- and longer-term information. Due to the troubleshooting nature of their jobs, middle managers experience extremely high needs for information in real time. To control properly, they also need current information on performance as measured against set standards. Middle managers are highly dependent on internal information. In contrast to operations managers, they have a high need for historical information, along with information that allows for the prediction of future events and simulation of numerous possible scenarios.

Strategic managers differ somewhat from both middle and operations managers in their information requirements. They are highly dependent on information from external sources that supply news of market trends and the strategies of competing corporations. Because the task of strategic managing demands projections into the uncertain future, strategic managers have a high need for information of a predictive nature and information that allows creation of many different what-if scenarios. Strategic managers also exhibit strong needs for periodically reported information as they seek to adapt to fast-moving changes.

## ORGANIZATIONAL CULTURE

Organizational culture is an established area of research that has grown remarkably in the last generation. Just as it is appropriate to think of organizations as including many technologies, it is similarly appropriate to see them as hosts to multiple, often competing subcultures.

There is still little agreement on what precisely constitutes an organizational subculture. It is agreed, however, that competing subcultures may be in conflict, attempting to gain adherents to their vision of what the organization should be. Research is in progress to determine the effects of virtual organizations and virtual teams on the creation of subcultures when members do not share a physical workspace but share tasks.

Rather than thinking about culture as a whole, it is more useful to think about the researchable determinants of subcultures, such as shared verbal and nonverbal symbolism. Verbal symbolism includes shared language used to construct, convey, and preserve subcultural myths, metaphors, visions, and humor. Nonverbal symbolism includes shared artifacts, rites, and ceremonies; clothing



## CONSULTING OPPORTUNITY 2.3

### Pyramid Power

**“W**e really look up to you,” says Paul LeGon. As a systems analyst, you have been invited to help Pyramid, Inc., a small, independent book-publishing firm that specializes in paperback books outside of the publishing mainstream.

Paul continues, “We deal with what some folks think are fringe topics. You know, pyramid power, end-of-the-world prophecies, and healthier living by thinking of the color pink. Sometimes when people see our books, they just shake their heads and say, ‘Tut—uncommon topic.’ But we’re not slaves to any particular philosophy, and we’ve been very successful. So much so that because I’m 24, people call me the ‘boy king.’” Paul pauses to decipher your reaction.

Paul continues, “I’m at the top as president, and functional areas such as editorial, accounting, production, and marketing are under me.”

Paul’s assistant, Ceil Toom, who has been listening quietly up to now, barges in with her comments: “The last systems experts that did a project for us recommended the creation of liaison committees

of employees between accounting, production, and marketing, so that we could share newly computerized inventory and sales figures across the organization. They claimed that committees such as that would cut down on needless duplication of output, and each functional area would be better integrated with all the rest.”

Paul picks up the story, saying, “It was fair—oh, for a while—and the employees shared information, but the reason you’re here is that the employees said they didn’t have time for committee meetings and were uncomfortable sharing information with people from other departments who were further up the ladder than they were here at Pyramid.”

According to Paul and Ceil, what were the effects of installing a management information system at Pyramid, Inc., that required people to share information in ways that were not consistent with their structure? Propose some general ways to resolve this problem so that Pyramid employees can still obtain the sales and inventory figures they need.

of decision makers and workers; the use, placement, and decoration of offices; and rituals for celebrating members’ birthdays, promotions, and retirements.

Subcultures coexist within “official” organizational cultures. The officially sanctioned culture may prescribe a dress code, suitable ways to address superiors and coworkers, and proper ways to deal with the outside public. Subcultures may be powerful determinants of information requirements, availability, and use.

Organizational members may belong to one or more subcultures in the organization. Subcultures may exert a powerful influence on member behavior, including sanctions for or against the use of information systems.

Understanding and recognizing predominant organizational subcultures may help the systems analyst overcome the resistance to change that arises when a new information system is installed. For example, the analyst might devise user training to address specific concerns of organizational subcultures. Identifying subcultures may also help in the design of decision support systems that are tailored for interaction with specific user groups.

## SUMMARY

There are three broad organizational fundamentals to consider when analyzing and designing information systems: the concept of organizations as systems, the various levels of management, and the overall organizational culture.

Organizations are complex systems composed of interrelated and interdependent subsystems. In addition, systems and subsystems are characterized by their internal environments on a continuum from open to closed. An open system allows free passage of resources (people, information, materials) through its boundaries; closed systems do not permit free flow of input or output. Organizations and teams can also be organized virtually with remote members connected electronically who are not in the same physical workspace. Enterprise resource planning systems are integrated organizational (enterprise) information systems developed with customized, proprietary software that help the flow of information between the functional areas in the organization. They support a systems view of the organization.



## HYPERCASE® EXPERIENCE 2

**Y**ou seem to have already made a good start at MRE. I'm glad you met Snowden Evans. As you know, you'll be reporting directly to him during your consulting project. As his administrative assistant for the last five years I can tell you a lot about the company, but remember that there are a number of ways to find out more. You will want to interview users, observe their decision-making settings, and look at archival reports, charts, and diagrams. To do so, you can click on the phone directory to get an appointment with an interviewee, click on the building map to view the layout of the building, or click on the corporate Web site to see the functional areas and formal hierarchical relationships at MRE.

"Many of the rules of corporate life apply in the MRE HyperCase. You can walk freely in many public areas. If you want to tour a private office, however, you must first book an appointment with one of our employees. Some secure areas are strictly off limits to you as an outsider since you could pose a security risk.

"I don't think you'll find us excessively secretive, however, because you may assume that any employee who grants you an interview will also grant you access to the archival material in his or her files as well as to current work on their desktops or screens.

"Unfortunately, some people in the company never seem to make themselves available to consultants. I suggest you be persistent. There are lots of ways to find out about the people and the systems of MRE. Creativity pays off. You'll notice that the systems consultants who follow their hunches, sharpen their technical skills, and never stop thinking about piecing together the puzzles at MRE are the ones who get the best results.

"Remember to use multiple methods—interviewing, observation, and investigation—to understand what we at MRE are trying to tell you. Sometimes actions, documents, and offices actually speak louder than words!"

There are many ways to graphically depict the system. The analyst should choose among these tools early on to get an overview of the system. These approaches include drawing context-level data flow diagrams, capturing relationships early on with entity-relationship diagrams; or drawing use case diagrams or writing use case scenarios based on user stories. Using these diagrams and techniques at the beginning of analysis can help the analyst define the boundaries and scope of the system, and can help bring into focus which people and systems are external to the system being developed.

Entity-relationship diagrams help the systems analyst understand the entities and relationships that comprise the organizational system. E-R diagrams can depict a one-to-one relationship, a one-to-many relationship, a many-to-one relationship, and a many-to-many relationship.

The three levels of managerial control are operational, middle management, and strategic. The time horizon of decision making is different for each level.



**FIGURE 2.HC1**

Click on key words in the HyperCase and find out more detail.

Organizational cultures and subcultures are important determinants of how people use information and information systems. By grounding information systems in the context of the organization as a larger system, it is possible to realize that numerous factors are important and should be taken into account when ascertaining information requirements and designing and implementing information systems.

### HYPERCASE Questions

1. What major organizational change recently took place at MRE? What department(s) was (or were) involved? Why was the change made?
2. What are the goals of the Training and Management Systems Department?
3. Would you categorize MRE as a service industry, a manufacturer, or both? What kind of "products" does MRE "produce"? Suggest how the type of industry MRE is in affects the information systems it uses.
4. What type of organizational structure does MRE have? What are the implications of this structure for MIS?
5. Describe in a paragraph the "politics" of the Training and Management Systems Department at MRE. Who is involved, and what are some of the main issues?
6. Draw a use case diagram representing the activities of the Webster Design group at MRE when developing site and facility master plans (use the MRE Web site to obtain your basic information).

## KEYWORDS AND PHRASES

actor	middle management
associative entity	openness
attributive entity	operations management
closedness	organizational boundaries
context-level data flow diagram	organizational culture
crow's foot notation	scope of the system
enterprise resource planning (ERP)	strategic management
enterprise systems	systems
entity (fundamental entity)	use case
entity-relationship (E-R) diagrams	use case diagram
environment	use case scenario
feedback	virtual enterprise
four levels of use cases	virtual organization
interdependent	virtual team
interrelatedness	

## REVIEW QUESTIONS

1. What are the three groups of organizational fundamentals that carry implications for the development of information systems?
2. What is meant by saying that organizational subsystems are interrelated and interdependent?
3. Define the term *organizational boundary*.
4. What are the two main purposes for feedback in organizations?
5. Define openness in an organizational environment.
6. Define closedness in an organizational environment.
7. What is the difference between a traditional organization and a virtual one?
8. What are the potential benefits and a drawback of a virtual organization?
9. Give an example of how systems analysts could work with users as a virtual team.
10. What are enterprise systems?
11. What is ERP, and what is its purpose?
12. What problems do analysts often encounter when they try to implement an ERP package?
13. What are the two symbols on a use case diagram, and what do they represent?
14. What is a use case scenario?
15. What are the three main parts of a use case scenario?
16. What are the four steps in creating use case descriptions?
17. What are the five altitude metaphors for describing use case on different levels? What do they represent?
18. What does a process represent on a context-level data flow diagram?
19. What is an entity on a data flow diagram?
20. What is meant by the term *entity-relationship diagram*?
21. What symbols are used to draw E-R diagrams?
22. List the types of E-R diagrams.
23. How do an entity, an associative entity, and an attributive entity differ?
24. List the three broad, horizontal levels of management in organizations.
25. How can understanding organizational subcultures help in the design of information systems?

## PROBLEMS

1. “It’s hard to focus on what we want to achieve. I look at what our real competitors, the convenience stores, are doing and think we should copy that. Then a hundred customers come in, and I listen to each of them, and they say we should keep our little store the same, with friendly clerks and old-fashioned cash registers. Then, when I pick up a copy of *SuperMarket News*, they say that the wave of the future is super grocery stores, with no individual prices marked and UPC scanners replacing clerks. I’m pulled in so many directions I can’t really settle on a strategy for our grocery store,” admits Geoff Walsham, owner and manager of Jiffy Geoff’s Grocery Store.

In a paragraph, apply the concept of permeable organizational boundaries to analyze Geoff’s problem in focusing on organizational objectives.

2. Write seven sentences explaining the right-to-left relationships in Figure 2.8.

3. Draw an entity-relationship diagram of a patient–doctor relationship.
  - a. Which of the types of E-R diagrams is it?
  - b. In a sentence or two, explain why the patient–doctor relationship is diagrammed in this way.
4. You began drawing E-R diagrams soon after your entry into the health maintenance organization for which you’re designing a system. Your team member is skeptical about using E-R diagrams before the design of the database is begun. In a paragraph, persuade your team member that early use of E-R diagrams is worthwhile.
5. Neil is a decision maker for Pepe’s Atlantic Sausage Company. Because there are several suppliers of ingredients and their prices fluctuate, he has come up with several different formulations for the various sausages that he makes, depending on the availability of particular ingredients from particular suppliers. He then orders ingredients accordingly twice a week. Even though he cannot predict when ingredients will become available at a particular price, his ordering of supplies can be considered routine.
  - a. On what level of management is Neil working? Explain in a paragraph.
  - b. What attributes of his job would have to change before you would categorize him as working on a different level of management? List them.
6. Many of the people who work at Pepe’s (Problem 5) are extremely dedicated to Pepe’s and have devoted their lives to the company. Others feel that the company is behind the times and should use more sophisticated production systems, information systems, and supply chain management to make the company more competitive. Members of a third group feel that what they do is unappreciated. Describe the various subculture in words. Assign them a name based on their emotions.
7. Alice in the human resources department at the Cho Manufacturing plant is constantly being asked by employees how much is taken out of their paychecks for insurance, taxes, medical, mandatory retirement, and voluntary retirement. “It takes up to a few hours every day,” says Alice.

She would like a Web system that would allow employees to use a secure logon to view the information. Alice wants the system to interface with health and dental insurance companies to obtain the amount remaining in the employee’s account for the year. She would also like to obtain retirement amounts saved along with investment results. Alice has a high regard for privacy and wants the system to have employees register and give permission to obtain financial amounts from the dental insurance and retirement companies. Draw a use case diagram representing the activities of the Employee Benefit system.
8. Write up a use case scenario for the use case diagram you constructed for Cho Manufacturing.
9. What level are you creating your use case at? Choose one of the four altitude metaphors and explain why you chose it.
10. Create a context-level data flow diagram for the Employee Benefit system in Problem 7. Make any assumptions about the data to and from the central process. Do you find this to be better or not as good at explaining the system to Alice than the use case and use case scenarios?
11. Draw a use case and write up a use case scenario for getting two or three email accounts. Think about the steps that are needed to ensure security.

## GROUP PROJECTS

1. Break up into groups of five. Assign one person to act as the Web site designer, one to write copy for a company’s product, one to keep track of customer payments, one to monitor distribution, and one to satisfy customers who have questions about using the product. Then select a simple product (one that does not have too many versions). Good examples are a digital camera, a DVD player, a GPS, a box of candy, or a specialty travel hat (rainproof or sunblocker). Now spend 20 minutes trying to explain to the Web site designer what to include on the Web site. Describe in about three paragraphs what experience your group had in coordination. Elaborate on the interrelatedness of subsystems in the organization (your group).
2. In a small group, develop a use case and a use case scenario for making air, hotel, and car reservations for domestic travel.
3. Change your answer in Group Project 2 to include foreign travel. How does the use case and use case scenario change?
4. With your group, draw a context-level data flow diagram of your school’s or university’s registration system. Label each entity and process. Discuss why there appear to be different ways to draw the diagram. Reach consensus as a group about the best way to draw the diagram and defend your choice in a paragraph. Now, working with your group’s members, follow the appropriate steps for developing an E-R diagram and create one for your school or university registration system. Make sure your group indicates whether the relationship you depict is one-to-one, one-to-many, many-to-one, or many-to-many.

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## EPISODE 2

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

## Picturing the Relationships

“So the project involves more than simply performing maintenance work on the current programs,” Chip says. “Are we using a formal methodology for analyzing and designing the new system?”

“Yes,” replies Anna. “We are also using Microsoft Visio to create and modify the diagrams and some simple repository information. We also have a CASE tool, Visible Analyst, to analyze and design the system.<sup>1</sup> We’ve recently installed the products on the computer in the office.”

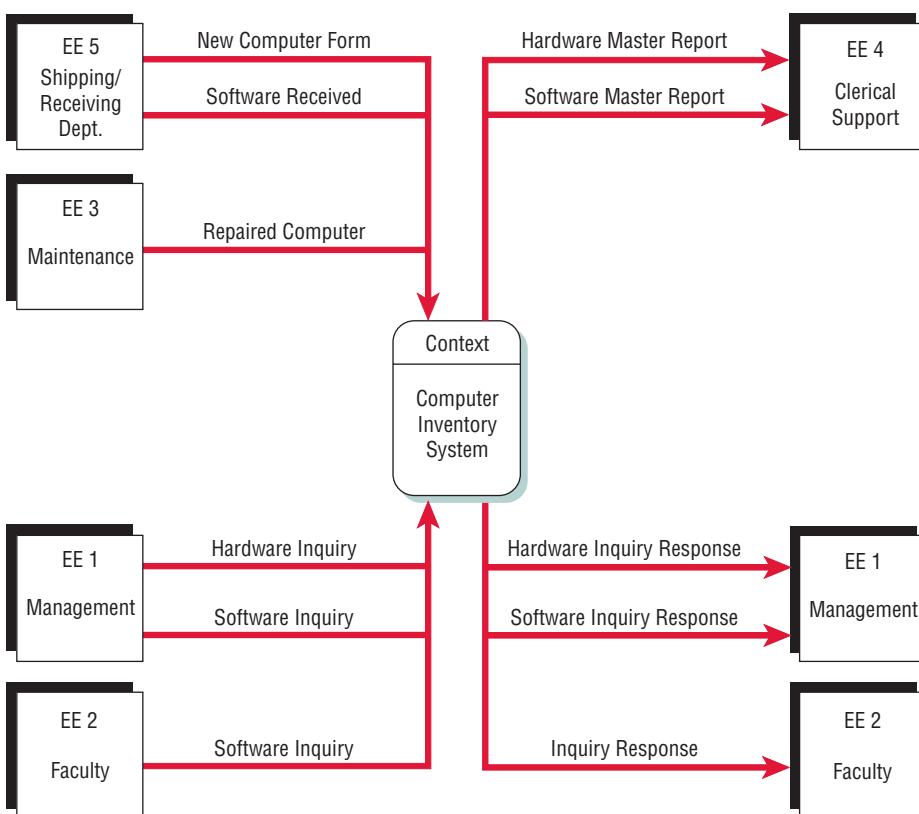
With a few easy mouse clicks Anna comes to a context-level data flow diagram (see Figure E2.1). “It’s very useful to begin thinking of the system this way,” Anna says as they look at the diagram on the screen.

Chip agrees, saying, “I can very easily see what you think is happening with the system. For instance, I see that the external entity Management supplies hardware and software inquiries and receives the corresponding responses in return. It shows the system within the larger organization.”

“I’ve also drawn a preliminary E-R diagram of the system,” Anna says as she brings up the entity-relationship diagram on the screen (see Figure E2.2). “It may need modification as we learn more about the system.”

“Yes, the many-to-many and one-to-many relationships are very clear when you look at this,” Chip says, viewing the screen.

“There is one more view of the system,” continues Anna, opening the use case diagram. “This is the preliminary use case diagram for our system (see Figure E2.3). We are going to use it to obtain some valuable



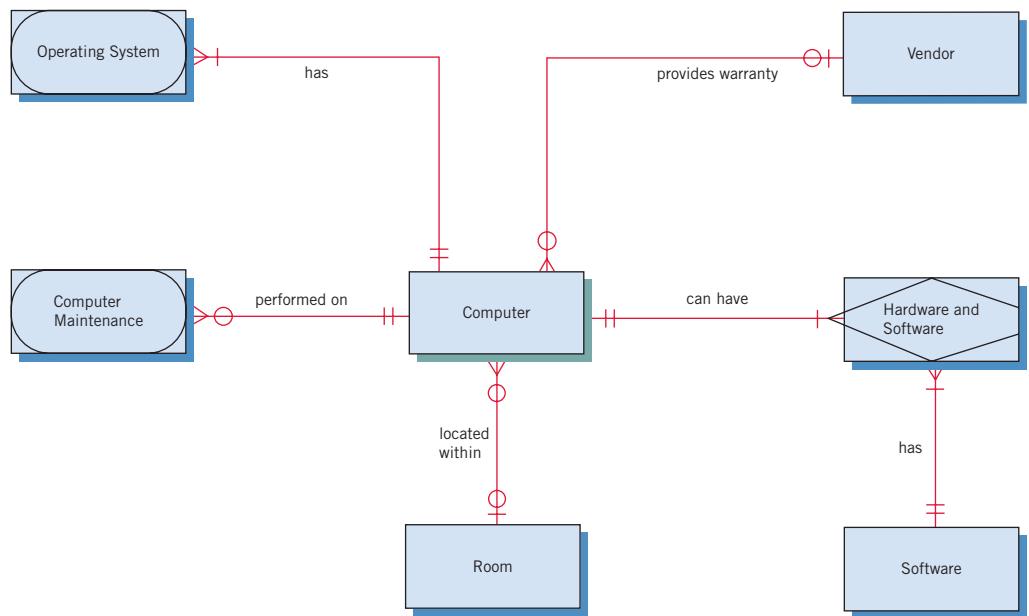
**FIGURE E2.1**

Context-level data flow diagram, current system.

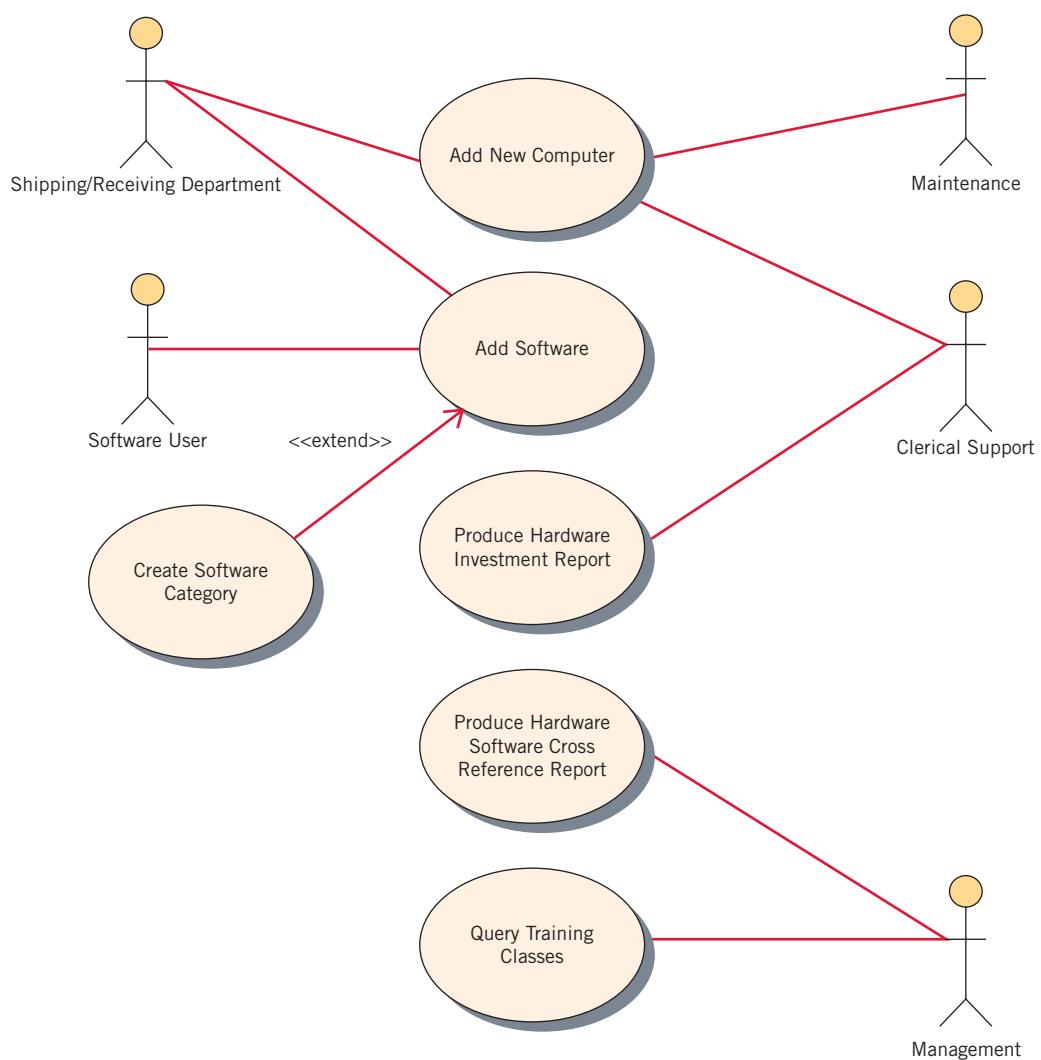
<sup>1</sup>For more details on how to begin using Visible Analyst, see Allen Schmidt, *Working with Visible Analyst*, 2d ed. (Upper Saddle River, NJ: Prentice Hall, 2004).

**FIGURE E2.2**

Entity-relationship diagram, current system.

**FIGURE E2.3**

Use case diagram for the CPU computer system.



feedback from the users. The use cases are not all complete, but I can show you one of them.” Anna clicks on the use case symbol, displaying the use case description in the repository shown in Figure E2.4.

“You’ve got a good start here,” Chip continues as he eyes the use case description. “This helps to understand the activities that take place. Let’s get to work and see what needs to be done next.”

## EXERCISES

- E-1. Use Microsoft Visio or Visible Analyst to view and print the context-level data flow diagram for the computer inventory system, as Chip and Anna did.
- E-2. Use the Repository feature or the Repository Web page to view the entry for the central process.
- E-3. Use Microsoft Visio or Visible Analyst to view and print the entity-relationship diagram for the computer inventory system.
- E-4. Explain why the external entities on the context-level diagram are not found on the entity-relationship diagram.



**FIGURE E2.4**

Use case scenario for the CPU computer system.

<b>Use case name:</b> Add New Computer	
<b>Area:</b>	Computer Inventory
<b>Actors:</b>	Shipping/Receiving Department, Maintenance
<b>Stakeholder:</b>	Faculty, Student, Staff
<b>Level:</b>	Blue
<b>Description:</b>	Add a new computer and generate a list of all machines for software installation
<b>Trigger:</b>	Add Computer menu choice clicked
<b>Trigger Type:</b>	<input checked="" type="checkbox"/> External <input type="checkbox"/> Temporal
<b>Steps Performed (Main Path)</b>	
1. Information is entered about new computers.	<b>Information for Steps</b> Invoice and specification sheets
2. Computer is added to Computer Master.	
3. Pending orders are updated with computers that have been received.	Computer Master
4. Produce the Installation Listing report for all desktop models.	Pending Order database table
5. Produce Software Installation Listing report showing all standard software for all received computers.	Computer Master
	Computer Master
<b>Preconditions:</b>	Computer has been received by the receiving department.
<b>Postconditions:</b>	A computer has been added to the database and reports have been generated.
<b>Assumptions:</b>	User has successfully logged on with access to Add Computer screen.
<b>Success Guarantee:</b>	A computer has been added to the database and required reports printed.
<b>Minimum Guarantee:</b>	Computer has been received and will be added later.
<b>Objectives Met:</b>	Add and install new computers.
<b>Outstanding Issues:</b>	What course of action should be taken when pending computers do not match those received.
<b>Priority (optional):</b>	High
<b>Risk (optional):</b>	Medium

- E-5.** Explain why the entities MANAGEMENT and FACULTY are found on both sides of the process on the context-level diagram.
- E-6.** Use Microsoft Visio or Visible Analyst to view and print the use case diagram for the computer inventory system.
- E-7.** Add the following actors and use cases to the use case diagram:
- FACULTY actor in the lower left side of the use case diagram.
  - Connect the FACULTY actor to the QUERY TRAINING CLASSES use case.
  - Since the computers may have software installed for a specific computer lab, the clerical support staff may be responsible for installing software on the computers. Connect the CLERICAL SUPPORT actor to the ADD SOFTWARE use case.
  - Add two new use cases below the QUERY TRAINING CLASSES use case: QUERY SOFTWARE EXPERT and below it, QUERY SOFTWARE INFORMATION.
  - Connect the FACULTY actor to the QUERY SOFTWARE EXPERT and QUERY SOFTWARE INFORMATION use cases.
  - Connect the MANAGEMENT actor to the QUERY SOFTWARE EXPERT use case.
- E-8.** Add the INSTALL DESKTOP COMPUTER use case to the upper right area of the diagram. This use case extends the ADD NEW COMPUTER use case.
- E-9.** Add a use case description for the ADD SOFTWARE use case. It should contain the following information:
- Obtain the use case name and actors from the use case diagram. The stakeholder and level are the same as those in Figure E2.3.
  - The description should be: Add new software to the Software database table and print an installation listing.
  - The activity is started (triggered) when the user clicks the Add Software menu item.
  - The steps performed and information for steps are:
- |  |                        |
|--|------------------------|
| Software is keyed into the new system and validated    | Software received form |
| Software is added to the Software Master               | Software Master        |
| The Software Installation List is produced             | Software Master, Order |
| The software user is notified about installed software | Order                  |
- Preconditions are that software has been received. Postconditions are that the software has been added to the database and reports have been created. Assumptions are that the user has successfully logged on with access to the Add Software entry screen. A success guarantee is that the software has been added to the database and the required report printed. A minimum guarantee is that the software has been received. The objectives met are to add and install new software. The outstanding issue is how to determine which software to install on which machines. The priority is high and the risk is medium.
- E-10.** Write a use case description for the PRODUCE HARDWARE SOFTWARE CROSS REFERENCE REPORT use case. Use the use case diagram to determine the heading information, making any reasonable assumptions. The steps would be to read a software record, use that information to read the hardware-software relational table, then read the hardware record. Use the hardware record to print a line, accumulating totals. Print subtotals and grand totals. This is a medium priority, low-risk activity. Preconditions are that all the information must have been previously added to the appropriate database tables. Postconditions are that the report has been printed. Assumptions are that all the information on the database tables is correct. A success guarantee would be the report has been successfully created. A minimum guarantee would be the report could not be printed. The objectives met are to produce information about what software is found on which machine. Outstanding issues are: What if the software is older and is not currently installed on any machines, how should the report be produced: printed, in a PDF file, or should it really be a query for one software package?

- E-11.** Write the use case description for the PRODUCE HARDWARE INVESTMENT REPORT use case. Use the use case diagram to define the header information. The steps involve reading each hardware record, counting the number of machines, and totaling the amount invested in them for each computer model. When the computer brand changes, produce subtotals, with a grand total at the end of the report. All information comes from the Hardware Master database table. Make any reasonable assumptions about preconditions, postconditions, assumptions, success guarantee, minimum guarantee, objectives met, outstanding issues, priority, and risk.
- E-12.** Write the use case description for the QUERY TRAINING CLASSES use case. Use the use case diagram to define the header information. The steps involve entering information on the Web form, validating the information, and storing the data on a Training Request database table. Make any reasonable assumptions about preconditions (such as if the software have to be already purchased), postconditions, assumptions, success guarantee, minimum guarantee, objectives met, outstanding issues, priority (would this be a high priority task), and risk.

The exercises preceded by a www icon indicate value-added material that is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises. Alternatively, many of the exercises can be accomplished manually if software is unavailable.

# CHAPTER 3

# Project Management

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand how projects are initiated and selected, define a business problem, and determine the feasibility of a proposed project.
2. Inventory and appraise current and proposed hardware and software and the way it supports human interactions with technology.
3. Evaluate software by addressing the trade-offs among creating custom software, purchasing COTS software, and outsourcing to an application service provider.
4. Forecast and analyze tangible and intangible costs and benefits.
5. Plan a project by identifying activities and scheduling them.
6. Manage team members and analysis and design activities so that the project objectives are met while the project remains on schedule.
7. Professionally write and present an effective systems proposal, concentrating on both content and design.



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Initiating projects, determining project feasibility, scheduling projects, and planning and then managing activities and team members for productivity are all important capabilities for the systems analyst to master. As such, they are considered project management fundamentals.

A systems project begins with problems or with opportunities for improvement in a business that often come up as the organization adapts to change. The increasing popularity of ecommerce means that some fundamental changes are occurring as businesses either originate their enterprises on, or move their internal operations as well as external relationships to, the Internet. Changes that require a systems solution occur in the legal environment as well as in the industry's environment. Analysts work with users to create a problem definition reflecting current business systems and concerns. Once a project is suggested, the systems analyst works quickly with decision makers to determine whether it is feasible. If a project is approved for a full systems study, the project activities are scheduled through the use of tools such as Gantt charts and Program Evaluation and Review Techniques (PERT) diagrams so that the project can be completed on time. Part of assuring the productivity of systems analysis team members is effectively managing their scheduled activities. This chapter is devoted to a discussion of project management fundamentals.



## PROJECT INITIATION

Systems projects are initiated by many different sources for many reasons. Some of the projects suggested will survive various stages of evaluation to be worked on by you (or you and your team); others will not and should not get that far. Businesspeople suggest systems projects for two

broad reasons: (1) because they experience problems that lend themselves to systems solutions, and (2) because they recognize opportunities for improvement through upgrading, altering, or installing new systems when they occur. Both situations can arise as the organization adapts to and copes with natural, evolutionary change.

### Problems in the Organization

Managers do not like to conceive of their organization as having problems, let alone talk about them or share them with someone from outside. Good managers, however, realize that recognizing symptoms of problems or, at a later stage, diagnosing the problems themselves and then confronting them are imperative if the business is to keep functioning at its highest potential.

Problems surface in many different ways. One way of conceptualizing what problems are and how they arise is to think of them as situations in which goals have never been met or are no longer being met. Useful feedback gives information about the gap between actual and intended performance. In this way feedback spotlights problems.

In some instances problems that require the services of systems analysts are uncovered because performance measures are not being met. Problems (or symptoms of problems) with processes that are visible in output and that could require the help of a systems analyst include excessive errors and work performed too slowly, incompletely, incorrectly, or not at all. Other symptoms of problems become evident when people do not meet baseline performance goals. Changes in employee behavior such as unusually high absenteeism, high job dissatisfaction, or high worker turnover should alert managers to potential problems. Any of these changes, alone or in combination, might be sufficient reason to request the help of a systems analyst.

Although difficulties such as those just described occur in the organization, feedback on how well the organization is meeting intended goals may come from outside, in the form of complaints or suggestions from customers, vendors, or suppliers, and lost or unexpectedly lower sales. This feedback from the external environment is extremely important and should not be ignored.

A summary of symptoms of problems and approaches useful in problem detection is provided in Figure 3.1. Notice that checking output, observing or researching employee behavior, and listening to feedback from external sources are all valuable in problem finding. When reacting to accounts of problems in the organization, the systems analyst plays the roles of consultant, supporting expert, and agent of change, as discussed in Chapter 1. As you might expect, roles for the systems analyst shift subtly when projects are initiated because the focus is on opportunities for improvement rather than on the need to solve problems.

### Defining the Problem

Whether using the classical SDLC or an object-oriented approach, the analyst first defines the problems and objectives of the system. These form the foundation of determining what needs to be accomplished by the system. Methods like Six Sigma (refer to Chapter 16 for details) start with a problem definition.

To Identify Problems	Look for These Specific Signs:
Check output against performance criteria.	<ul style="list-style-type: none"> <li>• Too many errors</li> <li>• Work completed slowly</li> <li>• Work done incorrectly</li> <li>• Work done incompletely</li> <li>• Work not done at all</li> </ul>
Observe behavior of employees.	<ul style="list-style-type: none"> <li>• High absenteeism</li> <li>• High job dissatisfaction</li> <li>• High job turnover</li> </ul>
Listen to external feedback from: Vendors. Customers. Suppliers.	<ul style="list-style-type: none"> <li>• Complaints</li> <li>• Suggestions for improvement</li> <li>• Loss of sales</li> <li>• Lower sales</li> </ul>

**FIGURE 3.1**

Checking output, observing employee behavior, and listening to feedback are all ways to help the analyst pinpoint systems problems and opportunities.



## CONSULTING OPPORTUNITY 3.1

### The Sweetest Sound I've Ever Sipped

Felix Straw, who represents one of the many U.S. distributors of the European soft drink Sipps, gazes unhappily at a newspaper weather map, which is saturated with dark red, indicating that most of the United States is experiencing an early spring heat wave with no signs of a letup. Pointing to the paper as he speaks, he tells your systems group, "It's the best thing that could happen to us, or at least it should be. But when we had to place our orders three months ago, we had no idea that this spring monster heat wave was going to devour the country this way!" Nodding his head toward a picture of their European plant on the wall, he continues. "We need to be able to tell them when things are hot over here so we can get enough product. Otherwise, we'll miss out every time. This happened two years ago and it just about killed us."

"Each of us distributors meets with our district managers to do three-month planning. When we agree, we fax our orders into European headquarters. They make their own adjustments, bottle the drinks, and then we get our modified orders about 9 to 15 weeks later. But we need ways to tell them what's going on now. Why, we even have some new superstores that are opening up here. They should know we have extra-high demand."

Corky, his assistant, agrees, saying, "Yeah, they should at least look at our past sales around this time of year. Some springs are hot, others are just average."

Straw concurs, saying, "It would be music to my ears, it would be really sweet, if they would work with us to spot trends and changes—and then respond quickly."

Stern's, based in Blackpool, England, is a European beverage maker and the developer and producer of Sipps. Sipps is a sweet, fruit-flavored, nonalcoholic, noncarbonated drink, which is served chilled or with ice, and it is particularly popular when the weather is hot. Selling briskly in Europe and growing in popularity in the United States since its introduction five years ago, Sipps has had a difficult time adequately managing inventory and keeping up with U.S. customer demand, which is affected by seasonal temperature fluctuations. Places with year-round, warm-temperature climates and lots of tourists (such as Florida and California) have large standing orders, but other areas of the country could benefit from a less cumbersome, more responsive order-placing process. Sipps is distributed by a network of local distributors located throughout the United States and Canada.

As one of the systems analysts assigned to work with the U.S. distributors of Sipps, begin your analysis by listing some of the key symptoms and problems you have identified after studying the information flows, ordering process, and inventory management, and after interviewing Mr. Straw and his assistant. In a paragraph describe which problems might indicate the need for a systems solution.

*Note:* This consulting opportunity is loosely based on J. C. Perez, "Heineken's HOPS Software Keeps A-Head on Inventory," *PC Week*, Vol. 14, No. 2, January 13, 1997, pp. 31 and 34.

A problem definition usually contains some sort of problem statement, summarized in a paragraph or two. This is followed by a series of issues, or major, independent pieces of the problem. The issues are followed by a series of objectives, or goals that match the issues point by point. Issues are the current situation; objectives are the desired situation. The objectives may be very specific or worded using a general statement.

Here are some examples of business questions relating to business objectives:

- What are the purposes of the business?
- Is the business profit or nonprofit?
- Does the company plan to grow or expand?
- What is the business's attitude (culture) about technology?
- What is the business's budget for IT?
- Does the business's staff have the expertise?

Needless to say, the systems analyst needs to understand how a business works.

The last part of the problem definition contains requirements, the things that must be accomplished, along with the possible solutions and the constraints that limit the development of the system. The requirements section may include security, usability, government requirements, and so on. Constraints often include the word *not*, indicating a limitation, and may contain budget restrictions or time limitations.

The problem definition is produced after completing interviews, observations, and document analysis with the users. The result of gathering this information is a wealth of facts and important opinions in need of summary. The first step in producing the problem definition is to find a num-

ber of points that may be included in one issue. Major points can be identified in the interview in a number of ways:

1. Users may identify an issue, topic, or theme that is repeated several times, sometimes by different people in several interviews.
2. Users may communicate the same metaphors, such as saying the business is a journey, war, game, organism, machine, and so on.
3. Users may speak at length on a topic.
4. Users may tell you outright that “This is a major problem.”
5. Users may communicate importance by body language or may speak emphatically on an issue.
6. The problem may be the first thing mentioned by the user.

Once the issues have been created, the objectives must be stated. At times the analyst may have to do a follow-up interview to obtain more precise information about the objectives. After the objectives are stated, the relative importance of the issues or objectives must be determined. If there are not enough funds to develop the complete system, the most critical objectives must be completed first. The identification of the most critical objectives is best done by users (with the support of analysts), because users are domain experts in their business area and in how they work best with technologies in the organization.

One technique is to ask the users to assign a weight for each issue or objective of the first draft of the problem definition. This is a subjective judgment by the user, but, if a number of users all assign weights and they are averaged together, the result might reflect the bigger picture. After the weights have been determined, the problem definition issues and objectives are resequenced in order of decreasing importance, the most important issues listed first. There is software such as Expert Choice ([www.expertchoice.com](http://www.expertchoice.com)) and other decision support software that can assist with the weighting and prioritizing of objectives.

Besides looking through data and interviewing people, try to witness the problem firsthand. When looking at the same situation, an employee may view a problem very differently than a systems analyst does. This also gives analysts the opportunity to confirm their findings. In this way they use multiple methods, thereby strengthening the case for taking appropriate action.

**A PROBLEM DEFINITION EXAMPLE: CATHERINE’S CATERING.** Catherine’s Catering is a small business that caters meals, receptions, and banquets for business and social occasions such as luncheons and weddings. It was inspired by Catherine’s love of cooking and her talent for preparing fine meals. At first it was a small company with a handful of employees working on small projects. Catherine met with customers to determine the number of people, the type of meals, and other information necessary to cater an event. As their reputation for creating superb food and the quality of the service began to blossom, the number of events started to increase. The building of a new convention center, along with a prospering business community in the city, increased the number of catering events.

Catherine was able to manage the business using spreadsheets and word processing but found difficulty in keeping up with endless phone calls about what types of meals were available, changes to the number of guests attending the event, and the availability of specialty dietary items, such as vegan, vegetarian, low-fat, low-carbohydrate, and so on. Catherine’s decisions to hire a number of part-time employees to cook and cater the events meant that the complexity of scheduling personnel was becoming overwhelming to the new human resources manager. Catherine decided to hire an IT and business consulting company to help her address the problems her catering enterprise was facing.

After performing interviews and observing a number of key staff, the consultants found the following concerns:

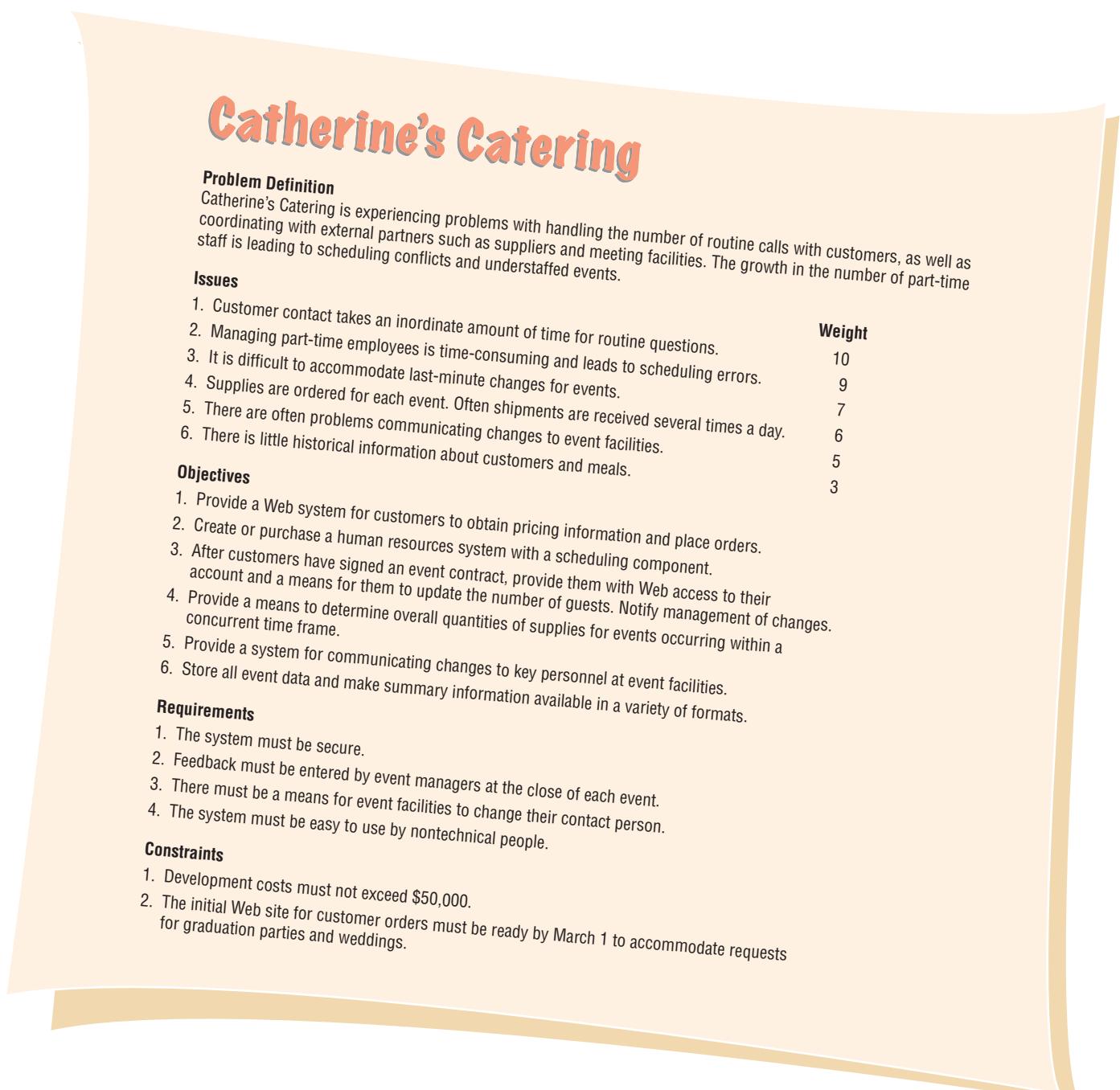
1. The master chef ordered supplies (produce, meat, and so on) from suppliers for each event. The suppliers would provide discounts if greater quantities were ordered at a single time for all events occurring in a given time frame.
2. Customers often called to change the number of guests for an event, with some changes made only one or two days before the event was scheduled.
3. It was too time-consuming for Catherine and her staff to handle each request for catering, with about 60 percent of the calls resulting in a contract.

4. Conflicts in employee schedules were occurring and some events were understaffed. Complaints about the timeliness of service were becoming more frequent.
5. Catherine does not have any summary information about the number of events and types of meals. It would be helpful to have trend information that would help guide her customers in their choice of meals.
6. Events are often held at hotels or other meeting halls, which provide table settings for sit-down meals. There are problems with having sufficient waitstaff and changes with the number of guests.

The problem definition is shown in Figure 3.2. Notice the weights on the right, representing an average of the weights assigned by each employee. Objectives match the issues. Each objective is used to create user requirements.

**FIGURE 3.2**

Problem definition for Catherine's Catering, developed with the help of users.



User requirements are then used to create either use cases and a use case diagram or data flow diagram processes. Each objective may create one or more user requirements or several objectives may create one or perhaps no use cases (use cases are not often created for simple reports), or each requirement may create one data flow diagram process. The user requirements for Catherine's Catering are to:

1. Create a dynamic Web site to allow current and potential clients to view and obtain pricing information for a variety of different products.
2. Allow current and potential clients to submit a request with their catering choices, with the request routed to an account manager.
3. Add clients to the client database, assigning them a userID and a password for access to their projects.
4. Create a Web site for clients to view and update the number of guests for an event and restrict changing the number of guests when the event day is less than five days in the future.
5. Obtain or create software to communicate directly with event facility personnel.
6. Create or purchase a human resources system for scheduling part-time employees, allowing management to add employees and schedule them using a number of constraints.
7. Provide queries or reports with summary information.

Each requirement may be used to create a preliminary test plan. Since scant details are available at this time, the test plan will be revised as the project progresses.

A simple test plan for Catherine's Catering is:

1. Design test data that would allow clients to view each different type of product.
2. Test to ensure that a catering request has been entered with valid data, as well as each possible condition of invalid data (data will be defined later). Ensure that the request is routed to the appropriate account manager.
3. Test that all data fields pass all validation criteria for each field. Test good data to ensure that clients are added to the client database, and that a userID and a password are correctly assigned.
4. Create a test plan that will test that clients are able to view event information. Test that updates may not be made within five days of the event. Design test data that will check to ensure correct updating of the number of guests for an event.
5. Test that the software works correctly for communicating directly with event facility personnel.
6. Test the human resources system for scheduling part-time employees, checking that employees have been correctly added and that all invalid values for each field are detected and reported. Check scheduling software for valid updates and each invalid entry.
7. Check that all queries or reports work correctly and contain the correct summary information.

## Selection of Projects

Projects come from many different sources and for many reasons. Not all should be selected for further study. You must be clear in your own mind about the reasons for recommending a systems study on a project that seems to address a problem or could bring about improvement. Consider the motivation that prompts a proposal on the project. You need to be sure that the project under consideration is not being proposed simply to enhance your own political reputation or power, or that of the person or group proposing it, because there is a high probability that such a project will be ill-conceived and eventually ill-accepted.

As outlined in Chapter 2, prospective projects need to be examined from a systems perspective in such a way that you are considering the impact of the proposed change on the entire organization. Recall that the various subsystems of the organization are interrelated and interdependent, so a change to one subsystem might affect all the others. Even though the decision makers directly involved ultimately set the boundaries for the systems project, a systems project cannot be contemplated or selected in isolation from the rest of the organization.

Beyond these general considerations are five specific criteria for project selection:

1. Backing from management.
2. Appropriate timing of project commitment.

3. Possibility of improving attainment of organizational goals.
4. Practical in terms of resources for the systems analyst and organization.
5. Worthwhile project compared with other ways the organization could invest resources.

First and foremost is backing from management. Absolutely nothing can be accomplished without the endorsement of the people who eventually will foot the bill. This statement does not mean that you lack influence in directing the project or that people other than management can't be included, but management backing is essential.

Another important criterion for project selection includes timing for you and the organization. Ask yourself and the others who are involved if the business is presently capable of making a time commitment for installation of new systems or improvement to existing ones. You must also be able to commit all or a portion of your time for the duration.

A third criterion is the possibility of improving attainment of organizational goals such as (1) improving corporate profits, (2) supporting the competitive strategy of the organization, (3) improving cooperation with vendors and partners, (4) improving internal operations support so that goods and services are produced efficiently and effectively, (5) improving internal decision support so that decisions are more effective, (6) improving customer service, and (7) increasing employee morale. The project should put the organization on target, not deter it from its ultimate goals.

A fourth criterion is selecting a project that is practicable in terms of your resources and capabilities as well as those of the business. Some projects will not fall within your realm of expertise, and you must be able to recognize them.

Finally, you need to come to a basic agreement with the organization about the worthiness of the systems project relative to any other possible project being considered. There are many possibilities for improvements, including, (1) speeding up a process, (2) streamlining a process through the elimination of unnecessary or duplicated steps, (3) combining processes, (4) reducing errors in input through changes of forms and display screens, (5) reducing redundant storage, (6) reducing redundant output, and (7) improving integration of systems and subsystems. Remember that when a business commits to one project, it is committing resources that thereby become unavailable for other projects. It is useful to view all possible projects as competing for the business resources of time, money, and people.

## DETERMINING FEASIBILITY

Once the number of projects has been narrowed according to the criteria discussed previously, it is still necessary to determine if the selected projects are feasible. Our definition of feasibility goes much deeper than common usage of the term, because systems projects feasibility is assessed in three principal ways: operationally, technically, and economically. The feasibility study is not a full-blown systems study. Rather, the feasibility study is used to gather broad data for the members of management that in turn enables them to make a decision on whether to proceed with a systems study.

Data for the feasibility study can be gathered through interviews, which are covered in detail in Chapter 4. The kind of interview required is directly related to the problem or opportunity being suggested. The systems analyst typically interviews those requesting help and those directly concerned with the decision-making process, typically management. Although it is important to address the correct problem, the systems analyst should not spend too much time doing feasibility studies, because many projects will be requested and only a few can or should be executed. The feasibility study must be highly time compressed, encompassing several activities in a short span of time.

### Determining Whether It Is Possible

After an analyst determines reasonable objectives for a project, the analyst needs to determine if it is possible for the organization and its members to see the project through to completion. Generally, the process of feasibility assessment is effective in screening out projects that are inconsistent with the business's objectives, technically impossible, or economically without merit.

Although it is painstaking, studying feasibility is worthwhile because it saves businesses and systems analysts time and money. In order for an analyst to recommend further development, a project must show that it is feasible in all three of the following ways: technically, economically, and operationally, as shown in Figure 3.3.

The Three Key Elements of Feasibility	
Technical Feasibility	Add on to present system Technology available to meet users' needs
Economic Feasibility	Systems analysts' time Cost of systems study Cost of employees' time for study Estimated cost of hardware Cost of packaged software or software development
Operational Feasibility	Whether the system will operate when installed Whether the system will be used

**FIGURE 3.3**

The three key elements of feasibility include technical, economic, and operational feasibility.

**TECHNICAL FEASIBILITY.** The analyst must find out whether it is possible to develop the new system given the current technical resources. If not, can the system be upgraded or added to in a manner that fulfills the request under consideration? If existing systems cannot be added onto or upgraded, the next question becomes whether there is technology in existence that meets the specifications.

At the same time, the analyst can ask whether the organization has the staff who are technically proficient enough to accomplish the objectives. If not, the question becomes whether they can hire additional programmers, testers, experts, or others who may have different programming skills from theirs, or maybe outsource the project completely. Still another question is whether there are software packages available that can accomplish their objectives, or does the software need to be customized for the organization?

**ECONOMIC FEASIBILITY.** Economic feasibility is the second part of resource determination. The basic resources to consider are your time and that of the systems analysis team, the cost of doing a full systems study (including the time of employees you will be working with), the cost of the business employee time, the estimated cost of hardware, and the estimated cost of software or software development.

The concerned business must be able to see the value of the investment it is pondering before committing to an entire systems study. If short-term costs are not overshadowed by long-term gains or produce no immediate reduction in operating costs, the system is not economically feasible and the project should not proceed any further.

**OPERATIONAL FEASIBILITY.** Suppose for a moment that technical and economic resources are both judged adequate. The systems analyst must still consider the operational feasibility of the requested project. Operational feasibility is dependent on the human resources available for the project and involves projecting whether the system will operate and be used once it is installed.

If users are virtually wed to the present system, see no problems with it, and generally are not involved in requesting a new system, resistance to implementing the new system will be strong. Chances for it ever becoming operational are low.

Alternatively, if users themselves have expressed a need for a system that is operational more of the time, in a more efficient and accessible manner, chances are better that the requested system will eventually be used. Much of the art of determining operational feasibility rests with the user interfaces that are chosen, as we see in Chapter 14.

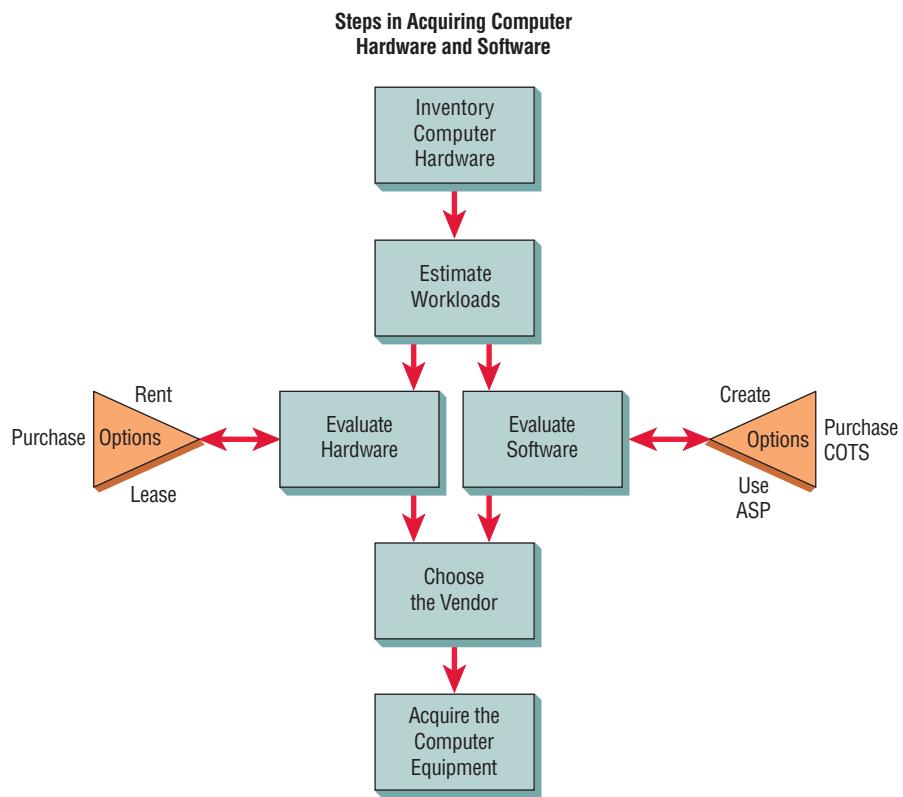
## ASCERTAINING HARDWARE AND SOFTWARE NEEDS

Assessing technical feasibility includes evaluating the ability of computer hardware and software to handle workloads adequately. Figure 3.4 shows the steps the systems analyst takes in ascertaining hardware and software needs. First, all current computer hardware the organization owns must be inventoried to discover what is on hand and what is usable.

The systems analyst needs to work with users to determine what hardware will be needed. Hardware determinations can come only in conjunction with determining human information

**FIGURE 3.4**

Steps in choosing hardware and software.



requirements. Knowledge of the organizational structure (as discussed in Chapter 2) and how users interact with technologies in an organizational setting can also be helpful in hardware decisions. Only when systems analysts, users, and management have a good grasp of what kinds of tasks must be accomplished can hardware options be considered.

### Inventorying Computer Hardware

Begin by inventorying what computer hardware is already available in the organization. As will become apparent, some of the hardware options involve expanding or recycling current hardware, so it is important to know what is on hand.

If an updated computer hardware inventory is unavailable, the systems analyst needs to set up one quickly and carry through on it. You need to know the following:

1. The type of equipment: model number, manufacturer.
2. The operation status of the equipment: on order, operating, in storage, in need of repair.
3. The estimated age of the equipment.
4. The projected life of the equipment.
5. The physical location of the equipment.
6. The department or person considered responsible for the equipment.
7. The financial arrangement for the equipment: owned, leased, rented.

Ascertaining the current hardware available will result in a sounder decision-making process when hardware decisions are finally made, because much of the guesswork about what exists will be eliminated. Through your earlier interviews with users, questionnaires surveying them, and research of archival data, you will already know the number of people available for data processing as well as their skills and capabilities. Use this information to project how well the staffing needs for new hardware can be met.

### Estimating Workloads

The next step in ascertaining hardware needs is to estimate workloads. Thus, systems analysts formulate numbers that represent both current and projected workloads for the system so that any hardware obtained will possess the capability to handle current and future workloads.

	Existing System	Proposed System
Task	Compare performance of distribution warehouses by running the summary program.	Compare performance of distribution warehouses on the Web-based dashboard.
Method	Computer programs are run when needed; processing is done from the workstation.	Updates occur immediately; processing is done online.
Personnel	Distribution manager	Distribution manager
When and how	<p>Daily: Enter shipments on Excel spreadsheet; verify accuracy of spreadsheet manually; and then write files to backup media.</p> <p>Monthly: Run program that summarizes daily records and prints report; get report and make evaluations.</p>	<p>Daily: Enter shipments on the Web-based system using drop-down boxes. Data are automatically backed up to remote location.</p> <p>Monthly: Compare warehouses online using the performance dashboard; print only if needed.</p>
Human time requirements	Daily: 20 minutes Monthly: 30 minutes	Daily: 10 minutes Monthly: 10 minutes
Computer time requirements	Daily: 20 minutes Monthly: 30 minutes	Daily: 10 minutes Monthly: 10 minutes

**FIGURE 3.5**

Comparisons of workloads between existing and proposed systems.

If estimates are accomplished properly, the business should not have to replace hardware solely due to unforeseen growth in system use. (Other events, however, such as superior technological innovations, may dictate hardware replacement if the business wants to maintain its competitive edge.)

Out of necessity, workloads are sampled rather than actually put through several computer systems. The guidelines given on sampling in Chapter 5 can be of use here, because in workload sampling, the systems analyst is taking a sample of necessary tasks and the computer resources required to complete them.

Figure 3.5 is a comparison of the times required by an existing and a proposed information system that are supposed to handle a given workload. Notice that the company is currently using a legacy computer system to prepare a summary of shipments to its distribution warehouses, and a Web-based dashboard is being suggested. The workload comparison looks at when and how each process is done, how much human time is required, and how much computer time is needed. Notice that the newly proposed system should cut down the required human and computer time significantly.

### Evaluating Computer Hardware

Evaluating computer hardware is the shared responsibility of management, users, and systems analysts. Although vendors will be supplying details about their particular offerings, analysts need to oversee the evaluation process personally because they will have the best interests of the business at heart. In addition, systems analysts may have to educate users and management about the general advantages and disadvantages of hardware before they can capably evaluate it.

Based on the current inventory of computer equipment and adequate estimates of current and forecasted workloads, the next step in the process is to consider the kinds of equipment available that

appear to meet projected needs. Information from vendors on possible systems and system configurations becomes more pertinent at this stage and should be reviewed with management and users.

In addition, workloads can be simulated and run on different systems, including those already used in the organization. This process is referred to as benchmarking.

Criteria that the systems analysts and users should use to evaluate performance of different systems hardware include the following:

1. The time required for average transactions (including how long it takes to input data and how long it takes to receive output).
2. The total volume capacity of the system (how much can be processed at the same time before a problem arises).
3. The idle time of the CPU or network.
4. The size of the memory provided.

Some criteria will be shown in formal demonstrations; some cannot be simulated and must be gleaned from manufacturers' specifications. It is important to be clear about the required and desired functions before getting too wrapped up in vendors' claims during demonstrations.

Once functional requirements are known and the current products available are comprehended and compared with what already exists in the organization, decisions are made by the systems analysts in conjunction with users and management about whether obtaining new hardware is necessary. Options can be thought of as existing on a continuum from using only equipment already available in the business all the way to obtaining entirely new equipment. In between are options to make minor or major modifications to the existing computer system.

**COMPUTER SIZE AND USE.** The rapid advance of technology dictates that the systems analyst research types of computers available at the particular time that the systems proposal is being written. Computer sizes range all the way from miniature mobile phones to room-sized supercomputers. Each has different attributes that should be considered when deciding how to implement a computer system.

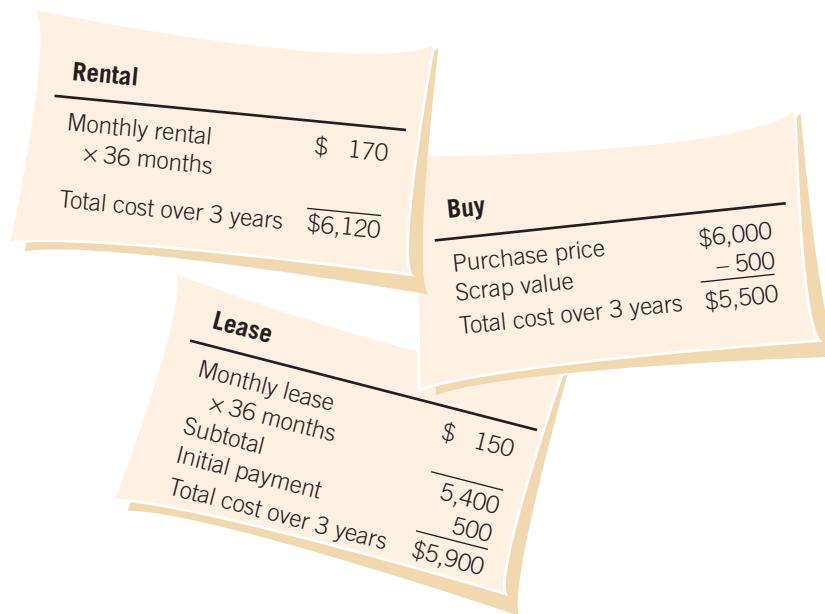
### Acquisition of Computer Equipment

The three main options for acquisition of computer hardware are buying, leasing, or renting it. There are advantages and disadvantages that ought to be weighed for each of the decisions, as shown in Figure 3.6. Some of the more influential factors to consider in deciding which option is best for a particular installation include initial versus long-term costs, whether the business can afford to tie up capital in computer equipment, and whether the business desires full control of and responsibility for the computer equipment.

**FIGURE 3.6**

Comparing the advantages and disadvantages of buying, leasing, and renting computer equipment.

	Advantages	Disadvantages
<b>Buying</b>	<ul style="list-style-type: none"> <li>• Cheaper than leasing or renting over the long run</li> <li>• Ability to change system</li> <li>• Provides tax advantages of accelerated depreciation</li> <li>• Full control</li> </ul>	<ul style="list-style-type: none"> <li>• Initial cost is high</li> <li>• Risk of obsolescence</li> <li>• Risk of being stuck if choice was wrong</li> <li>• Full responsibility</li> </ul>
<b>Leasing</b>	<ul style="list-style-type: none"> <li>• No capital is tied up</li> <li>• No financing is required</li> <li>• Leases are lower than rental payments</li> </ul>	<ul style="list-style-type: none"> <li>• Company doesn't own the system when lease expires</li> <li>• Usually a heavy penalty for terminating the lease</li> <li>• Leases are more expensive than buying</li> </ul>
<b>Renting</b>	<ul style="list-style-type: none"> <li>• No capital is tied up</li> <li>• No financing is required</li> <li>• Easy to change systems</li> <li>• Maintenance and insurance are usually included</li> </ul>	<ul style="list-style-type: none"> <li>• Company doesn't own the computer</li> <li>• Cost is very high because vendor assumes the risk (most expensive option)</li> </ul>

**FIGURE 3.7**

Comparison of alternatives for computer acquisition.

Buying implies that the business itself will own the equipment. One of the main determinants of whether to buy is the projected life of the system. If the system will be used longer than four to five years (with all other factors held constant), the decision is usually made to buy. Notice in the example in Figure 3.7 that the cost of purchase after three years is lower than that of leasing or renting. As systems become smaller, more powerful, and less expensive, and as distributed systems become more popular, more businesses are deciding to purchase equipment.

Leasing, rather than purchasing, computer hardware is another possibility. Leasing equipment from the vendor or a third-party leasing company is more practical when the projected life of the system is less than four years. In addition, if significant change in technology is imminent, leasing is a better choice. Leasing also allows the business to put its money elsewhere, where it can be working for the company rather than be tied up in capital equipment. Over a long period, however, leasing is not an economical way to acquire computer equipment.

Renting computer hardware is the third main option for computer acquisition. One of the main advantages of renting is that none of the company's capital is tied up, and hence no financing is required. Also, renting computer hardware makes it easier to change system hardware. Finally, maintenance and insurance are usually included in rental agreements. Because of the high costs involved and the fact that the company will not own the rented equipment, however, renting should be contemplated only as a short-term move to handle nonrecurring or limited computer needs or technologically volatile times.

**EVALUATION OF VENDOR SUPPORT FOR COMPUTER HARDWARE.** Several key areas ought to be evaluated when weighing the support services available to businesses from vendors. Most vendors offer testing of hardware on delivery and a 90-day warranty covering any factory defects, but you must ascertain what else the vendor has to offer. Vendors of comparable quality frequently distinguish themselves from others by the range of support services they offer.

A list of key criteria that ought to be checked when evaluating vendor support is provided in Figure 3.8. Most of the extra vendor support services listed there are negotiated separately from hardware lease or purchase contracts.

Support services include routine and preventive maintenance of hardware, specified response time (within six hours, next working day, etc.) in case of emergency equipment breakdowns, loan of equipment in the event that hardware must be permanently replaced or off-site repair is required, and in-house training or off-site group seminars for users. Peruse the support services documents accompanying the purchase or lease of equipment and remember to involve appropriate legal staff before signing contracts for equipment or services.

Unfortunately, evaluating computer hardware is not as straightforward as simply comparing costs and choosing the least expensive option. Some other eventualities commonly brought up by

**FIGURE 3.8**

Guidelines for vendor selection.

Vendor Services	Specifics Vendors Typically Offer
<b>Hardware Support</b>	Full line of hardware Quality products Warranty
<b>Software Support</b>	Complete software needs Custom programming Warranty
<b>Installation and Training</b>	Commitment to schedule In-house training Technical assistance
<b>Maintenance</b>	Routine maintenance procedures Specified response time in emergencies Equipment loan while repair is being done

users and management include (1) the possibility of adding on to the system if the need comes up later; (2) the possibility of interfacing with equipment from other vendors if the system needs to grow; (3) the benefits of buying more memory than is projected as necessary, with the expectation that business will eventually “grow into it”; and (4) the corporate stability of the vendor.

Competition among vendors has made the idea of producing hardware that is compatible with competitors’ hardware important for vendors’ survival. Before becoming convinced that buying cheaper compatibles is the way to endow your system with add-on capability, however, do enough research to feel confident that the original vendor is a stable corporate entity.

### Software Evaluation

Analysts and organizations are increasingly faced with a make, buy, or outsource decision when assessing software for information systems projects, particularly when contemplating upgrades to existing or legacy systems.

You have seen the decisions that analysts make when deciding about renting, buying, or leasing hardware. Some of the decision making surrounding purchase of commercial off-the-shelf (COTS) software, “rental” of the software from an application service provider (ASP), or creation of custom software for the project is analogous to the hardware decision process.

It should be noted that regardless of whether you develop software or purchase a COTS product for a particular project, it is imperative to complete a human information requirements analysis of the users and the systems they use first (as discussed in preceding chapters). As an analyst, part of the expertise you are developing is to make sound judgments regarding developing software versus the purchase of COTS software for new and existing systems. The following sections discuss when to create your own software, when to purchase COTS packages, and when to use an ASP. Figure 3.9 summarizes the advantages and disadvantages of each of these options.

**WHEN TO CREATE CUSTOM SOFTWARE.** There are several situations that call for the creation of original software or software components. The most likely instance is when COTS software does not exist or cannot be identified for the desired application. Alternatively, the software may exist but it is unaffordable or cannot easily be purchased or licensed.

Original software should be created when the organization is attempting to gain a competitive advantage through the leveraged use of information systems. This is often the case when an organization is creating ecommerce or other innovative applications where none existed. It is also possible that the organization is a “first mover” in the use of a particular technology or in its particular industry. Organizations that have highly specialized requirements or exist in niche industries can also benefit from original software.

The advantages of creating your own software include being able to respond to specialized user and business needs, gaining a competitive advantage by creating innovative software, having in-house staff available to maintain the software, and the pride of owning something you have created.

The drawbacks of developing your own software include the potential for a significantly higher initial cost compared to purchasing COTS software or contracting with an ASP, the neces-

Advantages	Disadvantages
<b>Creating Custom Software</b> <ul style="list-style-type: none"> <li>• Specific response to specialized business needs</li> <li>• Innovation may give firm a competitive advantage</li> <li>• In-house staff available to maintain software</li> <li>• Pride of ownership</li> </ul>	<ul style="list-style-type: none"> <li>• May be significantly higher initial cost compared to COTS software or ASP</li> <li>• Necessity of hiring or working with a development team</li> <li>• Ongoing maintenance</li> </ul>
<b>Purchasing COTS Packages</b> <ul style="list-style-type: none"> <li>• Refined in the commercial world</li> <li>• Increased reliability</li> <li>• Increased functionality</li> <li>• Often lower initial cost</li> <li>• Already in use by other firms</li> <li>• Help and training comes with software</li> </ul>	<ul style="list-style-type: none"> <li>• Programming focused; not business focused</li> <li>• Must live with the existing features</li> <li>• Limited customization</li> <li>• Uncertain financial future of vendor</li> <li>• Less ownership and commitment</li> </ul>
<b>Using an ASP</b> <ul style="list-style-type: none"> <li>• Organizations that do not specialize in information systems can focus on what they do best (their strategic mission)</li> <li>• There is no need to hire, train, or retain a large IT staff</li> <li>• There is no expenditure of employee time on nonessential IT tasks</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of control of data, systems, IT employees, and schedules</li> <li>• Concern over the financial viability and long-run stability of the ASP</li> <li>• Security, confidentiality, and privacy concerns</li> <li>• Loss of potential strategic corporate advantage regarding innovativeness of applications</li> </ul>

**FIGURE 3.9**

Comparing the advantages and disadvantages of creating custom software, purchasing COTS packages, and outsourcing to an ASP.

sity of hiring or working with a development team, and the fact that you are responsible for the ongoing maintenance because you were the software's creator.

**WHEN TO BUY COTS SOFTWARE.** Commercial off-the-shelf software includes such products as the Microsoft Office suite, which includes Word for word processing, Excel for spreadsheets, Access for building databases, and other applications. Other types of COTS software are for organizational-level systems rather than office or personal use. Some authors include popular (but costly) ERP packages such as Oracle and SAP in their examples of COTS software. These packages differ radically in the amount of customization, support, and maintenance required compared to Microsoft Office. COTS software can also refer to software components or objects (also called building blocks) that can be purchased to provide a particular needed functionality in a system.

Consider using COTS software when you can easily integrate the applications or packages into existing or planned systems, and when you have identified no necessity to immediately or continuously change or customize them for users. Your forecasts should demonstrate that the organization you are designing the system for is unlikely to undergo major changes after the proposed purchase of COTS software, such as a dramatic increase in customers or large physical expansions.

There are some advantages to purchasing COTS software that you should keep in mind as you weigh alternatives. One advantage is that these products have been refined through the process of commercial use and distribution, so that often there are additional functionalities offered. Another advantage is that packaged software is typically extensively tested, and thus extremely reliable.

Increased functionality is often offered with COTS software, because a commercial product is likely to have sister products, add-on features, and upgrades that enhance its attractiveness. Additionally, analysts often find that the initial cost of COTS software is lower than the cost for either in-house software development or the use of an ASP.

Another advantage of purchasing COTS packages includes their use by many other companies, so analysts are not experimenting on their clients with one-of-a-kind software applications.



## CONSULTING OPPORTUNITY 3.2

### Veni, Vidi, Vendi, or, I Came, I Saw, I Sold

**I**t's really some choice. I mean, no single package seems to have everything we want. Some of them come darn close, though," says Roman, an advertising executive for *Empire Magazine* with whom you have been working on a systems project. Recently, the two of you have decided that packaged software would probably suit the advertising department's needs and stem its general decline.

"The last guy's demo we saw, you know, the one who worked for Data Coliseum, really had a well-rounded pitch. And I like their brochure. Full-color printing, on card stock. Classic," Roman asserts.

"And what about those people from Vesta Systems? They're really fired up. And their package was easy to use with a minimum of ceremony. Besides, they said they would train all 12 of us, on-site, at no charge. But look at their advertising. They just take things off their printers."

Roman fiddles in his chair as he continues his ad hoc review of software and software vendors. "That one package from Mars, Inc., really sold me all on its own, though. I mean, it had a built-in

calendar. And I like the way the menus for the screen displays could all be chosen by Roman numerals. It was easy to follow. And the vendor isn't going to be hard to move on price. I think they're already in a price war."

"Do you want to know my favorite, though?" Roman asks archly. "It's the one put out by Jupiter, Unlimited. I mean, it has everything, doesn't it? It costs a little extra coin, but it does what we need it to do, and the documentation is heavenly. They don't do any training, of course. They think they're above it."

You are already plotting that to answer Roman's burning questions by your March 15 deadline, you need to evaluate the software as well as the vendors, systematically, and then render a decision. Evaluate each vendor and package based on what Roman has said so far (assume you can trust his opinions). What are Roman's apparent biases when evaluating software and vendors? What further information do you need about each company and its software before making a selection? Set up a table to evaluate each vendor. Answer each question in a separate paragraph.

Lastly, COTS software boasts an advantage in the help and training that accompanies the purchase of the packaged software.

One example of the use of COTS software is from a theatre company in the nonprofit sector, in which organizations (particularly in the performing arts) tend to lag behind their for-profit counterparts in adoption of information communication technologies (ICTs). The theatre company was predictably slow to move to the Web. When they desired to create ecommerce applications, they were put in a position of having to hire outside designers to create ecommerce applications for them. In light of the expense and lack of in-house expertise, many nonprofit organizations simply did not move the business portion of their organizations to the Web, waiting instead for COTS packages, such as PC-based, box-office software, or ASPs such as online ticketing agencies with automation already in place, to make these services available to patrons. In-house software development was out of the question for most of these groups, who typically have small or nonexistent IT staffs and budgets, and minimal internal IT expertise.

There is a downside to the use of COTS software. Because it is not meant to be fully customizable, the theatre company lost its ability to change the software to include key features in its donor database that users were reliant on. COTS software may also include errors that could expose an organization to liability issues.

There are other disadvantages to consider with the purchase of COTS software, including the fact that packages are programmed, rather than being focused on human users working in a business. Additionally, users must live with whatever features exist in the software, whether they are appropriate or not. A disadvantage that grows out of this is the limited customizability of most packaged software. Other disadvantages to purchasing COTS software include the necessity of investigating the financial stability of the software vendor, and the diminished sense of ownership and commitment that is inevitable when the software is considered a product rather than a process.

To achieve some perspective on systems being developed, you should recognize that over half of the projects are built from scratch (two-thirds using traditional methods like SDLC and prototyping and one-third using agile or object-oriented technologies). Most of these are developed using an internal systems analysis team. Programmers may be in-house or outsourced.

Less than half of all projects are developed from existing applications or components. The great majority are modified, some extensively. Less than 5 percent of software is off-the-shelf software that requires no modifications at all.

### WHEN TO OUTSOURCE SOFTWARE SERVICES TO AN APPLICATION SERVICE PROVIDER.

Organizations may realize some benefits from taking an entirely different approach to procuring software. This third option is to outsource some of the organization's software needs to an application service provider that specializes in IT applications.

There are specific benefits to outsourcing applications to an application service provider (ASP). For example, organizations that desire to retain their strategic focus and do what they're best at may want to outsource the production of information systems applications. Additionally, outsourcing one's software needs means that the organization doing the outsourcing may be able to sidestep the need to hire, train, and retain a large IT staff. This can result in significant savings. When an organization uses an ASP, there is little or no expenditure of valuable employee time on nonessential IT tasks (these are handled professionally by the ASP).

Hiring an ASP should not be considered a magic formula for addressing software requirements. There are drawbacks to the use of an ASP that must be seriously considered. One disadvantage is a general loss of control over corporate data, information systems, IT employees, and even processing and project schedules. Some companies believe that the heart of their business is their information, so even the thought of relinquishing control over it is distressing. Another disadvantage is concern over the financial viability of any ASP that is chosen. There might also be concerns about the security of the organization's data and records, along with concern about confidentiality of data and client privacy. Finally, when choosing an ASP, there is a potential loss of strategic corporate advantage that might have been gained through the company's own deployment of innovative applications created by their employees.

**EVALUATION OF VENDOR SUPPORT FOR SOFTWARE AND ASPS.** Whether you purchase a COTS package or contract for ASP services, you will be dealing with vendors who may have their own best interests at heart. You must be willing to evaluate software with users and not be unduly influenced by vendors' sales pitches. Specifically, there are six main categories on which to grade software, as shown in Figure 3.10: performance effectiveness, performance efficiency, ease of use, flexibility, quality of documentation, and manufacturer support.

Software Requirements	Specific Software Features
<b>Performance Effectiveness</b>	Able to perform all required tasks Able to perform all tasks desired Well-designed display screens Adequate capacity
<b>Performance Efficiency</b>	Fast response time Efficient input Efficient output Efficient storage of data Efficient backup
<b>Ease of use</b>	Satisfactory user interface Help menus available "Read Me" files for last-minute changes Flexible interface Adequate feedback Good error recovery
<b>Flexibility</b>	Options for input Options for output Usable with other software
<b>Quality of Documentation</b>	Good organization Adequate online tutorial Web site with FAQ
<b>Manufacturer Support</b>	Technical support hotline Newsletter/email Web site with downloadable product updates

**FIGURE 3.10**

Guidelines for evaluating software.

Evaluate packaged software based on a demonstration with test data from the business considering it and an examination of accompanying documentation. Vendors' descriptions alone will not suffice. Vendors typically certify that software is working when it leaves their supply house, but they will not guarantee that it will be error-free in every instance or that it will not crash when incorrect actions are taken by users. Obviously, they will not guarantee their packaged software if used in conjunction with faulty hardware.

## IDENTIFYING, FORECASTING, AND COMPARING COSTS AND BENEFITS

Costs and benefits of the proposed computer system must always be considered together, because they are interrelated and often interdependent. Although the systems analyst is trying to propose a system that fulfills various information requirements, decisions to continue with the proposed system will be based on a cost-benefit analysis, not on information requirements. In many ways, benefits are measured by costs, as becomes apparent in the next section.

### Forecasting

Systems analysts are required to predict certain key variables before the proposal is submitted to the client. To some degree, a systems analyst will rely on a what-if analysis, such as, "What if labor costs rise only 5 percent per year for the next three years, rather than 10 percent?" The systems analyst should realize, however, that he or she cannot rely on what-if analysis for everything if the proposal is to be credible, meaningful, and valuable.

The systems analyst has many forecasting models available. The main condition for choosing a model is the availability of historical data. If they are unavailable, the analyst must turn to one of the judgment methods: estimates from the sales force, surveys to estimate customer demand, Delphi studies (a consensus forecast developed independently by a group of experts through a series of iterations), creating scenarios, or drawing historical analogies.

If historical data are available, the next differentiation between classes of techniques involves whether the forecast is conditional or unconditional. Conditional implies that there is an association among variables in the model or that such a causal relationship exists. Common methods in this group include correlation, regression, leading indicators, econometrics, and input/output models.

Unconditional forecasting means the analyst isn't required to find or identify any causal relationships. Consequently, systems analysts find that these methods are low-cost, easy-to-implement alternatives. Included in this group are graphical judgment, moving averages, and analysis of time-series data. Because these methods are simple, reliable, and cost effective, the remainder of the section focuses on them.

**ESTIMATION OF TRENDS.** Trends can be estimated in a number of different ways. One way to estimate trends is to use a moving average. This method is useful because some seasonal, cyclical, or random patterns may be smoothed, leaving the trend pattern. The principle behind moving averages is to calculate the arithmetic mean of data from a fixed number of periods; a three-month moving average is simply the average of the last three months. For example, the average sales for January, February, and March is used to predict the sales for April. Then the average sales for February, March, and April are used to predict the sales for May, and so on.

When the results are graphed, it is easily noticeable that the widely fluctuating data are smoothed. The moving average method is useful for its smoothing ability, but at the same time it has many disadvantages. Moving averages are more strongly affected by extreme values than by using graphical judgment or estimating using other methods such as least squares. The analyst should learn forecasting well, as it often provides information valuable in justifying the entire project.

### Identifying Benefits and Costs

Benefits and costs can be thought of as either tangible or intangible. Both tangible and intangible benefits and costs must be taken into account when systems are considered.

**TANGIBLE BENEFITS.** Tangible benefits are advantages measurable in dollars that accrue to the organization through the use of the information system. Examples of tangible benefits are an increase in the speed of processing, access to otherwise inaccessible information, access to information on a more timely basis than was possible before, the advantage of the computer's



## CONSULTING OPPORTUNITY 3.3

### We're Off to See the Wizards

Elphaba I. Menzel and Glinda K. Chenoweth are the owners of Emerald City Beautyscapes, a commercial landscaping company. They are trying to decide whether to write their own software, perhaps using Microsoft Access as a basis; adopt a COTS software package such as QuickBooks Pro; or hire a service called Lawn Wizards, Inc., to perform all of their bookkeeping functions.

Elphaba turned to Glinda and asked, "Is it possible for us to create a system of our own?"

Glinda replied, "I suppose we could, but it would take forever. We would need to define all our fields, our queries, and our reports. We would need to know who hasn't paid us yet, and how long it has been since we last billed them."

"Yes," says Elphaba, "and we would also have to create product descriptions, service descriptions, and codes for everything we sell and provide."

"If that was all we needed, we could probably do it," says Glinda. "But we also need to include a scheduling system. We need to know when we can provide the services to our customers and what to do if we fall behind schedule. Maybe it just isn't worth it."

"Still," reflects Glinda, "my mother used to say 'There's no place like home.' Maybe there's no software like home grown."

"You see both sides of everything," remarks Elphaba. "But the path you want to take is too long and risky. We need a software package that is ready for us to use now. I hear that there are products they call commercial off-the-shelf software that we can buy and adapt to our lawn service business. I'll investigate." So, Elphaba sets out to look for software that may be suitable.

"I've found something," cries Elphaba. "I found this software called QuickBooks Pro at [www.quickbooks.com](http://www.quickbooks.com) and it looks like we can afford it. There are numerous versions of the software already—one for accounting, one for construction, one for health services. Maybe we can find a package that suits us. If not, it looks like we can customize the generic version of QuickBooks Pro to fit our needs."

"Our system could grow, too. QuickBooks Pro is readily scalable. We can add customers, suppliers, or products easily. I

just wanted to plant the idea of buying a ready-made package on you."

"That's interesting," says Glinda, "but I've been doing my own research. Some of our competitors have told me they let a company do all the work for them. The company is called Lawn Wizards. They do landscaping, but they also maintain accounts receivable and scheduling packages."

So off they went to see the Wizards.

Joel Green, the owner and creator of Lawn Wizards, is proud of his software. "I spent a great deal of time working with my suppliers, that is, nurseries, in the area, and we have developed a coding system for everything," he brags. "All the trees, sizes of trees, shrubs, flowers, mulch, and even lawn care tools have numbers."

"I started with a small firm, but when customers realized I paid attention to every little detail, my business blossomed." He adds, "My suppliers love my system because it cuts down on confusion."

"I noticed that my competitors were working with the same suppliers, but were getting less preferential treatment because they couldn't communicate about product very effectively. So I decided I would offer my software for hire. I would make money by renting out my software and demand even greater respect from my suppliers. My end user license agreement states that I own the software, product codes, and data generated by the system."

"Using my unique Wizards software, I can customize the package a bit for the customer, but essentially all the lawn services in the state will be using my database, codes, and B2B features. I maintain my software. If you could see the software code, it would look just like a manicured lawn."

Now Glinda and Elphaba are even more confused than before. They have three distinct options: to create a package on their own, buy commercial off-the-shelf software such as QuickBooks Pro, or outsource their needs to Lawn Wizards. Help them learn the true secret of (software) happiness by helping them articulate the pros and cons of each of their alternatives. What would you recommend? In two paragraphs, write a recommendation that grows out of your consideration of their specific business situation.

superior calculating power, and decreases in the amount of employee time needed to complete specific tasks. There are still others. Although measurement is not always easy, tangible benefits can actually be measured in terms of dollars, resources, or time saved.

**INTANGIBLE BENEFITS.** Some benefits that accrue to the organization from the use of the information system are difficult to measure but are important nonetheless. They are known as intangible benefits.

Intangible benefits include improving the decision-making process, enhancing accuracy, becoming more competitive in customer service, maintaining a good business image, and increasing job satisfaction for employees by eliminating tedious tasks. As you can judge from the list given, intangible benefits are extremely important and can have far-reaching implications for the business as it relates to people both outside and within the organization.

Although intangible benefits of an information system are important factors that must be considered when deciding whether to proceed with a system, a system built solely for its intangible

benefits will not be successful. You must discuss both tangible and intangible benefits in your proposal, because presenting both will allow decision makers in the business to make a well-informed decision about the proposed system.

**TANGIBLE COSTS.** The concepts of tangible and intangible costs present a conceptual parallel to the tangible and intangible benefits discussed already. Tangible costs are those that can be accurately projected by the systems analyst and the business's accounting personnel.

Included in tangible costs are the cost of equipment such as computers and terminals, the cost of resources, the cost of systems analysts' time, the cost of programmers' time, and other employees' salaries. These costs are usually well established or can be discovered quite easily, and are the costs that will require a cash outlay of the business.

**INTANGIBLE COSTS.** Intangible costs are difficult to estimate and may not be known. They include losing a competitive edge, losing the reputation for being first with an innovation or the leader in a field, declining company image due to increased customer dissatisfaction, and ineffective decision making due to untimely or inaccessible information. As you can imagine, it is next to impossible to project a dollar amount for intangible costs accurately. To aid decision makers who want to weigh the proposed system and all its implications, you must include intangible costs even though they are not quantifiable.

### Comparing Costs and Benefits

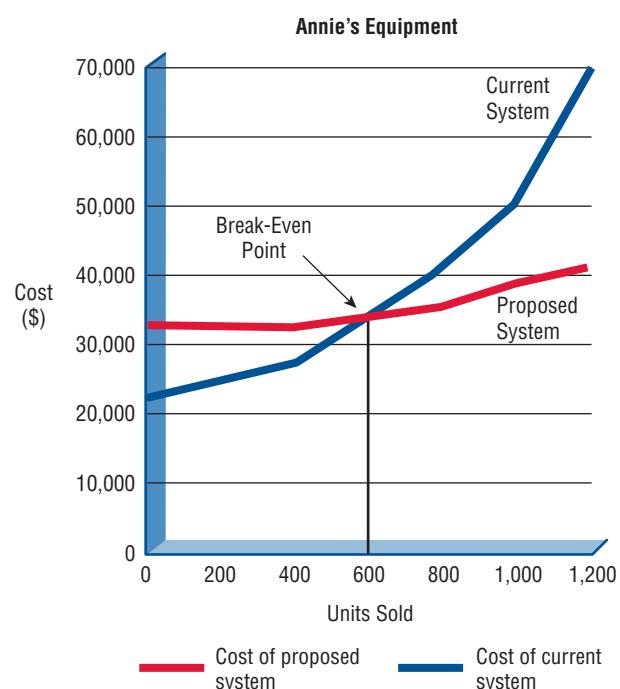
There are many well-known techniques for comparing the costs and benefits of the proposed system. They include break-even analysis, payback, cash-flow analysis, and present value analysis. All these techniques provide straightforward ways of yielding information to decision makers about the worthiness of the proposed system.

**BREAK-EVEN ANALYSIS.** By comparing costs alone, the systems analyst can use break-even analysis to determine the break-even capacity of the proposed information system. The point at which the total costs of the current system and the proposed system intersect represents the break-even point, the point where it becomes profitable for the business to get the new information system.

Total costs include the costs that recur during operation of the system plus the developmental costs that occur only once (one-time costs of installing a new system), that is, the tangible costs that were just discussed. Figure 3.11 is an example of a break-even analysis on a small store that maintains inventory using a manual system. As volume rises, the costs of the manual system rise at an increasing rate. A new computer system would cost a substantial sum up front, but the in-

**FIGURE 3.11**

Break-even analysis for the proposed inventory system.



cremental costs for higher volume would be rather small. The graph shows that the computer system would be cost effective if the business sold about 600 units per week.

Break-even analysis is useful when a business is growing and volume is a key variable in costs. One disadvantage of break-even analysis is that benefits are assumed to remain the same, regardless of which system is in place. From our study of tangible and intangible benefits, we know that is clearly not the case.

Break-even analysis can also determine how long it will take for the benefits of the system to pay back the costs of developing it. Figure 3.12 illustrates a system with a payback period of three and a half years.

**CASH-FLOW ANALYSIS.** Cash-flow analysis examines the direction, size, and pattern of cash flow that is associated with the proposed information system. If you are proposing the replacement of an old information system with a new one and if the new information system will not be generating any additional cash for the business, only cash outlays are associated with the project. If that is the case, the new system cannot be justified on the basis of new revenues generated and must be examined closely for other tangible benefits if it is to be pursued further.

Figure 3.13 shows a cash-flow analysis for a small company that is providing a mailing service to other small companies in the city. Revenue projections are that only \$5,000 will be generated in the first quarter, but after the second quarter, revenue will grow at a steady rate. Costs will be large in the first two quarters and then level off. Cash-flow analysis is used to determine when a company will begin to make a profit (in this case, it is in the third quarter, with a cash flow of \$7,590) and when it will be “out of the red,” that is, when revenue has made up for the initial investment (in the first quarter of the second year, when accumulated cash flow changes from a negative amount to a positive \$10,720).

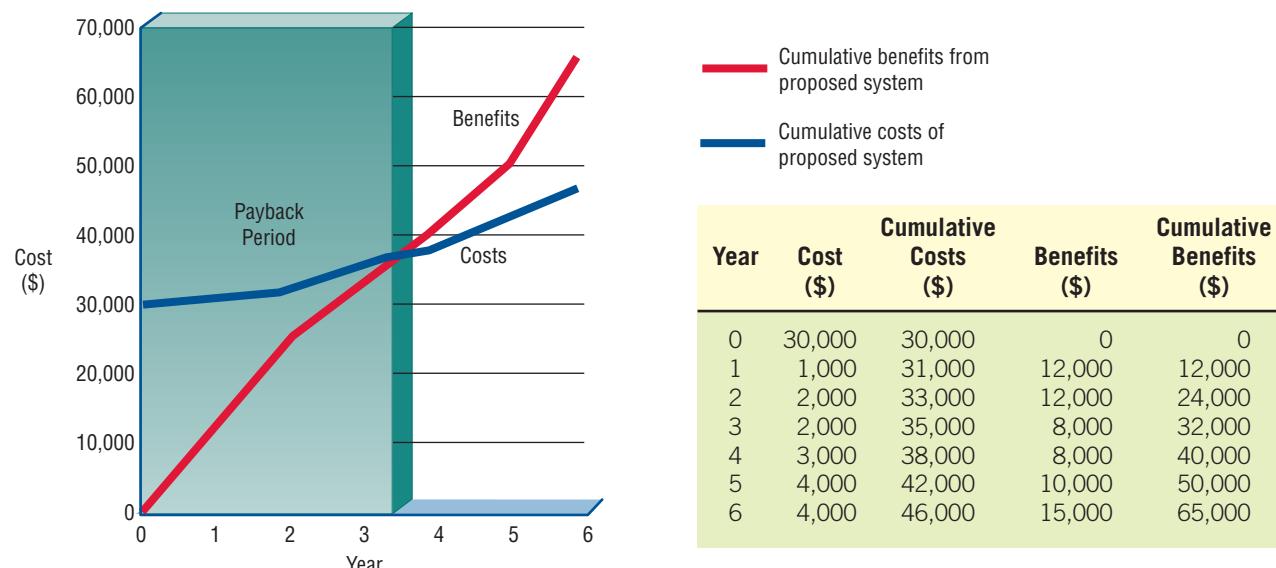
The proposed system should have increased revenues along with cash outlays. Then the size of the cash flow must be analyzed along with the patterns of cash flow associated with the purchase of the new system. You must ask when cash outlays and revenues will occur, not only for the initial purchase but also over the life of the information system.

**PRESENT VALUE ANALYSIS.** Present value analysis helps the systems analyst to present to business decision makers the time value of the investment in the information system as well as the cash flow (as discussed in the previous section). Present value is a way to assess all the economic outlays and revenues of the information system over its economic life, and to compare costs today with future costs and today's benefits with future benefits.

In Figure 3.14, system costs total \$272,000 over six years and benefits total \$280,700. Therefore, we might conclude that benefits outweigh the costs. Benefits only started to surpass costs after the fourth year, however, and dollars in the sixth year will not be equivalent to dollars in the first year.

**FIGURE 3.12**

Break-even analysis showing a payback period of three and a half years.



**FIGURE 3.13**

Cash-flow analysis for the computerized mail-addressing system.

	Quarter 1	Quarter 2	Year 1	Quarter 4	Year 2 Quarter 1
Revenue	\$5,000	\$20,000	\$24,960	\$31,270	\$39,020
<b>Costs</b>					
Software development	10,000	5,000			
Personnel	8,000	8,400	8,800	9,260	9,700
Training	3,000	6,000			
Equipment lease	4,000	4,000	4,000	4,000	4,000
Supplies	1,000	2,000	2,370	2,990	3,730
Maintenance	0	2,000	2,200	2,420	2,660
<b>Total Costs</b>	26,000	27,400	17,370	18,670	20,090
<b>Cash Flow</b>	-21,000	-7,400	7,590	12,600	18,930
<b>Cumulative Cash Flow</b>	-21,000	-28,400	-20,810	-8,210	10,720

**FIGURE 3.14**

Without considering present value, the benefits appear to outweigh the costs.

	Year						
	1	2	3	4	5	6	Total
<b>Costs</b>	\$40,000	42,000	44,100	46,300	48,600	51,000	272,000
<b>Benefits</b>	\$25,000	31,200	39,000	48,700	60,800	76,000	280,700

For instance, a dollar investment at 7 percent today will be worth \$1.07 at the end of the year and will double in approximately 10 years. The present value, therefore, is the cost or benefit measured in today's dollars and depends on the cost of money. The cost of money is the opportunity cost, or the rate that could be obtained if the money invested in the proposed system were invested in another (relatively safe) project.

The present value of \$1.00 at a discount rate of  $i$  is calculated by determining the factor

$$\frac{1}{(1 + i)^n}$$

**FIGURE 3.15**

Taking into account present value, the conclusion is that the costs are greater than the benefits. The discount rate,  $i$ , is assumed to be .12 in calculating the multipliers in this table.

where  $n$  is the number of periods. Then the factor is multiplied by the dollar amount, yielding the present value as shown in Figure 3.15. In this example, the cost of money—the discount rate—is assumed to be .12 (12 percent) for the entire planning horizon. Multipliers are calculated for each period:  $n = 1, n = 2, \dots, n = 6$ . Present values of both costs and benefits are then calculated using these multipliers. When that step is done, the total benefits (measured in today's dollars) are

	Year						
	1	2	3	4	5	6	Total
<b>Costs</b>	\$40,000	42,000	44,100	46,300	48,600	51,000	
<b>Multiplier</b>	.89	.80	.71	.64	.57	.51	
<b>Present Value of Costs</b>	35,600	33,600	31,311	29,632	27,702	26,010	183,855
<b>Benefits</b>	\$25,000	31,200	39,000	48,700	60,800	76,000	
<b>Multiplier</b>	.89	.80	.71	.64	.57	.51	
<b>Present Value of Benefits</b>	22,250	24,960	27,690	31,168	34,656	38,760	179,484

\$179,484, and thus less than the costs (also measured in today's dollars). The conclusion to be drawn is that the proposed system is not worthwhile if present value is considered.

Although this example, which used present value factors, is useful in explaining the concept, all electronic spreadsheets have a built-in present value function. The analyst can directly compute present value using this feature.

**GUIDELINES FOR ANALYSIS.** The use of the methods discussed in the preceding subsections depends on the methods employed and accepted in the organization itself. For general guidelines, however, it is safe to say the following:

1. Use break-even analysis if the project needs to be justified in terms of cost, not benefits, or if benefits do not substantially improve with the proposed system.
2. Use payback when the improved tangible benefits form a convincing argument for the proposed system.
3. Use cash-flow analysis when the project is expensive relative to the size of the company or when the business would be significantly affected by a large drain (even if temporary) on funds.
4. Use present value analysis when the payback period is long or when the cost of borrowing money is high.

Whichever method is chosen, it is important to remember that cost-benefit analysis should be approached systematically, in a way that can be explained and justified to managers, who will eventually decide whether to commit resources to the systems project. Next, we turn to the importance of comparing many systems alternatives.

## ACTIVITY PLANNING AND CONTROL

Systems analysis and design involves many different types of activities that together make up a project. The systems analyst must manage the project carefully if the project is to be successful. Project management involves the general tasks of planning and control.

Planning includes all the activities required to select a systems analysis team, assign members of the team to appropriate projects, estimate the time required to complete each task, and schedule the project so that tasks are completed in a timely fashion. Control means using feedback to monitor the project, including comparing the plan for the project with its actual evolution. In addition, control means taking appropriate action to expedite or reschedule activities to finish on time while motivating team members to complete the job properly.

### Estimating Time Required

The systems analyst's first decision is to determine the amount of detail that goes into defining activities. The lowest level of detail is the SDLC itself, whereas the highest extreme is to include every detailed step. The optimal answer to planning and scheduling lies somewhere in between.

A structured approach is useful here. In Figure 3.16 the systems analyst beginning a project has broken the process into three major phases: analysis, design, and implementation. Then the

Phase	Activity
<b>Analysis</b>	Data gathering Data flow and decision analysis Proposal preparation
<b>Design</b>	Data entry design Input design Output design Data organization
<b>Implementation</b>	Implementation Evaluation

**FIGURE 3.16**

Beginning to plan a project by breaking it into three major activities.





## CONSULTING OPPORTUNITY 3.4

### Food for Thought

**W**e could really make some changes. Shake up some people. Let them know we're with it. Technologically, I mean," said Malcolm Warner, vice president for AllFine Foods, a wholesale dairy products distributor. "That old system should be overhauled. I think we should just tell the staff that it's time to change."

"Yes, but what would we actually be improving?" Kim Han, assistant to the vice president, asks. "I mean, there aren't any substantial problems with the system input or output that I can see."

Malcolm snaps, "Kim, you're purposely not seeing my point. People out there see us as a stodgy firm. A new computer system could help change that. Change the look of our invoices. Send jazzier reports to the food store owners. Get some people excited about us as leaders in wholesale food distributing and computers."

"Well, from what I've seen over the years," Kim replies evenly, "a new system is very disruptive, even when the business really needs it. People dislike change, and if the system is performing the way it should, maybe there are other things we could do to update our image that wouldn't drive everyone nuts in the process. Besides, you're talking big bucks for a new gimmick."

Malcolm says, "I don't think just tossing it around here between the two of us is going to solve anything. Check on it and get back to me. Wouldn't it be wonderful?"

A week later Kim enters Malcolm's office with several pages of interview notes in hand. "I've talked with most of the people who have extensive contact with the system. They're happy, Malcolm. And they're not just talking through their hats. They know what they're doing."

"I'm sure the managers would like to have a newer system than the guys at Quality Foods," Malcolm replies. "Did you talk to them?"

Kim says, "Yes. They're satisfied."

"And how about the people in systems? Did they say the technology to update our system is out there?" Malcolm inquires insistently.

"Yes. It can be done. That doesn't mean it should be," Kim says firmly.

As the systems analyst for AllFine Foods, how would you assess the feasibility of the systems project Malcolm is proposing? Based on what Kim has said about the managers, users, and systems people, what seems to be the operational feasibility of the proposed project? What about the economic feasibility? What about the technological feasibility? Based on what Kim and Malcolm have discussed, would you recommend that a full-blown systems study be done? Discuss your answer in a paragraph.

analysis phase is further broken down into data gathering, data flow and decision analysis, and proposal preparation. Design is broken down into data entry design, input and output design, and data organization. The implementation phase is divided into implementation and evaluation.

In subsequent steps the systems analyst needs to consider each of these tasks and break them down further so that planning and scheduling can take place. Figure 3.17 shows how the analy-

**FIGURE 3.17**

Refining the planning and scheduling of analysis activities by adding detailed tasks and establishing the time required to complete the tasks.

Activity	Detailed Activity	Weeks Required
Data gathering	Conduct interviews Administer questionnaires Read company reports Introduce prototype Observe reactions to prototype	3 4 4 5 3
Data flow and decision analysis	Analyze data flow	8
Proposal preparation	Perform cost-benefit analysis Prepare proposal Present proposal	3 2 2

*Break these down further,*

*then estimate time required.*

sis phase is described in more detail. For example, data gathering is broken down into five activities, from conducting interviews to observing reactions to the prototype. This particular project requires data flow analysis but not decision analysis, so the systems analyst has written in “analyze data flow” as the single step in the middle phase. Finally, proposal preparation is broken down into three steps: perform cost-benefit analysis, prepare proposal, and present proposal.

The systems analyst, of course, has the option to break down steps further. For instance, the analyst could specify each of the persons to be interviewed. The amount of detail necessary depends on the project, but all critical steps need to appear in the plans.

Sometimes the most difficult part of project planning is the crucial step of estimating the time it takes to complete each task or activity. When quizzed about reasons for lateness on a particular project, project team members cited poor scheduling estimates that hampered the success of projects from the outset. There is no substitute for experience in estimating time requirements, and systems analysts who have had the opportunity of an apprenticeship are fortunate in this regard.

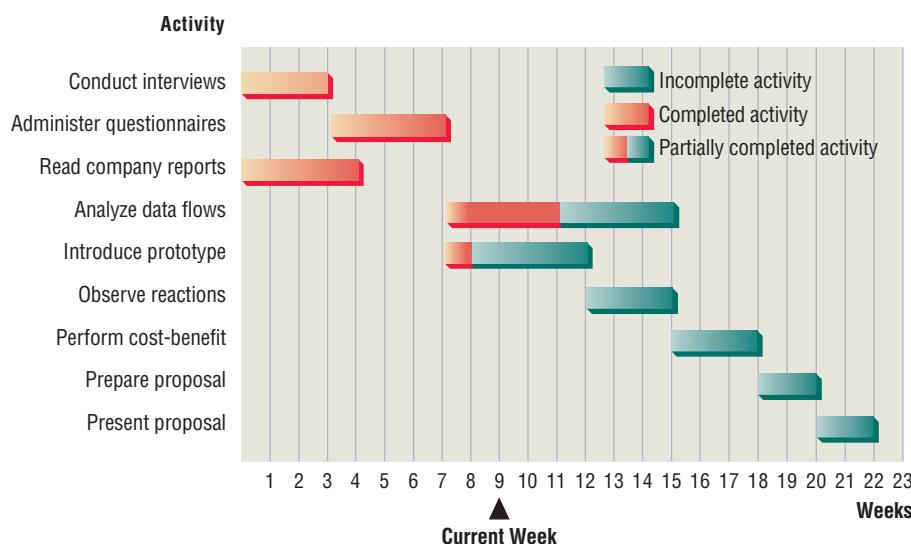
Planners have attempted to reduce the inherent uncertainty in determining time estimates by projecting most likely, pessimistic, and optimistic estimates and then using a weighted average formula to determine the expected time an activity will take. This approach offers little more in the way of confidence, however. Perhaps the best strategy for the systems analyst is to adhere to a structured approach in identifying activities and describing these activities in sufficient detail. In this manner, the systems analyst will at least be able to limit unpleasant surprises.

### Using Gantt Charts for Project Scheduling

A Gantt chart is an easy way to schedule tasks. It is a chart on which bars represent each task or activity. The length of each bar represents the relative length of the task.

Figure 3.18 is an example of a two-dimensional Gantt chart in which time is indicated on the horizontal dimension and a description of activities makes up the vertical dimension. In this example the Gantt chart shows the analysis or information gathering phase of the project. Notice on the Gantt chart that conducting interviews will take three weeks, administering the questionnaire will take four weeks, and so on. These activities overlap part of the time. In the chart the special symbol ▲ signifies that it is week 9. The bars with color shading represent projects or parts of projects that have been completed, telling us that the systems analyst is behind in introducing prototypes but ahead in analyzing data flows. Action must be taken on introducing prototypes soon so that other activities or even the project itself will not be delayed as a result.

The main advantage of the Gantt chart is its simplicity. The systems analyst will find not only that this technique is easy to use but also that it lends itself to worthwhile communication with end users. Another advantage of using a Gantt chart is that the bars representing activities or tasks are drawn to scale; that is, the size of the bar indicates the relative length of time it will take to complete each task.



**FIGURE 3.18**

Using a two-dimensional Gantt chart for planning activities that can be accomplished in parallel.

### Using PERT Diagrams

PERT is an acronym for Program Evaluation and Review Techniques. A program (a synonym for a project) is represented by a network of nodes and arrows that are then evaluated to determine the critical activities, improve the schedule if necessary, and review progress once the project is undertaken. PERT was developed in the late 1950s for use in the U.S. Navy's Polaris nuclear submarine project. It reportedly saved the U.S. Navy two years' development time.

PERT is useful when activities can be done in parallel rather than in sequence. The systems analyst can benefit from PERT by applying it to systems projects on a smaller scale, especially when some team members can be working on certain activities at the same time that fellow members are working on other tasks.

Figure 3.19 compares a simple Gantt chart with a PERT diagram. The activities expressed as bars in the Gantt chart are represented by arrows in the PERT diagram. The length of the arrows has no direct relationship with the activity durations. Circles on the PERT diagram are called events and can be identified by numbers, letters, or any other arbitrary form of designation. The circular nodes are present to (1) recognize that an activity is completed and (2) indicate which activities need to be completed before a new activity may be undertaken (precedence).

In reality activity C may not be started until activity A is completed. Precedence is not indicated at all in the Gantt chart, so it is not possible to tell whether activity C is scheduled to start on day 4 on purpose or by coincidence.

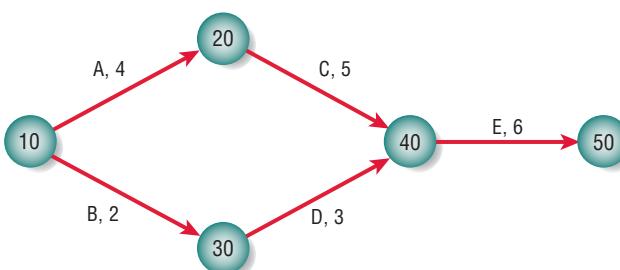
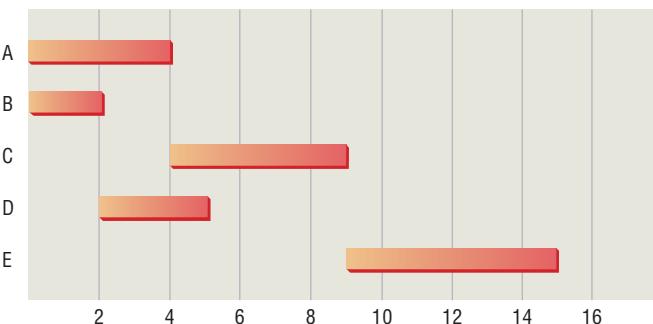
A project has a beginning, a middle, and an end; the beginning is event 10 and the end is event 50. To find the length of the project, each path from beginning to end is identified, and the length of each path is calculated. In this example path 10–20–40–50 has a length of 15 days, whereas path 10–30–40–50 has a length of 11 days. Even though one person may be working on path 10–20–40–50 and another on path 10–30–40–50, the project is not a race. The project requires that both sets of activities (or paths) be completed; consequently, the project takes 15 days to complete.

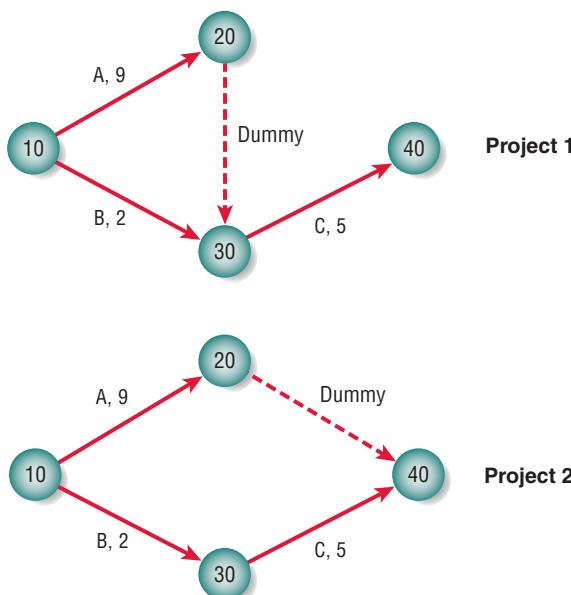
The longest path is referred to as the critical path. Although the critical path is determined by calculating the longest path, it is defined as the path that will cause the whole project to fall behind if even one day's delay is encountered on it. Note that if you are delayed one day on path 10–20–40–50, the entire project will take longer, but if you are delayed one day on path 10–30–40–50, the entire project will not suffer. The leeway to fall behind somewhat on noncritical paths is called slack time.

Occasionally, PERT diagrams need pseudo-activities, referred to as dummy activities, to preserve the logic of or clarify the diagram. Figure 3.20 shows two PERT diagrams with dummies. Project 1 and project 2 are quite different, and the way the dummy is drawn makes the difference

**FIGURE 3.19**

Gantt charts compared with PERT diagrams for scheduling activities.



**FIGURE 3.20**

Precedence of activities is important in determining the length of the project when using a PERT diagram.

clear. In project 1 activity C can only be started if both A and B are finished, because all arrows coming into a node must be completed before leaving the node. In project 2, however, activity C requires only activity B's completion and can therefore be under way while activity A is still taking place.

Project 1 takes 14 days to complete, whereas project 2 takes only 9 days. The dummy in project 1 is necessary, of course, because it indicates a crucial precedence relationship. The dummy in project 2, on the other hand, is not required, and activity A could have been drawn from 10 to 40 and event 20 may be eliminated completely.

Therefore, there are many reasons for using a PERT diagram over a Gantt chart. The PERT diagram allows:

1. Easy identification of the order of precedence.
2. Easy identification of the critical path and thus critical activities.
3. Easy determination of slack time.

**A PERT EXAMPLE.** Suppose a systems analyst is trying to set up a realistic schedule for the data gathering and proposal phases of the systems analysis and design life cycle. The systems analyst looks over the situation and lists activities that need to be accomplished along the way. This list, which appears in Figure 3.21, also shows that some activities must precede other activities. The time estimates were determined as discussed in an earlier section of this chapter.

**DRAWING THE PERT DIAGRAM.** In constructing the PERT diagram, the analyst looks first at those activities requiring no predecessor activities, in this case A (conduct interviews) and C (read company reports). In the example in Figure 3.22, the analyst chose to number the nodes 10, 20, 30, and so on, and he or she drew two arrows out of the beginning node 10. These arrows represent

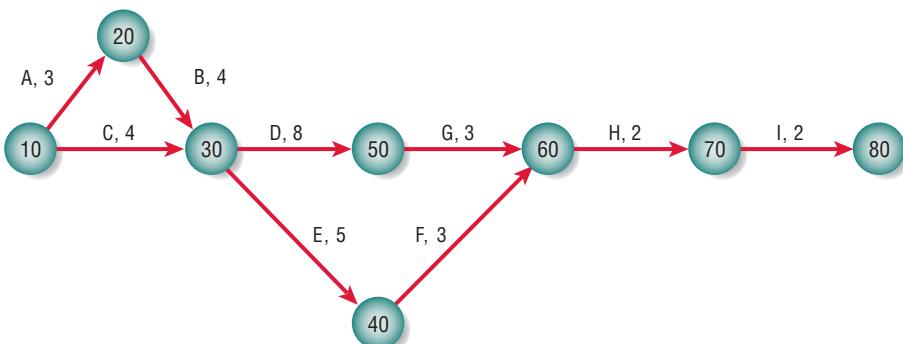
Activity	Predecessor	Duration
A Conduct interviews	None	3
B Administer questionnaires	A	4
C Read company reports	None	4
D Analyze data flow	B, C	8
E Introduce prototype	B, C	5
F Observe reactions to prototype	E	3
G Perform cost-benefit analysis	D	3
H Prepare proposal	F, G	2
I Present proposal	H	2

**FIGURE 3.21**

Listing activities for use in drawing a PERT diagram.

**FIGURE 3.22**

A completed PERT diagram for the analysis phase of a systems project.



activities A and C and are labeled as such. Nodes numbered 20 and 30 are drawn at the end of these respective arrows. The next step is to look for any activity requiring only A as a predecessor; task B (administer questionnaires) is the only one, so it can be represented by an arrow drawn from node 20 to node 30.

Because activities D (analyze data flow) and E (introduce prototype) require both activities B and C to be finished before they are started, arrows labeled D and E are drawn from node 30, the event that recognizes the completion of both B and C. This process is continued until the entire PERT diagram is completed. Notice that the entire project ends at an event called node 80.

**IDENTIFYING THE CRITICAL PATH.** Once the PERT diagram is drawn, it is possible to identify the critical path by calculating the sum of the activity times on each path and choosing the longest path. In this example, there are four paths: 10–20–30–50–60–70–80, 10–20–30–40–60–70–80, 10–30–50–60–70–80, and 10–30–40–60–70–80. The longest path is 10–20–30–50–60–70–80, which takes 22 days. It is essential that the systems analyst carefully monitors the activities on the critical path so as to keep the entire project on time or even shorten the project length if warranted.

## MANAGING THE PROJECT

The process of analysis and design can become unwieldy, especially when the system being developed is large. To keep the development activities as manageable as possible, we usually employ some of the techniques of project management to help us get organized.

One important aspect of project management is how to manage one's schedule to finish the system on time, but it is not the only thing needed. The person in charge, called the project manager, is often the lead systems analyst. The project manager needs to understand how to determine what is needed and how to initiate a project; how to develop a problem definition; how to examine feasibility of completing the systems project; how to reduce risk; how to identify and manage activities; and how to hire, manage, and motivate other team members.

### Addressing System Complexity

Estimating models, such as Costar ([www.softstarsystems.com](http://www.softstarsystems.com)) or Construx ([www.construx.com](http://www.construx.com)), work as follows: First the systems analyst enters an estimate of the size of the system. This can be entered in a number of different ways, including the lines of source code of the current system. Then it may be helpful to adjust the degree of difficulty based on how familiar the analyst is with this type of project.

Also considered are other variables, like the experience or capability of the team, the type of platform or operating system, the level of usability of the finished software (for example, what languages are necessary), and other factors that can drive up costs. Once the data are entered, calculations are made, and a rough projection of the completion date is produced. As the project gets underway, more specific estimates are possible.

Another way of estimating the amount of work that needs to be done and how large a staff one needs to complete a project is called function point analysis. This method takes the five main components of a computer system—(1) external inputs, (2) external outputs, (3) external queries, (4) internal logical files, and (5) external interface files—and then rates them in terms of complexity.

Function point analysis can estimate the time it takes to develop a system in different computer languages and compare them to one another. For more information about function point analysis, visit the International Function Point Users Group's Web site at [www.ifpug.org](http://www.ifpug.org).

The screenshot shows the OmniPlan application window titled "World's Trend Web site.omniplan". The interface includes a toolbar with icons for View, Group, Connection, Assignment, Level, Set Baseline, Catch Up, and Reschedule. The main area has two columns: "Task" on the left and a Gantt chart on the right. The Gantt chart spans two weeks, Week 1 and Week 2. Tasks are color-coded by resource: blue for Joel; green for Bobbie; red for Charlie; and purple for Nancy and Jeff. Some tasks have multiple resource assignments. The task list on the left includes Phase 1, Short Releases (Mock-ups, Review), Public Release, Promotion, and Project completion, each with several sub-tasks.

**FIGURE 3.MAC**

OmniPlan project management software from The Omni Group.

## MANAGING ANALYSIS AND DESIGN ACTIVITIES

Along with managing time and resources, systems analysts must also manage people. Management is accomplished primarily by communicating accurately to team members who have been selected for their competency and compatibility. Goals for project productivity must be set, and members of systems analysis teams must be motivated to achieve them.

### Assembling a Team

Assembling a team is desirable. If a project manager has the opportunity to create a dream team of skilled people to develop a system, whom should he or she choose? In general, project managers need to look for others who share their values of teamwork guided by the desire to deliver a high-quality system on time and on budget. Other desirable team member characteristics include a good work ethic, honesty, competency; a readiness to take on leadership based on expertise; motivation, enthusiasm for the project, and trust of teammates.

The project manager needs to know about business principles, but it doesn't hurt to have at least one other person on the team who understands how a business operates. Perhaps this person should be a specialist in the same area as the system being developed. When developing an ecommerce site, teams can enlist the help of someone in marketing; those developing an inventory system can ask a person versed in production and operations to provide expertise.

A team ideally should have two systems analysts on it. They can help each other, check each other's work, and shift their workloads accordingly. There is certainly a need to have people with



## HYPERCASE® EXPERIENCE 3.1

**I**hope everyone you've encountered at MRE has treated you well. Here's a short review of some of the ways you can access our organization through HyperCase. The reception area at MRE contains the key links to the rest of our organization. Perhaps you've already discovered these on your own, but I wanted to remind you of them now, because I don't want to get so engrossed in the rest of our organizational problems that I forget to mention them.

"The empty doorway you see is a link to the next room, which we call the East Atrium. You have probably noticed that all open doorways are links to adjacent rooms. Notice the building map displayed in the reception area. You are free to go to public areas such as the canteen, but as you know, you must have an employee escort you into a private office. You cannot go there on your own.

"By now you have probably noticed the two documents and the computer on the small table in the reception area. The little one is the MRE internal phone directory. Just click on an employee name, and if that person is in, he or she will grant you an interview and a tour of the office. I leave you to your own devices in figuring out what the other document is.

"The computer on the table is on and displays the Web home page for MRE. You should take a look at the corporate site and visit

all the links. It tells the story of our company and the people who work here. We're quite proud of it and have gotten positive feedback about it from visitors.

"If you have had a chance to interview a few people and see how our company works, I'm sure you are becoming aware of some of the politics involved. We are also worried, though, about more technical issues, such as what constitutes feasibility for a training project and what does not."

### HYPERCASE Questions

1. What criteria does the Training Unit use to judge the feasibility of a new project? List them.
2. List any changes or modifications to these criteria that you would recommend.
3. Snowden Evans has asked you to help prepare a proposal for a new project tracking system for the Training Unit. Briefly discuss the technical, economic, and operational feasibility of each alternative for a proposed project tracking system for the Training Unit.
4. Which option would you recommend? Use evidence from HyperCase to support your decision.

programming skills on board. Coding is important, but people who know how to conduct walk-throughs, reviews, testing, and documenting systems are important as well. Some people are good at seeing the big picture, while others perform well when tasks are broken down into smaller ones for them. Every team should have both types of individuals.

Beyond the basics, a project manager should look for people with both experience and enthusiasm. Experience is especially important when trying to estimate the time required to complete a project. Experience in programming can mean code is developed five times faster than if it is developed by an inexperienced team. A usability expert is also a useful addition to the team.

The team must be motivated. One way to keep the team positively oriented throughout the entire process is to select good people at the outset. Look for enthusiasm, imagination, and an ability to communicate with different kinds of people. These basic attributes hold the potential for success. It also helps to hire superior writers and articulate speakers who can present proposals and work directly with customers.

Trust is an important part of a team. All members of the project need to act responsibly and agree to do their best and complete their part of the project. People may have different work styles, but they all need to agree to work together toward a common goal.

### Communication Strategies for Managing Teams

Teams have their own personalities, a result of combining each individual team member with every other in a way that creates a totally new network of interactions. A way to organize your thinking about teams is to visualize them as always seeking a balance between accomplishing the work at hand and maintaining the relationships among team members.

In fact, teams will often have two leaders, not just one. Usually one person will emerge who leads members to accomplish tasks, and another person will emerge who is concerned with the social relationships among group members. Both are necessary for the team. These individuals



## CONSULTING OPPORTUNITY 3.5

### Goal Tending

**H**ere's what I think we can accomplish in the next five weeks," says Hy, the leader of your systems analysis team, as he confidently pulls out a schedule listing each team member's name alongside a list of short-term goals. Just a week ago your systems analysis team went through an intense meeting on expediting their project schedule for the Kitchener, Ontario, Redwings, a hockey organization whose management is pressuring you to produce a prototype.

The three other members of the team look at the chart in surprise. Finally, one of the members, Rip, speaks: "I'm in shock. We each have so much to do as it is, and now this."

Hy replies defensively, "We've got to aim high, Rip. They're in the off-season. It's the only time to get them. If we set our goals too low, we won't finish the system prototype, let alone the system itself, before another hockey season passes. The idea is to give the Kitchener Redwings the fighting edge through the use of their new system."

Fiona, another team member, enters the discussion, saying, "Goodness knows their players can't give them that!" She pauses

for the customary groan from the assembled group, then continues. "But seriously, these goals are killers. You could have at least asked us what we thought, Hy. We may even know better than you what's possible."

"This is a pressing problem, not a tea party, Fiona," Hy replies. "Polite polling of team members was out of the question. Something had to be done quickly. So I went ahead with these. I say we submit our schedule to management based on this. We can push back deadlines later if we have to. But this way they'll know we're committed to accomplishing a lot during the off-season."

As a fourth team member listening to the foregoing exchange, formulate three suggestions that would help Hy improve his approach to goal formation and presentation. How well motivated do you think the team will be if they share Fiona's view of Hy's goals? What are the possible ramifications of supplying management with overly optimistic goals? Write one paragraph devoted to short-term effects and another one discussing the long-term effects of setting unrealistically high goals.

have been labeled by other researchers as, respectively, task leader and socioemotional leader. Every team is subject to tensions that are an outgrowth of seeking a balance between accomplishing tasks and maintaining relationships among team members.

For the team to continue its effectiveness, tensions must be continually resolved. Minimizing or ignoring tensions will lead to ineffectiveness and eventual disintegration of the team. Much of the tension release necessary can be gained through skillful use of feedback by all team members. All members, however, need to agree that the way they interact (i.e., process) is important enough to merit some time. Productivity goals for processes are discussed in a later section.

Securing agreement on appropriate member interaction involves creating explicit and implicit team norms (collective expectations, values, and ways of behaving) that guide members in their relationships. A team's norms belong to it and will not necessarily transfer from one team to another. These norms change over time and are better thought of as a team process of interaction rather than a product.

Norms can be functional or dysfunctional. Just because a particular behavior is a norm for a team does not mean it is helping the team to achieve its goals. For example, an expectation that junior team members should do all project scheduling may be a team norm. By adhering to this norm, the team is putting extreme pressure on new members and not taking full advantage of the experience of the team. It is a norm that, if continued, could make team members waste precious resources.

Team members need to make norms explicit and periodically assess whether norms are functional or dysfunctional in helping the team achieve its goals. The overriding expectation for your team must be that change is the norm. Ask yourself whether team norms are helping or hindering the team's progress.

### Setting Project Productivity Goals

When you have worked with your team members on various kinds of projects, you or your team leader will acquire acumen for projecting what the team can achieve in a specific amount of time. Using the hints discussed in the earlier section in this chapter on methods for estimating time required and coupling them with experience will enable the team to set worthwhile productivity goals.

Systems analysts are accustomed to thinking about productivity goals for employees who show tangible outputs, such as the number of blue jeans sewn per hour, the number of entries keyed in per minute, or the number of items scanned per second. As manufacturing productivity rises, however, it is becoming clear that managerial productivity must keep pace. It is with this aim in mind that productivity goals for the systems analysis team are set.

Goals need to be formulated and agreed to by the team, and they should be based on team members' expertise, former performance, and the nature of the specific project. Goals will vary somewhat for each project undertaken, because sometimes an entire system will be installed, whereas other projects might involve limited modifications to a portion of an existing system.

### Motivating Project Team Members

Although motivation is an extremely complex topic, it is a good one to consider, even if briefly, at this point. To oversimplify, recall that people join organizations to provide for some of their basic needs such as food, clothing, and shelter. All humans, however, also have higher-level needs, which include affiliation, control, independence, and creativity. People are motivated to fulfill unmet needs on several levels.

Team members can be motivated, at least partially, through participation in goal setting, as described in the previous section. The very act of setting a challenging but achievable goal and then periodically measuring performance against the goal seems to work in motivating people. Goals act almost as magnets in attracting people to achievement.

Part of the reason goal setting motivates people is that team members know prior to any performance review exactly what is expected of them. The success of goal setting for motivating can also be ascribed to it, affording each team member some autonomy in achieving the goals. Although a goal is predetermined, the means to achieve it may not be. In this instance team members are free to use their own expertise and experience to meet their goals.

Setting goals can also motivate team members by clarifying for them and others what must be done to get results. Team members are also motivated by goals because goals define the level of achievement that is expected of them. This use of goals simplifies the working atmosphere, but it also electrifies it with the possibility that what is expected can indeed be done.

### Managing Ecommerce Projects

Many of the approaches and techniques discussed earlier are transferable to ecommerce project management. You should be cautioned, however, that although there are many similarities, there are also many differences. One difference is that the data used by ecommerce systems are scattered all over the organization. Therefore, you are not just managing data in a self-contained department or even one solitary unit. Hence, many organizational politics can come into play, because units often feel protective of the data they generate and do not understand the need to share them across the organization.

Another stark difference is that ecommerce project teams typically need more staff with a variety of skills, including developers, consultants, database experts, and system integrators, from across the organization. Neatly defined, stable project groups that exist within a cohesive IS group or systems development team will be the exception rather than the rule. In addition, because so much help may be required initially, ecommerce project managers need to build partnerships externally and internally well ahead of the implementation, perhaps sharing talent across projects to defray costs of ecommerce implementations and to muster the required numbers of people with the necessary expertise. The potential for organizational politics to drive a wedge between team members is very real.

One way to prevent politics from sabotaging a project is for the ecommerce project manager to emphasize the integration of the ecommerce with the organization's internal systems and in so doing emphasize the organizational aspect embedded in the ecommerce project. As one ecommerce project manager told us, "Designing the front end [what the consumer sees] is the easy part of all this. The real challenge comes from integrating ecommerce strategically into all the organization's systems."

A fourth difference between traditional project management and ecommerce project management is that because the system will be linking with the outside world via the Internet, security is of the utmost importance. Developing and implementing a security plan before the new system is in place is a project in and of itself and must be managed as such.

## Creating the Project Charter

Part of the planning process is to agree on what will be done and at what time. Analysts who are external consultants, as well as those who are organization members, need to specify what they will eventually deliver and when they will deliver it. This chapter has elaborated on ways to estimate the delivery date for the completed system and also how to identify organizational goals and assess the feasibility of the proposed system.

The project charter is a written narrative that clarifies the following questions:

1. What does the user expect of the project (what are the objectives)? What will the system do to meet the needs (achieve the objectives)?
2. What is the scope (or what are the boundaries) of the project? (What does the user consider to be beyond the project's reach?)
3. What analysis methods will the analyst use to interact with users in gathering data, developing, and testing the system?
4. Who are the key participants? How much time are users willing and able to commit to participating?
5. What are the project deliverables? (What new or updated software, hardware, procedures, and documentation do the users expect to have available for interaction when the project is done?)
6. Who will evaluate the system and how will they evaluate it? What are the steps in the assessment process? How will the results be communicated and to whom?
7. What is the estimated project timeline? How often will analysts report project milestones?
8. Who will train the users?
9. Who will maintain the system?

The project charter describes in a written document the expected results of the systems project (deliverables) and the time frame for delivery. It essentially becomes a contract between the chief analyst (or project manager) and their analysis team with the organizational users requesting the new system.

## Avoiding Project Failures

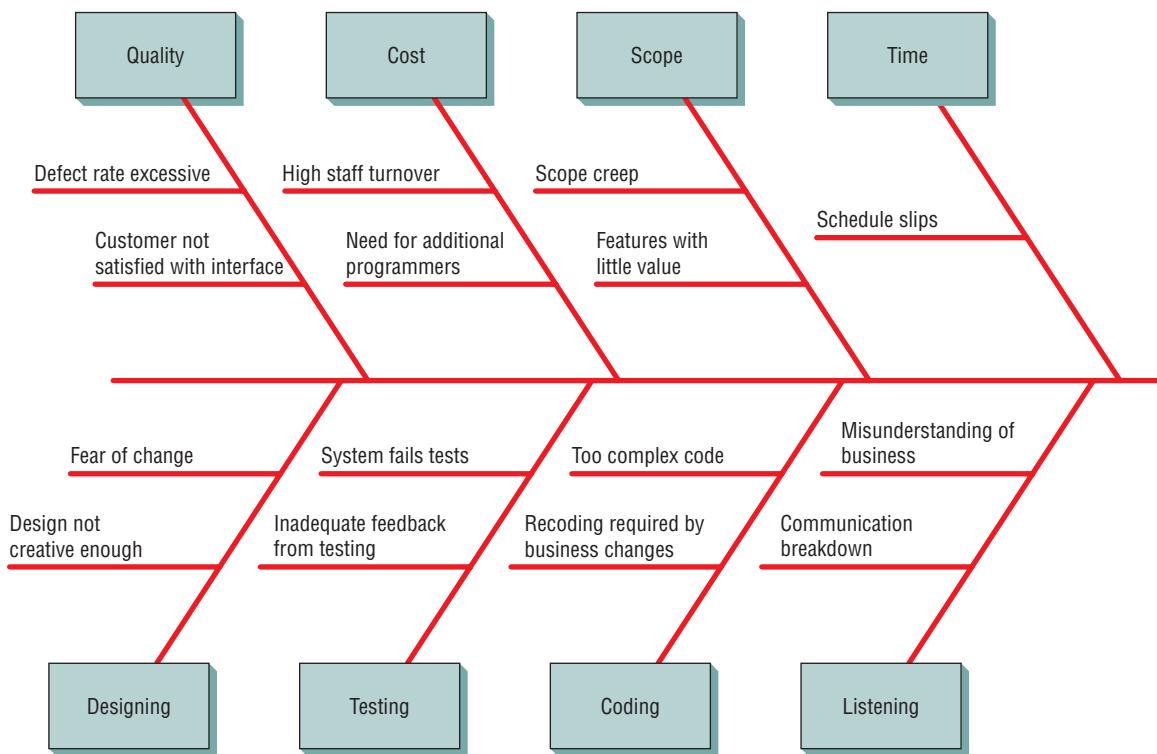
The early discussions you have with management and others requesting a project, along with the feasibility studies you do, are usually the best defenses possible against taking on projects that have a high probability of failure. Your training and experience will improve your ability to judge the worthiness of projects and the motivations that prompt others to request projects. If you are part of an in-house systems analysis team, you must keep current with the political climate of the organization as well as with financial and competitive situations.

It is important, however, to note that systems projects can and do have serious problems. Those that are developed using agile methods are not immune to such troubles. In order to illustrate what can go wrong in a project, a systems analyst may want to draw a fishbone diagram (also called a cause-and-effect diagram or an Ishikawa diagram). When you examine Figure 3.23, you will see that it is called a fishbone diagram because it resembles the skeleton of a fish.

The value of fishbone diagrams is to systematically list all the possible problems that can occur. In the case of the agile approach, it is useful to organize the fishbone diagram by listing all the resource control variables on the top and all the activities on the bottom. Some problems such as schedule slips might be obvious, but others such as scope creep (the desire to add features after the analyst hears new stories) or developing features with little value are not as obvious.

You can also learn from the wisdom gained by people involved in earlier project failures. When asked to reflect on why projects had failed, professional programmers cited the setting of impossible or unrealistic dates for completion by management, belief in the myth that simply adding more people to a project would expedite it (even though the original target date on the project was unrealistic), and management behaving unreasonably by forbidding the team to seek professional expertise from outside of the group to help solve specific problems.

Remember that you are not alone in the decision to begin a project. Although apprised of your team's recommendations, management will have the final say about whether a proposed project is worthy of further study (that is, further investment of resources). The decision process of your team must be open and stand up to scrutiny from those outside of it. The team members should

**FIGURE 3.23**

A fishbone diagram may be used to identify all the things that can go wrong in developing a system.

consider that their reputation and standing in the organization are inseparable from the projects they accept.

## THE SYSTEMS PROPOSAL

### Organizing the Systems Proposal

While the project charter serves the purpose of identifying objects, determining scope, and assigning responsibilities, the analyst still needs to prepare a systems proposal that includes much of the detail about system needs, options, and recommendations. This section covers both the content and style that makes up a systems proposal.

**WHAT TO INCLUDE IN THE SYSTEMS PROPOSAL.** Ten main sections comprise the written systems proposal. Each part has a particular function, and the eventual proposal should be arranged in the following order:

1. Cover letter.
2. Title page of project.
3. Table of contents.
4. Executive summary (including recommendations).
5. Outline of systems study with appropriate documentation.
6. Detailed results of the systems study.
7. Systems alternatives (three or four possible solutions).
8. Systems analysts' recommendations.
9. Proposal summary.
10. Appendices (assorted documentation, summary of phases, correspondence, and so on).

A cover letter to managers and the IT task force should accompany the systems proposal. It should list the people who did the study and summarize the objectives of the study. Keep the cover letter concise and friendly.

Include on the title page the name of the project, the names of the systems analysis team members, and the date the proposal is submitted. The proposal title must accurately express the content of the proposal, but it can also exhibit some imagination. The table of contents can be useful to readers of long proposals. If the proposal is less than 10 pages long, omit the table of contents.

The executive summary, in 250 to 375 words, provides the who, what, when, where, why, and how of the proposal, just as would the first paragraph in a news story. It should also include the recommendations of the systems analysts and desired management action, because some people will only have time to read the summary. It should be written last, after the rest of the proposal is complete.

The outline of the systems study provides information about all the methods used in the study and who or what was studied. Any questionnaires, interviews, sampling of archival data, observation, or prototyping used in the systems study should be discussed in this section.

This detailed results section describes what the systems analyst has found out about human and systems needs through all the methods described in the preceding section. Conclusions about problems workers experience when interacting with technologies and systems that have come to the fore through the study should be noted here. This section should raise the problems or suggest opportunities that call forth the alternatives presented in the next section.

In the systems alternatives section of the proposal, the analyst presents two or three alternative solutions that directly address the aforementioned problems. The alternatives you present should include one that recommends keeping the system the same. Each alternative should be explored separately. Describe the costs and benefits of each situation. Because there are usually trade-offs involved in any solution, be sure to include the advantages and disadvantages of each.

Each alternative must clearly indicate what users and managers must do to implement it. The wording should be as clear as possible, such as, “Buy notebook computers for all middle managers,” “Purchase packaged software to support users in managing inventory,” or “Modify the existing system through funding in-house programming efforts.”

After the systems analysis team has weighed the alternatives, it will have a definite professional opinion about which solution is most workable. The systems analysts’ recommendations section expresses the *recommended* solution. Include the reasons supporting the team’s recommendation so that it is easy to understand why it is being made. The recommendation should flow logically from the preceding analysis of alternative solutions, and it should clearly relate the human–computer interaction findings to the choice offered.

The proposal summary is a brief statement that mirrors the content of the executive summary. It gives the objectives of the study and the recommended solution. The analyst should once more stress the project’s importance and feasibility along with the value of the recommendations for reaching the users’ goals and improving the business. Conclude the proposal on a positive note.

The appendix is the last part of the systems proposal, and it can include any information that the systems analyst feels may be of interest to specific individuals, but that is not essential for understanding the systems study and what is being proposed.

Once the systems proposal is written, carefully select who should receive the report. Personally hand the report to the people you have selected. Your visibility is important for the acceptance and eventual success of the system.

## Using Figures for Effective Communication

The emphasis so far in this section has been on considering your audience when composing the systems proposal. Tables and graphs as well as words are important in capturing and communicating the basics of the proposed system. Good design should never be underestimated.

Integrating figures into your proposal helps demonstrate that you are responsive to the different ways people absorb information. Figures in the report supplement written information and must always be interpreted in words; they should never stand alone.

**EFFECTIVE USE OF TABLES.** Although tables are technically not visual aids, they provide a different way of grouping and presenting analyzed data that the analyst wants to communicate to the proposal reader.

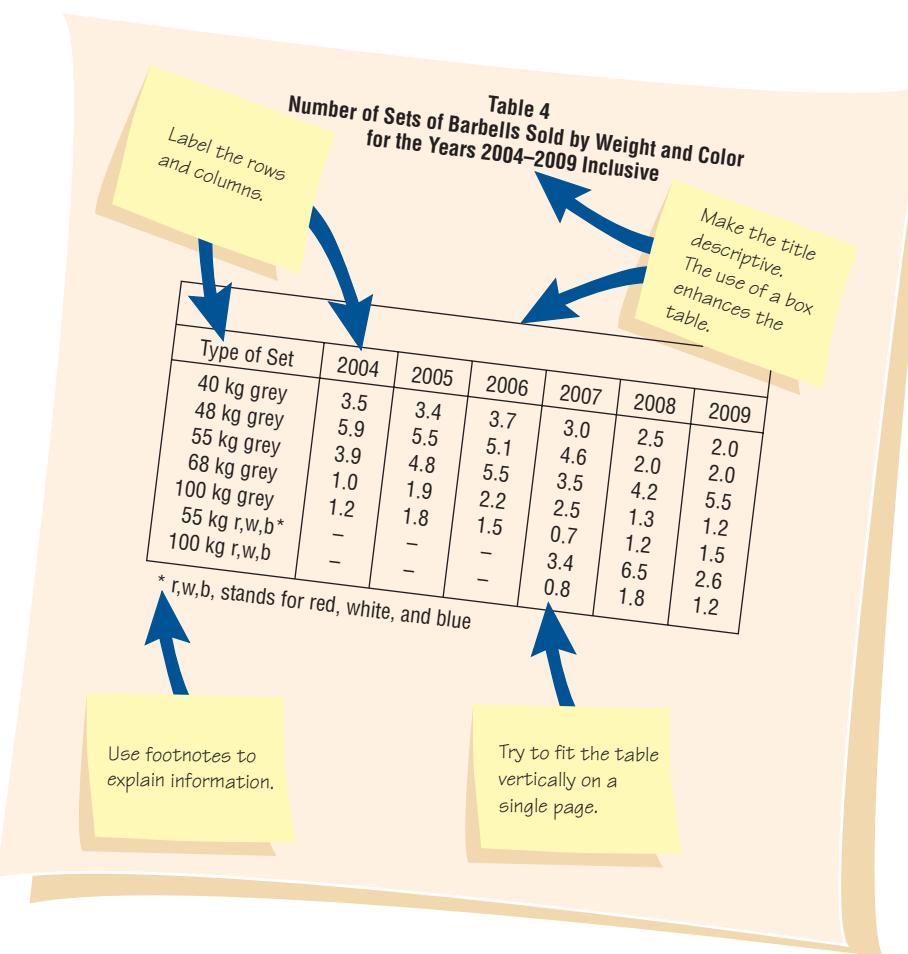
Tables use labeled columns and rows to present statistical or alphabetical data in an organized way. Each table must be numbered according to the order in which it appears in the proposal and should be meaningfully titled. Figure 3.24 shows the appropriate layout and labeling for a table.

Some guidelines for tables are the following:

1. Integrate tables into the body of the proposal. Don’t relegate them to the appendices.
2. Try to fit the entire table vertically on a single page if possible.

**FIGURE 3.24**

Guidelines for creating effective tables.



3. Number and title the table at the top of the page. Make the title descriptive and meaningful.
4. Label each row and column. Use more than one line for a title if necessary.
5. Use a boxed table if room permits. Vertically ruled columns will enhance the readability.
6. Use footnotes if necessary to explain detailed information contained in the table.

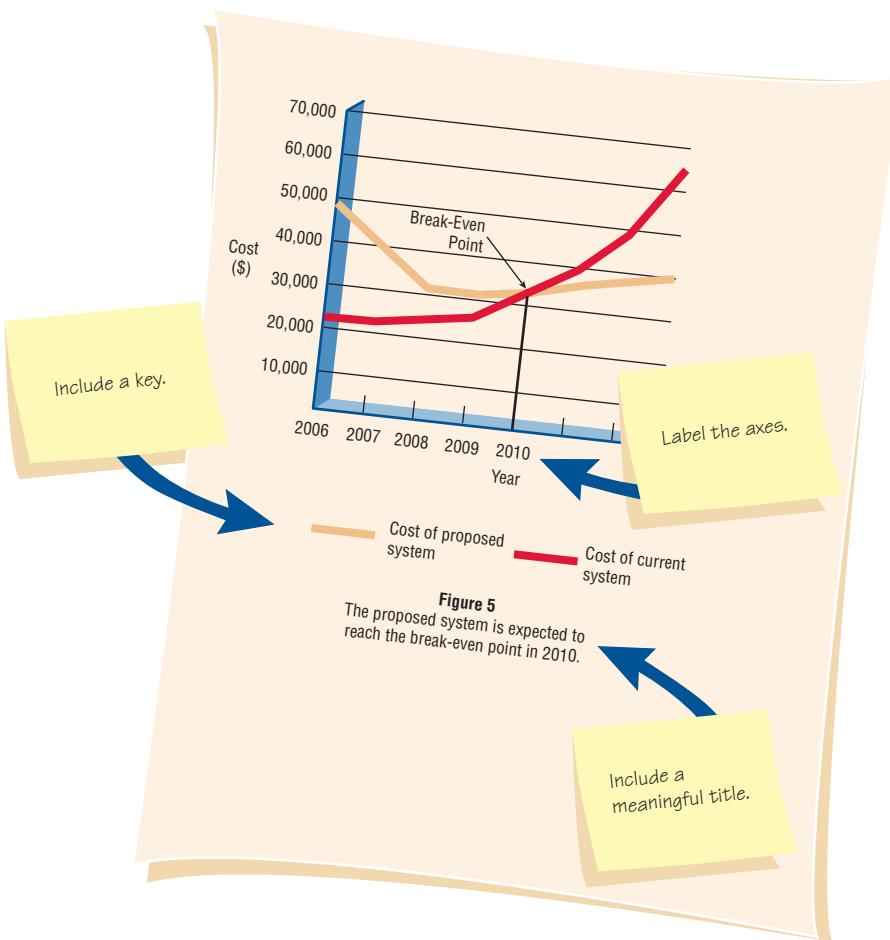
Several methods for comparing costs and benefits were presented in previous sections. Tabled results of those comparisons should appear in the systems proposal. If a break-even analysis is done, a table illustrating results of the analysis should be included. Payback can be shown in tables that serve as additional support for graphs. A short table comparing computer systems or options might also be included in the systems proposal.

**EFFECTIVE USE OF GRAPHS.** There are many different kinds of graphs: line graphs, column graphs, bar charts, and pie charts to name a few. Line graphs, column graphs, and bar charts compare variables, whereas pie charts and area charts illustrate the composition of 100 percent of an entity.

The guidelines for including effective graphs in a proposal (see Figure 3.25) are as follows:

1. Choose a style of graph that communicates your intended meaning well.
2. Integrate the graph into the body of the proposal.
3. Give the graph a sequential figure number and a meaningful title.
4. Label each axis and any lines, columns, bars, or pieces of the pie on the graph.
5. Include a key to indicate differently colored lines, shaded bars, or crosshatched areas.

Much of the detail that goes into a systems proposal is obtained from interviewing, providing questionnaires, sampling, discovering other hard data, and by observation. These topics are discussed in the next two chapters.

**FIGURE 3.25**

Guidelines for drawing effective line graphs.

## SUMMARY

The five major project management fundamentals that the systems analyst must handle are (1) project initiation—defining the problem, (2) determining project feasibility, (3) activity planning and control, (4) project scheduling, and (5) managing systems analysis team members. When faced with questions of how businesses can meet their goals and solve systems problems, the analyst creates a problem definition. A problem definition is a formal statement of the problem, including (1) the issues of the present situation, (2) the objectives for each issue, (3) the requirements that must be included in all proposed systems, and (4) the constraints that limit system development.

Selecting a project is a difficult decision, because more projects will be requested than can actually be done. Five important criteria for project selection are (1) that the requested project be backed by management, (2) that it be timed appropriately for a commitment of resources, (3) that it move the business toward attainment of its goals, (4) that it be practical, and (5) that it be important enough to be considered over other possible projects.

If a requested project meets these criteria, a feasibility study of its operational, technical, and economic merits can be done. Through the feasibility study, systems analysts gather data that enable management to decide whether to proceed with a full systems study. By inventorying equipment already on hand and on order, systems analysts will be able to better determine whether new, modified, or current computer hardware is to be recommended.

Computer hardware can be acquired through purchase, lease, or rental. Vendors will supply support services such as preventive maintenance and user training that are typically negotiated separately. Software can be created as a custom product, purchased as a commercial off-the-shelf (COTS) software package, or outsourced to an application service provider (ASP).

Preparing a systems proposal means identifying all the costs and benefits of a number of alternatives. The systems analyst has a number of methods available to forecast future costs, benefits, volumes of transactions, and economic variables that affect costs and benefits. Costs and benefits can be tangible

## HYPERCASE® EXPERIENCE 3.2

**S**ometimes the people who have been here for some time are surprised at how much we have actually grown. Yes, I do admit that it isn't easy to keep track of what each person is up to or even what purchases each department has made in the way of hardware and software. We're working on it, though. Snowden would like to see more accountability for computer purchases. He wants to make sure we know what we have, where it is, why we have it, who's using it, and if it's boosting MRE productivity, or, as he so delicately puts it, 'to see whether it's just an expensive toy' that we can live without."

### HYPERCASE Questions

1. Complete a computer equipment inventory for the Training and Management Systems Unit, describing all the systems

you find. Hint: Create an inventory form to simplify your task.

2. Using the software evaluation guidelines given in the text, do a brief evaluation of GEMS, a software package used by the Management Systems employees. In a paragraph, briefly critique this custom software by comparing it with commercial off-the-shelf software such as Microsoft Project.
3. List the intangible costs and benefits of GEMS as reported by employees of MRE.
4. Briefly describe the two alternatives Snowden is considering for the proposed project tracking and reporting system.
5. What organizational and political factors should Snowden consider in proposing his new system at MRE? (In a brief paragraph, discuss three central conflicts.)



**FIGURE 3.HC1**

The reception room resembles a typical corporation. While you are in this HyperCase screen, find the directory if you want to visit someone.

(quantifiable) or intangible (nonquantifiable and resistant to direct comparison). A systems analyst has many methods for analyzing costs and benefits, including break-even analysis, the payback method, and cash-flow analysis.

Project planning includes the estimation of time required for each of the analyst's activities, scheduling them, and expediting them if necessary to ensure that a project is completed on time. One technique available to the systems analyst for scheduling tasks is the Gantt chart, which displays activities as bars on a graph.

Another technique, called Program Evaluation and Review Techniques (PERT), displays activities as arrows on a network. PERT helps the analyst determine the critical path and slack time, which is the information required for effective project control.

Creating a project charter containing user expectations and analyst deliverables is recommended, since unrealistic management deadlines, adding unneeded personnel to a project that is trying to meet an unrealistic deadline, and not permitting developer teams to seek expert help outside their immediate group, were cited by programmers as reasons projects had failed. Project failures can usually be avoided by examining the motivations for requested projects, as well as your team's motives for recommending or avoiding a particular project.

The systems analyst has three main steps to follow for putting together an effective systems proposal: effectively organizing the proposal content, writing the proposal in an appropriate business style, and orally presenting an informative systems proposal. To be effective, the proposal should be written in a clear and understandable manner, and its content should be divided into 10 functional sections. Visual considerations are important when putting together a proposal.

## KEYWORDS AND PHRASES

benchmarking	present value
break-even analysis	problem definition
cash-flow analysis	productivity goals
critical path	project charter
ecommerce project management	socioemotional leader
economic feasibility	systems proposal
forecasting	tangible benefits
function point analysis	tangible costs
Gantt chart	task leader
intangible benefits	team motivation
intangible costs	team norms
moving average	team process
operational feasibility	technical feasibility
payback	vendor support
PERT diagram	

## REVIEW QUESTIONS

1. What are the five major project fundamentals?
2. List three ways to find out about problems or opportunities that might call for a systems solution.
3. List the five criteria for systems project selection.
4. Define technical feasibility.
5. Define economic feasibility.
6. Define operational feasibility.
7. List four criteria for evaluating system hardware.
8. What are the three main options for the acquisition of computer hardware?
9. What does COTS stand for?
10. What does ASP stand for in terms of software delivery?
11. Define tangible costs and benefits. Give an example of each one.
12. Define intangible costs and benefits. Give an example of each one.
13. List four techniques for comparing the costs and benefits of a proposed system.
14. When is break-even analysis useful?
15. What are the three drawbacks of using the payback method?
16. When is cash-flow analysis used?
17. As a general guideline, when should present value analysis be used?
18. What is a Gantt chart?
19. When is a PERT diagram useful for systems projects?
20. List three advantages of using a PERT diagram over a Gantt chart for scheduling systems projects.
21. Define the term *critical path*.
22. How does a project manager assess the risk of things going wrong and take that into consideration when planning the time needed to complete the project?
23. List the two types of team leaders.
24. What is meant by a dysfunctional team norm?
25. What is meant by team process?
26. What are three reasons that goal setting seems to motivate systems analysis team members?
27. What are four ways in which ecommerce project management differs from traditional project management?
28. What elements are contained in a project charter?

29. What is a fishbone diagram used for?
30. What are the three steps the systems analyst must follow to put together an effective systems proposal?
31. List the 10 main sections of the systems proposal.

## PROBLEMS

1. Williwonk's Chocolates of St. Louis makes an assortment of chocolate candy and candy novelties. The company has six in-city stores, five stores in major metropolitan airports, and a small mail-order branch. Williwonk's has a small, computerized information system that tracks inventory in its plant, helps schedule production, and so on, but this system is not tied directly into any of its retail outlets. The mail-order system is handled manually.

Recently, several Williwonk's stores experienced a rash of complaints from mail-order customers that the candy was spoiled upon arrival, that it did not come when promised, or that it never arrived; the company also received several letters complaining that candy in various airports tasted stale. Williwonk's has been selling a new, low-carb, dietetic form of chocolate made with sugar-free, artificial sweetener. Sales have been brisk, but there have been problems shipping the wrong type of chocolate to an address with a diabetic person. There were a number of complaints, and Williwonk's sent a number of free boxes of chocolate to ease the situation.

Management would like to sell products using the Web but only has a few Web pages with information about the company and an order form that could be printed. Web ordering does not exist. One of the senior executives would like to sell customized chocolates with the name of a person on each piece. Although the production area has assured management that this could be easily done, there is no method to order customized chocolates.

Another senior executive has mentioned that Williwonk's has partnered with several European chocolate manufacturers and will be importing chocolate from a variety of countries. At present, this must be done over the phone, by email, or by mail. The executive wants an internal Web site that will enable employees to order directly from the partner companies. All this has led a number of managers to request trend analysis. Too much inventory results in stale chocolate, while at other times there is a shortage of a certain kind of chocolate.

Seasonal and holiday variation trends would help Williwonk's maintain an adequate inventory. The inventory control manager has insisted that all changes must be implemented before the next holiday season. "The time for this to be complete is an absolute due date," remarked Candy, a senior manager. "Make sure that everything works perfectly before the site goes public," she continues. "I don't want any customers receiving the wrong chocolates!" In addition, the order processing manager has mentioned that the system must be secure.

You had been working for two weeks with Williwonk's on some minor modifications for its inventory information system when you overheard two managers discussing these occurrences. List the possible opportunities or problems among them that might lend themselves to systems projects.

2. Where is most of the feedback on problems with Williwonk's products coming from in Problem 1? How reliable are the sources? Explain in a paragraph.
3. After getting to know them better, you have approached Williwonk's management people with your ideas on possible systems improvements that could address some of the problems or opportunities given in Problem 1.
  - a. In two paragraphs, provide your suggestions for systems projects. Make any realistic assumptions necessary.
  - b. Are there any problems or opportunities discussed in Problem 1 that are not suitable? Explain your response.
4. Create a problem definition for Williwonk's, as described in Problem 1. Estimate the weights of importance. Include at least one requirement and one constraint.
5. Create a list of user requirements for the problem definition created in Problem 4.
6. Delicato, Inc., a manufacturer of precise measuring instruments for scientific purposes, has presented you with a list of attributes that its managers think are probably important in selecting a vendor for computer hardware and software. The criteria are not listed in order of importance.
  1. Low price.
  2. Precisely written software for engineering applications.
  3. Vendor performs routine maintenance on hardware.
  4. Training for Delicato employees.
    - a. Critique the list of attributes in a paragraph.
    - b. Using its initial input, help Delicato, Inc., draw up a more suitable list of criteria for selecting computer hardware and software vendors.
7. SoftWear Silhouettes is a rapidly growing mail-order house specializing in all-cotton clothing. Management would like to expand sales to the Web with the creation of an ecommerce site. The

company has two full-time system analysts and one programmer. Company offices are located in a small, isolated New England town, and the employees who handle the traditional mail-order business have little computer training.

- a. Considering the company's situation, draw up a list of software attributes that SoftWear Silhouettes should emphasize in its choice of software to create a Web site and integrate the mail-order business with business from the Web site.
  - b. Would you recommend COTS software, custom software, or outsourcing to an ASP? State your choice and defend it in a paragraph.
  - c. List the variables that contributed to your response in part b.
8. The following is 12 years' demand for Viking Village, a game now available for handhelds and smartphones.

<i>Year</i>	<i>Demand</i>
1998	20,123
1999	18,999
2000	20,900
2001	31,200
2002	38,000
2003	41,200
2004	49,700
2005	46,400
2006	50,200
2007	52,300
2008	49,200
2009	57,600

- a. Graph the demand data for Viking Village.
  - b. Determine the linear trend for Viking Village using a three-year moving average.
9. Do the data for Viking Village appear to have a cyclical variation? Explain.
10. Interglobal Paper Company has asked for your help in comparing its present computer system with a new one its board of directors would like to see implemented. Proposed system and present system costs are as follows:

<i>Item</i>	<i>Proposed System Costs</i>	<i>Present System Costs</i>
<b>Year 1</b>		
Equipment Lease	\$20,000	\$11,500
Salaries	30,000	50,000
Overhead	4,000	3,000
Development	30,000	—
<b>Year 2</b>		
Equipment Lease	\$20,000	\$10,500
Salaries	33,000	55,000
Overhead	4,400	3,300
Development	12,000	—
<b>Year 3</b>		
Equipment Lease	\$20,000	\$10,500
Salaries	36,000	60,000
Overhead	4,900	3,600
Development	—	—
<b>Year 4</b>		
Equipment Lease	\$20,000	\$10,500
Salaries	39,000	66,000
Overhead	5,500	4,000
Development	—	—

- a. Using break-even analysis, determine the year in which Interglobal Paper will break even.
- b. Graph the costs and show the break-even point.

11. The following are system benefits for Interglobal Paper Company (from Problem 10):

Year	Benefits
1	\$55,000
2	75,000
3	80,000
4	85,000

- a. Use the costs of Interglobal Paper's proposed system from Problem 10 to determine the payback period (use the payback method).  
 b. Graph the benefits versus the costs and indicate the payback period.
12. Glenn's Electronics, a small company, has set up a computer service. The table that follows shows the revenue expected for the first five months of operation, in addition to the costs for office remodeling, and so on. Determine the cash flow and accumulated cash flow for the company. When is Glenn's expected to show a profit?

	July	August	September	October	November
<b>Revenue</b>	\$35,000	\$36,000	\$42,000	\$48,000	\$57,000
<b>Costs</b>					
Office Remodeling	\$25,000	\$8,000			
Salaries	11,000	12,100	\$13,300	\$14,600	\$16,000
Training	6,000	6,000			
Equipment Lease	8,000	8,480	9,000	9,540	10,110
Supplies	3,000	3,150	3,300	3,460	3,630

13. Alamo Foods of San Antonio wants to introduce a new computer system for its perishable products warehouse. The costs and benefits are as follows:

Year	Costs	Benefits
1	\$33,000	\$21,000
2	34,600	26,200
3	36,300	32,700
4	38,100	40,800
5	40,000	51,000
6	42,000	63,700

- a. Given a discount rate of 8 percent (.08), perform present value analysis on the data for Alamo Foods. (*Hint:* Use the formula

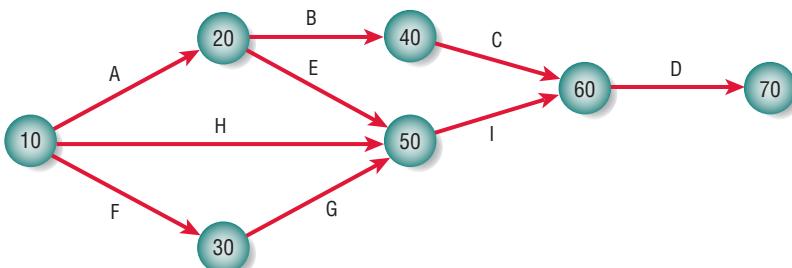
$$\frac{1}{(1+i)^n}$$

to find the multipliers for years 1 to 6.)

- b. What is your recommendation for Alamo Foods?  
 14. a. Suppose the discount rate in Problem 13a changes to 13 percent (.13). Perform present value analysis using the new discount rate.  
 b. What is your recommendation to Alamo Foods now?  
 c. Explain the difference between Problem 13b and Problem 14b.  
 15. Solve Problem 13 using an electronic spreadsheet program such as Excel.  
 16. Use a spreadsheet program to solve Problem 12.  
 17. Solve Problem 13 using a function for net present value, such as @NPV (x, range) in Excel.  
 18. Brian F. O'Byrne ("F," he says, stands for "frozen.") owns a frozen food company and wants to develop an information system for tracking shipments to warehouses.  
 a. Using the data from the table in Figure 3.EX1, draw a Gantt chart to help Brian organize his design project.  
 b. When is it appropriate to use a Gantt chart? What are the disadvantages? Explain in a paragraph.

Description	Task	Must Follow	Time (Weeks)
Draw data flow	A	None	5
Draw decision tree	B	A	4
Revise tree	C	B	10
Write up project	D	C, I	4
Organize data dictionary	E	A	7
Do output prototype	F	None	2
Revise output design	G	F	9
Write use cases	H	None	10
Design database	I	H, E, and G	8

19. In addition to a Gantt chart, you've drawn Brian a PERT diagram so that you can communicate the necessity to keep an eye on the critical path. Consult Figure 3.EX2, which was derived from the data from Figure 3.EX1. List all paths, and calculate and identify the critical path.



20. Cherry Jones owns a homeopathic medicine company called Faithhealers. She sells vitamins and other relatively nonperishable products for those who want choices regarding alternative medicine. Cherry is developing a new system that would require her staff to be retrained. Given the information in Figure 3.EX3, make a PERT diagram for her and identify the critical path. If Cherry could find a way to save time on the “write use cases” phase, would it help? Why or why not?

Description	Task	Must Follow	Time (Weeks)
Interview executives	A	None	6
Interview staff in order fulfillment	B	None	3
Design input prototype	C	B	2
Design output prototype	D	A, C	3
Write use cases	E	A, C	4
Record staff reactions to prototypes	F	D	2
Develop system	G	E, F	5
Write up training manual	H	B, G	3
Train staff working in order fulfillment	I	H	2

21. Angus McIndoe wants to modernize his popular restaurant by adapting it more closely to the preferences of his repeat customers—keeping track of his customers' likes and dislikes. Information such as where they like to sit, what they like to eat, and when they normally arrive at the restaurant are all items of interest to him, since he believes that in this way he can better serve his customers. Angus has asked you to develop a system for him that will help make his customers happy while increasing his business.

You have heard what Angus had to say about his customers. There are certainly more preferences that he can keep track of.

Develop a problem definition for Angus, similar to the one developed for Catherine's Catering in this chapter.

22. Recently, two analysts just out of college have joined your systems analyst group at the newly formed company, Mega Phone. When talking to you about the group, they mention that some things strike them as odd. One is that group members seem to look up to two group leaders, Bill and Penny, not just one.

**FIGURE 3.EX1**

Data to help in the organization of a design project for creating an information system that tracks shipments of frozen foods to warehouses.

**FIGURE 3.EX2**

The PERT diagram from Brian's Frozen Foods.

**FIGURE 3.EX3**

Tasks to be performed during systems development of an order fulfillment system.

Their observation is that Bill seems pretty relaxed, whereas Penny is always planning and scheduling activities. They have also observed that everyone “just seems to know what to do” when they get into a meeting, even though no instructions are given. Finally, they have remarked on the openness of the group in addressing problems as they arise, instead of letting things get out of hand.

- a. By way of explanation to the new team members, label the types of leaders Bill and Penny appear to be, respectively.
  - b. Explain the statement that “everyone just seems to know what to do.” What is guiding their behavior?
  - c. What concept best describes the openness of the group that the new team members commented on?
23. “I think it’s only fair to write up *all* the alternatives you’ve considered,” says Lou Cite, a personnel supervisor for Day-Glow Paints. “After all, you’ve been working on this systems thing for a while now, and I think my boss and everyone else would be interested to see what you’ve found out.” You are talking with Lou as you prepare to put together the final systems proposal that your team will be presenting to upper management.
- a. In a paragraph, explain to Lou why your proposal will not (and should not) contain all the alternatives that your team has considered.
  - b. In a paragraph, discuss the sorts of alternatives that should appear in the final systems proposal.

## GROUP PROJECTS

1. The Weil Smile Clinic is a dental practice run by Drs. Bonnie and Jeff, and they need to keep the necessary patient and insurance data safe and secure. They looked into online backup like SOS Online, Spare Backup, Mozy Remote Backup, and Data Deposit Box. Look into the cost of these or other services, then help Drs. Bonnie and Jeff make a decision. What are the intangible costs and benefits of backing up this way? Should they use a backup system or find some other way? Defend your analysis and recommendations.
2. Explore four or five voice-over IP (VoIP) providers. Make a list of costs including the setup fee, monthly cost of the basic plan, monthly cost of the unlimited plan, and cost of an adapter or other fees if required. Then make a list of attributes, such as free in-network calls, international calling, virtual telephone numbers, teleconferencing, support for caller ID, and so on. Explain how a person would use all of the quantitative and qualitative information to make an informed decision about which VoIP provider to select. Are any other variables important? Would you recommend any type of software to help compare these services?
3. Make a choice on a VoIP provider based on the analysis in Group Project 2.
4. With your group members, explore project management software such as Microsoft Project. What features are available? Work with your group to list them. Have your group evaluate the usefulness of the software for managing a systems analysis and design team project. In a paragraph, state whether the software you are evaluating facilitates team member communication and management of team activities, time, and resources. State which particular features support these aspects of any project. Note whether the software falls short of these criteria in any regard.
5. Draw a fishbone diagram of possible problems that can occur when constructing a Web site for a travel company that wants to sell vacations online for the next big travel period (either December or June).

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## EPISODE 3

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

## Getting to Know U

Chip enters Anna's office one day, saying, "I think the project will be a good one, even though it's taking some long hours to get started."

Anna looks up from her screen and smiles. "I like what you've done in getting us organized," she says. "I hadn't realized Microsoft Visio and Visible Analyst could help us this much with project management. I've decided to do a PERT diagram for the data gathering portion of the project. It should help us plan our time and work as a team on parallel activities."

"Can I take a look at the PERT diagram?" asks Chip.

Anna shows him a screen with a PERT diagram on it (see Figure E3.1) and remarks, "This will help immensely. It is much easier than planning haphazardly."

"I notice that you have Gather Reports, Gather Records and Data Capture Forms, and Gather Qualitative Documents as parallel tasks," notes Chip, gazing at the screen.

"Yes," replies Anna. "I thought that we would split up the time that it takes to gather the information. We can also divide up the task of analyzing what we have learned."

"I notice that you have a rather large number of days allocated for interviewing the users," notes Chip.

"Yes," replies Anna. "This activity also includes creating questions, sequencing them, and other tasks, such as taking notes of the office environment and analyzing them. I've also assumed a standard of six productive hours per day."

"After we interview the users, we will want to create a problem definition for the system, listing the issues and objectives," continues Anna. "Once this is finished, we'll have the users review it and assign weights. When this is complete, the next step is to create a list of user requirements."

"Sounds like a good plan," Chip remarks after a thoughtful pause. "Should we get started with a question list?"

Anna glances at her watch. "Not now, it's getting late. I think we've made a lot of progress in setting up our project. Let's call it a day, or should I say evening? Remember, I got us tickets for the football game."

Chip replies, "I haven't forgotten. Let me get my coat, and we'll walk over to the stadium together."

Walking across campus later, Chip says, "I'm excited. It's my first game here at CPU. What's the team mascot, anyway?"

"Chipmunks, of course," says Anna.

"And the team colors?" Chip asks, as they enter the stadium.

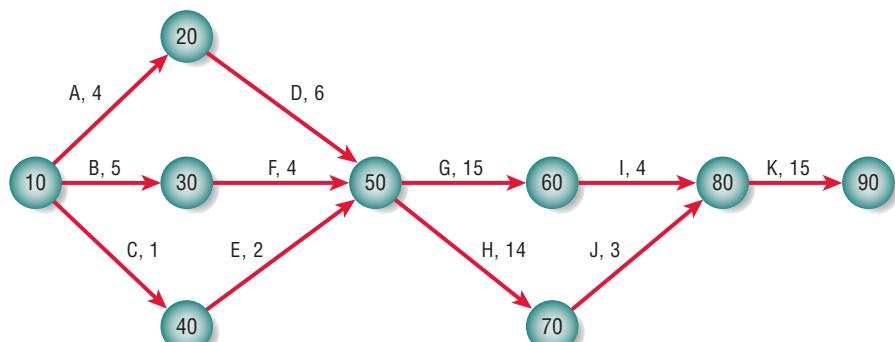
"Blue and white," Anna replies.

"Oh, that's why everyone's yelling, 'Go Big Blue!'" Chip says, listening to the roar of the crowd.

"Precisely," says Anna.

**FIGURE E3.1**

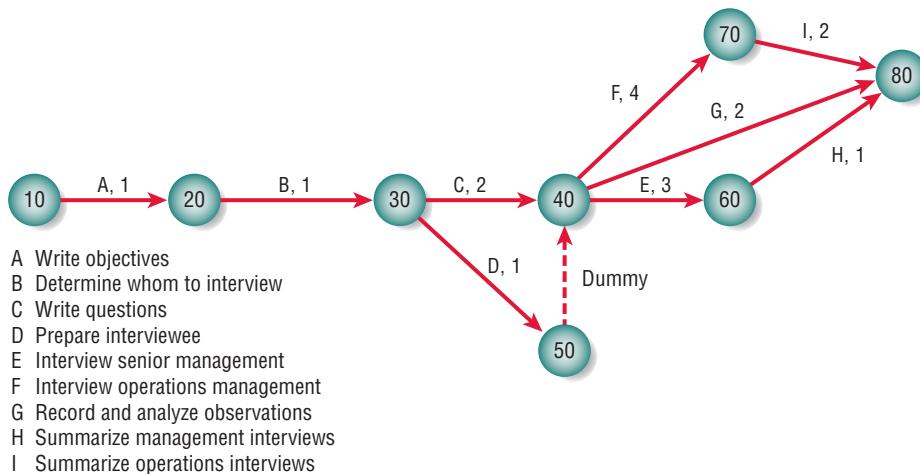
A PERT diagram for Central Pacific University that is used for gathering information.



- |   |                                       |   |                           |
|---|---------------------------------------|---|---------------------------|
| A | Gather reports                        | G | Interview users           |
| B | Gather records and data capture forms | H | Administer questionnaires |
| C | Gather qualitative documents          | I | Summarize interviews      |
| D | Analyze reports                       | J | Summarize survey results  |
| E | Understand corporate culture          | K | Prototype system          |
| F | Analyze records and forms             |   |                           |

## EXERCISES

- E-1. Use Microsoft Visio or Visible Analyst to view the Gathering Information PERT diagram.
- E-2. List all paths and calculate and determine the critical path for the Gathering Information PERT diagram.
- E-3. Use Microsoft Visio or Visible Analyst to create the PERT diagram shown in Figure E3.2. It represents the activities involved in interviewing the users and observing their offices.



**FIGURE E3.2**

A PERT diagram for Central Pacific University that is used for the interviewing users phase.

- E-4. List all paths and calculate and determine the critical path for the Interviewing Users PERT diagram.
- E-5. Use Visio or Visible Analyst to create a PERT diagram for creating system prototypes. The activity information is shown in Figure E3.3.



Activity	Predecessor	Duration
A Determine overall prototype screens and reports	None	2
B Determine report and screen contents	A	4
C Create report prototypes	B	3
D Create screen prototypes	B	4
E Obtain report prototype feedback	C	1
F Obtain screen prototype feedback	D	2
G Modify report prototypes	E	2
H Modify screen prototypes	F	4
I Obtain final approval	G, H	2

**FIGURE E3.3**

A list of activities and estimated duration times for the CPU project.

- E-6. Create the problem definition for the CPU case. Read the interview with Hy Perteks in the CPU case found in Chapter 4 as well as the interviews found on the support Web site for Systems Analysis and Design. Go to [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall) and click the **CPU Student Exercise** link for the 8/e text. Then click the first link called **CPU Interviews**. You will need to read all five additional interviews. There is a **Next** link in the lower right corner of the Web page to go to the next interview.
- E-7. Write user requirements for the CPU case.
- E-8. Design a test plan for the requirements created in Exercise E-7.

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

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# Information Gathering: Interactive Methods

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Recognize the value of interactive methods for information gathering.
2. Construct interview questions to elicit human information requirements.
3. Structure interviews in a way that is meaningful to users.
4. Understand the concept of JAD and when to use it.
5. Write effective questions to survey users about their work.
6. Design and administer effective questionnaires.



There are three key interactive methods that you can use to elicit human information requirements from organizational members. These three methods are interviewing, joint application design (JAD), and surveying people through questionnaires. Although different in their implementation, these methods have a great deal in common, too. The basis of their shared properties is talking with and listening to people in the organization to understand their interactions with technology through a series of carefully composed questions.

Each of the three interactive methods for information gathering possesses its own established process for you to follow in interacting with users. If followed, these systematic approaches will help ensure proper design and implementation of interviews, JAD workshops, and questionnaires, as well as support insightful analysis of the resulting data. Unobtrusive methods (sampling, investigation, and observing a decision maker's behavior and physical environment) that do not require the same degree of interactivity between analysts and users will be covered in an upcoming chapter. By using interactive methods with unobtrusive methods you will achieve a more complete portrait of the organization's information requirements.

## INTERVIEWING

Before you interview someone else, you must in effect interview yourself. You need to know your biases and how they will affect your perceptions. Your education, intellect, upbringing, emotions, and ethical framework all serve as powerful filters for what you will be hearing in your interviews.

You need to think through the interview thoroughly before you go. Visualize why you are going, what you will ask, and what will make it a successful interview in your eyes. You must anticipate how to make the interview fulfilling for the individual you interview, as well.

An information-gathering interview is a directed conversation with a specific purpose that uses a question-and-answer format. In the interview you want to get the opinions of the interviewee and his or her feelings about the current state of the system, organizational and personal goals, and informal procedures for interacting with information technologies.

Above all, seek the opinions of the person you are interviewing. Opinions may be more important and more revealing than facts. For example, imagine asking the owner of a traditional store who has recently added an online store how many customer refunds she typically gives for Web transactions each week. She replies, “About 20 to 25 a week.” When you monitor the transactions and discover that the average is only 10.5 per week, you might conclude that the owner is overstating the facts and the problem.

Imagine instead that you ask the owner what her major concerns are and that she replies, “In my opinion, customer returns of goods purchased over the Web are way too high.” By seeking opinions rather than facts, you discover a key problem that the owner wants addressed.

In addition to opinions, you should try to capture the feelings of the interviewee. Remember that the interviewee knows the organization better than you do. You can understand the organization’s culture more fully by listening to the feelings of the respondent.

Goals are important information that can be gleaned from interviewing. Facts that you obtain from hard data may explain past performance, but goals project the organization’s future. Try to find out as many of the organization’s goals as possible from interviewing. You may not be able to determine goals through any other data-gathering methods.

The interview is also a valuable time to explore key HCI (human–computer interaction) concerns, including the ergonomic aspects, the system usability, how pleasing and enjoyable the system is, and how useful it is in supporting individual tasks.

In the interview you are setting up a relationship with someone who is probably a stranger to you. You need to build trust and understanding quickly, but at the same time you must maintain control of the interview. You also need to sell the system by providing needed information to your interviewee. Do so by planning for the interview before you go so that conducting it is second nature to you. Fortunately, effective interviewing can be learned. As you practice, you will see yourself improving. Later in the chapter we discuss joint application design (JAD) (pronounced as one word, jd, rhymes with add), which can serve as an alternative to one-on-one interviewing in certain situations.

### Five Steps in Interview Preparation

The five major steps in interview preparation are shown in Figure 4.1. These steps include a range of activities from gathering basic background material to deciding who to interview.

**READ BACKGROUND MATERIAL.** Read and understand as much background information about the interviewees and their organization as possible. This material can often be obtained on the corporate Web site, from a current annual report, a corporate newsletter, or any publications sent out to explain the organization to the public. Check the Internet for any corporate information such as that in Standard and Poor’s.

As you read through this material, be particularly sensitive to the language the organizational members use in describing themselves and their organization. What you are trying to do is build up a common vocabulary that will eventually enable you to phrase interview questions in a way that is understandable to your interviewee. Another benefit of researching your organization is to maximize the time you spend in interviews; without such preparation you may waste time asking general background questions.

**ESTABLISH INTERVIEWING OBJECTIVES.** Use the background information you gathered as well as your own experience to establish interview objectives. There should be four to six key areas concerning HCI, information processing, and decision-making behavior about which you will want to ask questions. These areas include HCI concerns (the usefulness and usability of the

**FIGURE 4.1**

Steps the systems analyst follows in planning the interview.

Steps in Planning the Interview
<ol style="list-style-type: none"><li>1. Read background material.</li><li>2. Establish interviewing objectives.</li><li>3. Decide whom to interview.</li><li>4. Prepare the interviewee.</li><li>5. Decide on question types and structure.</li></ol>

system; how it fits physical aspects; how it suits a user's cognitive capabilities, whether it is engaging or aesthetically pleasing; and whether using the system is rewarded with desired consequences), information sources, information formats, decision-making frequency, qualities of information, and decision-making style.

**DECIDE WHOM TO INTERVIEW.** When deciding whom to interview, include key people at all levels who will be affected by the system in some manner. Strive for balance so that as many users' needs are addressed as possible. Your organizational contact will also have some ideas about whom should be interviewed.

**PREPARE THE INTERVIEWEE.** Prepare the person to be interviewed by calling ahead or sending an email message and allowing the interviewee time to think about the interview. If you are doing an in-depth interview, it is permissible to email your questions ahead of time to allow your interviewee time to think over his or her responses. Because there are many objectives to fulfill in the interview (including building trust and observing the workplace), however, interviews should typically be conducted in person and not via email. Interviews should be kept to 45 minutes or an hour at the most. No matter how much your interviewees seem to want to extend the interview beyond this limit, remember that when they spend time with you, they are not doing their work. If interviews go over an hour, it is likely that the interviewees will resent the intrusion, whether or not they articulate their resentment.

**DECIDE ON QUESTION TYPES AND STRUCTURE.** Write questions to cover the key areas of HCI and decision making that you discovered when you ascertained interview objectives. Proper questioning techniques are the heart of interviewing. Questions have some basic forms you need to know. The two basic question types are open-ended and closed. Each question type can accomplish something a little different from the other, and each has benefits and drawbacks. You need to think about the effect each question type will have.

It is possible to structure your interview in three different patterns: a pyramid structure, a funnel structure, or a diamond structure. Each is appropriate under different conditions and serves a different function, and each one is discussed later in this chapter.

## Question Types

**OPEN-ENDED QUESTIONS.** Open-ended questions include those such as "What do you think about putting all the managers on an intranet?" "Please explain how you make a scheduling decision." "In what ways does the system extend your capability to do tasks that would not be possible otherwise?" Consider the term *open-ended*. "Open" actually describes the interviewee's options for responding. They are open. The response can be two words or two paragraphs. Some examples of open-ended questions are found in Figure 4.2.

The benefits of using open-ended questions are numerous and include the following:

1. Putting the interviewee at ease.
2. Allowing the interviewer to pick up on the interviewee's vocabulary, which reflects his or her education, values, attitudes, and beliefs.
3. Providing richness of detail.
4. Revealing avenues of further questioning that may have gone untapped.
5. Making it more interesting for the interviewee.
6. Allowing more spontaneity.

### Open-Ended Interview Questions

- What's your opinion of the current state of business-to-business ecommerce in your firm?
- What are the critical objectives of your department?
- Once the data are submitted via the Web site, how are they processed?
- Describe the monitoring process that is available online.
- What are some of the common data entry errors made in this department?
- What are the biggest frustrations you've experienced during the transition to ecommerce?

**FIGURE 4.2**

Open-ended interview questions allow the respondent open options for responding. The examples were selected from different interviews and are not shown in any particular order.

**FIGURE 4.3**

Closed interview questions limit the respondent's options. The examples were selected from different interviews and are not shown in any particular order.

<b>Closed Interview Questions</b>
<ul style="list-style-type: none"> <li>• How many times a week is the project repository updated?</li> <li>• On average, how many calls does the call center receive monthly?</li> <li>• Which of the following sources of information is most valuable to you?           <ul style="list-style-type: none"> <li>◦ Completed customer complaint forms</li> <li>◦ Email complaints from consumers who visit the Web site</li> <li>◦ Face-to-face interaction with customers</li> <li>◦ Returned merchandise</li> </ul> </li> <li>• List your top two priorities for improving the technology infrastructure.</li> <li>• Who receives this input?</li> </ul>

7. Making phrasing easier for the interviewer.
8. Using them in a pinch if the interviewer is caught unprepared.

As you can see, there are several advantages to using open-ended questions. There are, however, also many drawbacks:

1. Asking questions that may result in too much irrelevant detail.
2. Possibly losing control of the interview.
3. Allowing responses that may take too much time for the amount of useful information gained.
4. Potentially seeming that the interviewer is unprepared.
5. Possibly giving the impression that the interviewer is on a “fishing expedition” with no real objective for the interview.

You must carefully consider the implications of using open-ended questions for interviewing.

**CLOSED QUESTIONS.** The alternative to open-ended questions is found in the other basic question type: closed questions. Such questions are of the basic form “Is it easy to use the current system?” and, “How many subordinates do you have?” The possible responses are closed to the interviewee, because he or she can only reply with a finite number such as “None,” “One,” or “Fifteen.” Some examples of closed questions can be found in Figure 4.3.

A closed question limits the response available to the interviewee. You may be familiar with closed questions through multiple-choice exams in college. You are given a question and five responses, but you are not allowed to write down your own response and still be counted as having correctly answered the question.

A special kind of closed question is the bipolar question. This type of question limits the interviewee even further by only allowing a choice on either pole, such as yes or no, true or false, agree or disagree. Examples of bipolar questions can be found in Figure 4.4.

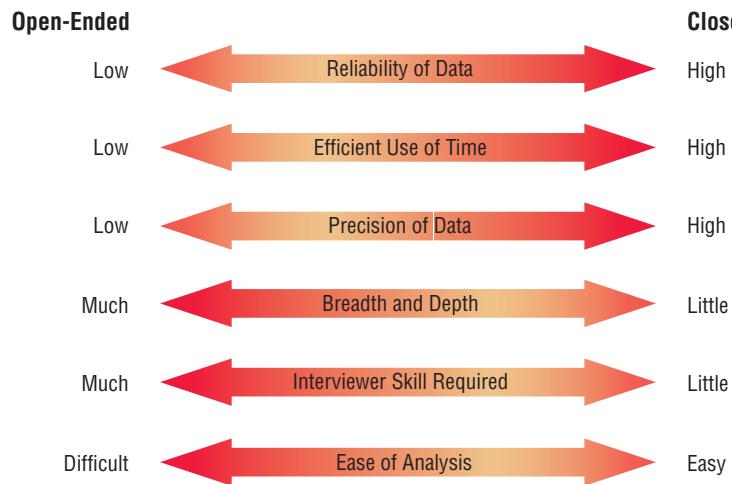
The benefits of using closed questions of either type include the following:

1. Saving time.
2. Easily comparing interviews.
3. Getting to the point.
4. Keeping control over the interview.
5. Covering lots of ground quickly.
6. Getting to relevant data.

**FIGURE 4.4**

Bipolar interview questions are a special kind of closed question. The examples were selected from different interviews and are not shown in any particular order.

<b>Bipolar Interview Questions</b>
<ul style="list-style-type: none"> <li>• Do you use the Web to provide information to vendors?</li> <li>• Do you agree or disagree that ecommerce on the Web lacks security?</li> <li>• Do you want to receive a printout of your account status every month?</li> <li>• Does your Web site maintain a FAQ page for employees with payroll questions?</li> <li>• Is this form complete?</li> </ul>

**FIGURE 4.5**

Attributes of open-ended and closed questions.

The drawbacks of using closed questions are substantial, however. They include the following:

1. Being boring for the interviewee.
2. Failing to obtain rich detail (because the interviewer supplies the frame of reference for the interviewee).
3. Missing main ideas for the preceding reason.
4. Failing to build rapport between interviewer and interviewee.

Thus, as the interviewer, you must think carefully about the question types you will use.

Both open-ended and closed questions have advantages and drawbacks, as shown in Figure 4.5. Notice that choosing one question type over the other actually involves a trade-off; although an open-ended question affords breadth and depth of reply, responses to open-ended questions are difficult to analyze.

**PROBES.** A third type of question is the probe or follow-up. The strongest probe is the simplest: the question, “Why?” Other probes are “Can you give me an example of a time you did not find the system trustworthy?” and “Will you elaborate on that for me?” Some examples of probing questions can be found in Figure 4.6. The purpose of the probe is to go beyond the initial answer to get more meaning, to clarify, and to draw out and expand on the interviewee’s point. Probes may be either open-ended or closed questions.

It is essential to probe. Most beginning interviewers are reticent about probing and consequently accept superficial answers. They are usually grateful that employees have granted interviews and feel somewhat obligated to accept unqualified statements politely.

### Arranging Questions in a Logical Sequence

Just as there are two generally recognized ways of reasoning—inductive and deductive—there are two similar ways of organizing your interviews. A third way combines both inductive and deductive patterns.

Probes
<ul style="list-style-type: none"> <li>• Why?</li> <li>• Give an example of how ecommerce has been integrated into your business processes.</li> <li>• Please give an illustration of the security problems you are experiencing with your online bill payment system.</li> <li>• You mentioned both an intranet and an extranet solution. Please give an example of how you think each differs.</li> <li>• What makes you feel that way?</li> <li>• Tell me step by step what happens after a customer clicks the “Submit” button on the Web registration form.</li> </ul>

**FIGURE 4.6**

Probes allow the systems analyst to follow up on questions to get more detailed responses. The examples were selected from different interviews and are not shown in any particular order.



## CONSULTING OPPORTUNITY 4.1

### Strengthening Your Question Types

**S**trongbodies, a large, local chain of sports clubs, has experienced phenomenal growth in the past five years. Management would like to refine its decision-making process for purchasing new body-building equipment. Currently, managers listen to customers, attend trade shows, look at advertisements, and put in requests for new equipment purchases based on their subjective perceptions. These are then approved or denied by Harry Mussels.

Harry is the first person you will interview. He is a 37-year-old division manager who runs five area clubs. He travels all over the city to their widespread locations. He keeps an office at the East location, although he is there less than a quarter of the time.

In addition, when Harry is present at a club, he is busy answering business-related phone calls, solving on-the-spot prob-

lems presented by managers, and interacting with club members. His time is short, and to compensate for that he has become an extremely well-organized, efficient divisional manager. He cannot grant you a lot of interview time. However, his input is important, and he feels he would be the main beneficiary of the proposed system.

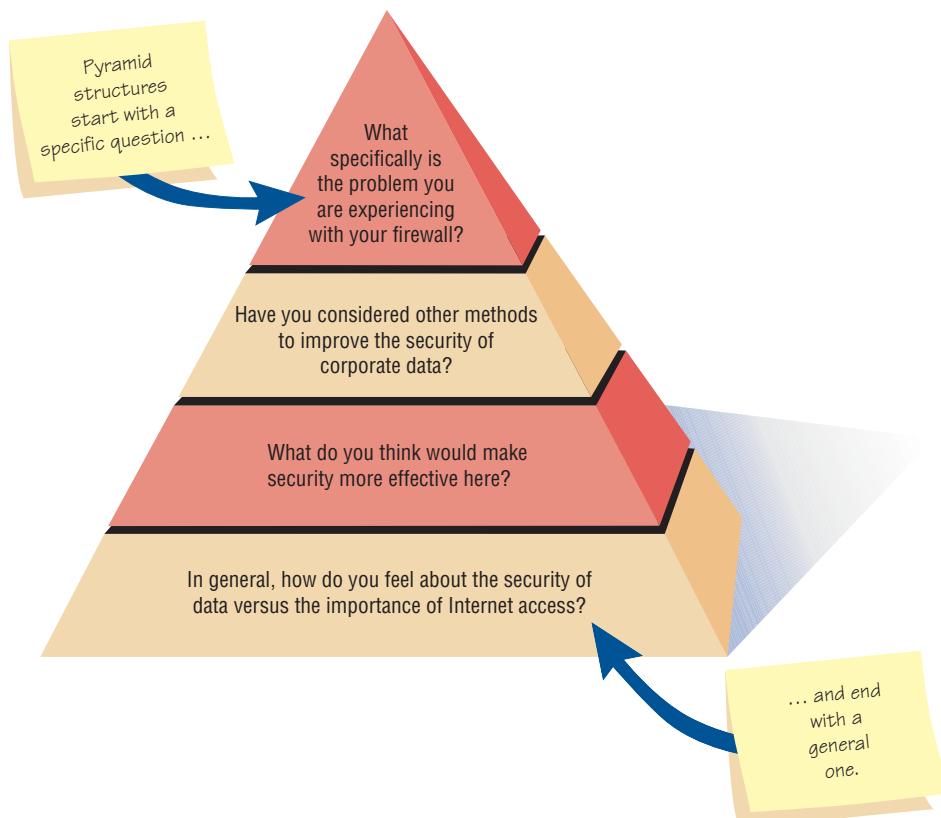
What type of interview question might be most suitable for your interview with Harry? Why is this type most appropriate? How will your choice of question type affect the amount of time you spend in preparation for interviewing Harry? Write 5 to 10 questions of this type. What other techniques might you use to supplement information unavailable through that type of question? Write a paragraph to explain.

**USING A PYRAMID STRUCTURE.** Inductive organization of interview questions can be visualized as having a pyramid shape. Using this form, the interviewer begins with very detailed, often closed, questions. The interviewer then expands the topics by allowing open-ended questions and more generalized responses, as shown in Figure 4.7.

A pyramid structure should be used if you believe your interviewee needs to warm up to the topic. Using a pyramid structure for question sequencing is also useful when you want an ending

**FIGURE 4.7**

Pyramid structure for interviewing goes from specific to general questions.



determination about the topic. Such is the case in the final question, “In general, how do you feel about the security of data versus the importance of Internet access?”

**USING A FUNNEL STRUCTURE.** In the second kind of structure, the interviewer takes a deductive approach by beginning with generalized, open-ended questions and then narrowing the possible responses by using closed questions. This interview structure can be thought of as funnel shaped, as that depicted in Figure 4.8. Using the funnel structure method provides an easy, nonthreatening way to begin an interview. A funnel-shaped question sequence is also useful when the interviewee feels emotional about the topic and needs freedom to express those emotions.

**USING A DIAMOND-SHAPED STRUCTURE.** Often a combination of the two structures, resulting in a diamond-shaped interview structure, is best. This structure entails beginning in a very specific way, then examining general issues, and finally coming to a very specific conclusion, as shown in Figure 4.9.

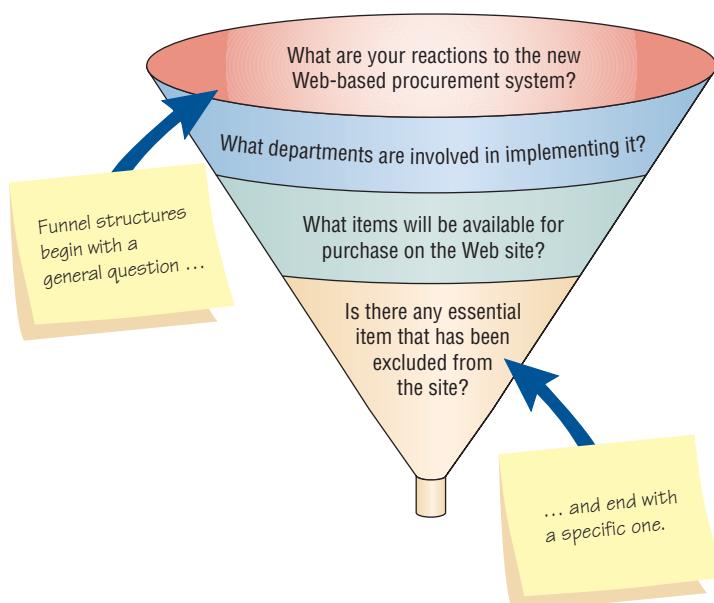
The interviewer begins with easy, closed questions that provide a warm-up to the interview process. In the middle of the interview, the interviewee is asked for opinions on broad topics that obviously have no “right” answer. The interviewer then narrows the questions again to get specific questions answered, thus providing closure for both the interviewee and the interviewer. The diamond structure combines the strengths of the other two approaches but has the disadvantage of taking longer than either other structure.

The end of the interview is a natural place to ask one key question: “Is there anything we haven’t touched on that you feel is important for me to know?” Considered a formula question by the interviewee most of the time, the response will often be “No.” You are interested in the other times, when this question opens the proverbial floodgates and much new data are presented, though.

As you conclude the interview, summarize and provide feedback on your overall impressions. Inform the interviewee about the subsequent steps to take and what you and other team members will do next. Ask the interviewee with whom you should talk next. Set up future appointment times for follow-up interviews, thank the interviewee for his or her time, and shake hands.

### Writing the Interview Report

Although the interview itself is complete, your work on the interview data is just beginning. You need to capture the essence of the interview through a written report. It is imperative that you write the interview report as soon as possible after the interview. This step is another way you can ensure quality of interview data. The longer you wait to write up your interview, the more suspect the quality of your data becomes.



**FIGURE 4.8**

Funnel structure for interviewing begins with broad questions, then funnels to specific questions.



## CONSULTING OPPORTUNITY 4.2

### Skimming the Surface

You are about to leave SureCheck Dairy after a preliminary tour when another member of your systems analysis team calls you at the dairy to say he cannot make his interview appointment with the plant manager because of illness. The plant manager is extremely busy, and you want to keep his enthusiasm for the project going by doing things as scheduled. You also realize that without the initial interview data, the rest of your data gathering will be slowed. Although you have no interview questions prepared, you make the decision to go ahead and interview the plant manager on the spot.

You have learned that SureCheck is interested in processing its own data on quantities and kinds of dairy products sold so that its

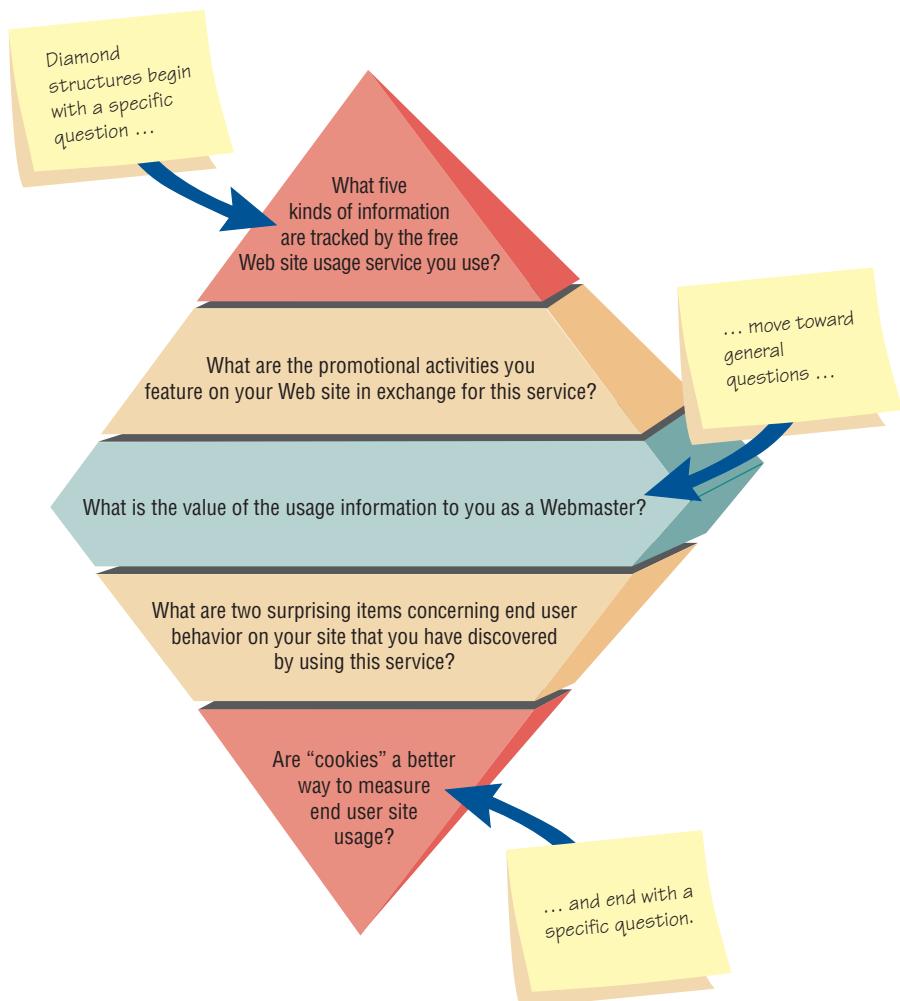
people can use that information to better control production of the company's large product line (it includes whole, skim, 2 percent, and 1 percent milk, half-and-half, cottage cheese, yogurt, and frozen novelties). Sales managers are currently sending their sales figures to corporate headquarters, 600 miles away, and processing turnaround seems slow. You will base your ad-libbed questions on what you have just found out on the tour.

In the few minutes before your interview begins, decide on a structure for it: funnel, pyramid, or diamond. In a paragraph, justify why you would proceed with the interview structure you have chosen based on the unusual context of this interview. Write a series of questions and organize them in the structure you have chosen.

After this initial summary, go into more detail, noting main points of the interview and your own opinions. Review the interview report with the respondent at a follow-up meeting. This step helps clarify the meaning the interviewee had in mind and lets the interviewee know that you are interested enough to take the time to understand his or her point of view and perceptions.

**FIGURE 4.9**

Diamond-shaped structure for interviewing combines the pyramid and funnel structures.



## JOINT APPLICATION DESIGN

No matter how adept you become as an interviewer, you will inevitably experience situations in which one-on-one interviews do not seem to be as useful as you would like. Personal interviews are time consuming and subject to error, and their data are prone to misinterpretation. An alternative approach to interviewing users one by one, called joint application design (JAD), was developed by IBM. The motivation for using JAD is to cut the time (and hence the cost) required by personal interviews, to improve the quality of the results of information requirements assessment, and to create more user identification with new information systems as a result of the participative processes.

Although JAD can be substituted for personal interviews at any appropriate juncture during the SDLC, it has usually been employed as a technique that allows you, as a systems analyst, to accomplish requirements analysis and to design the user interface jointly with users in a group setting. The many intricacies of this approach can only be learned in a paid seminar demonstrating proprietary methods. We can, however, convey enough information about JAD here to make you aware of some of its benefits and drawbacks in comparison with one-on-one interviews.

### Conditions That Support the Use of JAD

The following list of conditions will help you decide when the use of JAD may be fruitful. Consider using joint application design when:

1. User groups are restless and want something new, not a standard solution to a typical problem.
2. The organizational culture supports joint problem-solving behaviors among multiple levels of employees.
3. Analysts forecast that the number of ideas generated via one-on-one interviews will not be as plentiful as the number of ideas possible from an extended group exercise.
4. Organizational workflow permits the absence of key personnel during a two-to-four-day block of time.

### Who Is Involved?

Joint application design sessions include a variety of participants—analysts, users, executives, and so on—who will contribute differing backgrounds and skills to the sessions. Your primary concern here is that all project team members are committed to the JAD approach and become involved. Choose an executive sponsor, a senior person who will introduce and conclude the JAD session. Preferably, select an executive from the user group who has some sort of authority over the IS people working on the project. This person will be an important, visible symbol of organizational commitment to the systems project.

At least one IS analyst should be present, but the analyst usually takes a passive role, unlike traditional interviewing in which the analyst controls the interaction. As the project analyst, you should be present during JAD to listen to what users say and what they require. In addition, you will want to give an expert opinion about any disproportionate costs of solutions proposed during the JAD session itself. Without this kind of immediate feedback, unrealistic solutions with excessive costs may creep into the proposal and prove costly to discourage later on.

From eight to a dozen users can be chosen from any rank to participate in JAD sessions. Try to select users who can articulate what information they need to perform their jobs as well as what they desire in a new or improved computer system.

The session leader should not be an expert in systems analysis and design but rather someone who has excellent communication skills to facilitate appropriate interactions. Note that you do not want to use a session leader who reports to another person in the group. To avoid this possibility, an organization may want to retain an outside management consultant to serve as session leader. The point is to get a person who can bring the group's attention to bear on important systems issues, satisfactorily negotiate and resolve conflicts, and help group members reach a consensus.

Your JAD session should also include one or two observers who are analysts or technical experts from other functional areas to offer technical explanations and advice to the group during the sessions. In addition, one scribe from the IS department should attend the JAD sessions to formally write down everything that is done.



**W**ell, I did warn you that things weren't always smooth here at MRE. By now you've met many of our key employees and are starting to understand the 'lay of the land.' Who would have thought that some innocent decisions about systems, like whether to purchase a COMTEX or Shiroma, would cause such hostility? Well, live and learn, I always say. At least now you'll know what you're up against when you have to start recommending software and hardware!

"It's funny that not all questions are created equal. I myself favor asking open-ended questions, but when I have to answer them, it is not always easy.

### HYPERCASE Questions

1. Using the interview questions posed in HyperCase, give five examples of open-ended questions and five examples of closed questions. Explain why your examples are correctly classified as either open-ended or closed question types.
2. List three probing questions that are part of the Daniel Hill interview. In particular, what did you learn by following up on the questions you asked Daniel?
3. List three probing questions that are part of the Snowden Evans interview. In particular, what did you learn by following up on the questions you asked Snowden?

A screenshot of a web browser window titled "Interview: Daniel Hill - Mozilla Firefox". The main content area shows a portrait of Daniel Hill and his title, "Vice President for Engineering Systems Division". Below this, a section titled "Questions" contains three interview questions, each preceded by a question mark icon. The questions are: "Good morning, Mr. Hill. I'm from the Management Information Systems department working on the Global Engineering Management System project. I would like to ask you some questions that will help to get an overview of the project.", "What are your division's goals?", and "Could you tell me about the merger of Training and Management Systems: how did it come about, and why?". At the bottom of the interface are buttons for "Back", "Office", and "Observations".

**FIGURE 4.HC1**

Pointing to a question in HyperCase will reveal an answer.

### Where to Hold JAD Meetings

If at all possible, we recommend holding the two-to-four-day sessions off-site, away from the organization, in comfortable surroundings. Some groups use executive centers or even group decision support facilities that are available at major universities. The idea is to minimize the daily distractions and responsibilities of the participants' regular work. The room itself should comfortably hold the number of people invited. Minimal presentation support equipment includes two overhead projectors, a whiteboard, a flip chart, and easy access to a copier. Group decision support rooms will also provide networked PCs, a projection system, and software written to facilitate group interaction while minimizing unproductive group behaviors.

Schedule your JAD session when all participants can commit to attending. Do not hold the sessions unless everyone who has been invited can actually attend. This rule is critical to the success of the sessions. Ensure that all participants receive an agenda before the meeting, and con-



## CONSULTING OPPORTUNITY 4.3

### A Systems Analyst, I Presume?

“Know what I think of the work the last systems analyst team did? The printouts created are a jungle. To figure out the cost of raw materials to us, I have to cut my way through the overgrowth of data, hacking my path with a pen. I cross out everything that’s irrelevant. Sometimes I physically rip out the excess vegetation until I reach the numbers I need,” says Henry Stanley, accounting supervisor for Zenith Glass Company. As you interview him, he points unhappily to an untidy stack of mutilated printouts sprouting beside his desk.

Identify the overriding metaphor Henry is using to describe the printouts he is receiving and the accessibility of information in them. In a paragraph, describe how this step helps you understand Henry’s attitude toward any work proposed by your systems analysis team. In a paragraph, adopt Henry’s metaphor and extend it in a more positive sense during your interview with him.

sider holding an orientation meeting for a half day one week or so before the workshop so that those involved know what is expected of them. Such a premeeting allows you to move rapidly and act confidently once the actual meeting is convened.

#### Accomplishing a Structured Analysis of Project Activities

IBM recommends that the JAD sessions examine these points in the proposed systems project: planning, receiving, receipt processing/tracking, monitoring and assigning, processing, recording, sending, and evaluating. For each topic, the questions who, what, how, where, and why should also be asked and answered. Clearly, ad hoc interactive systems such as decision support systems and other types of systems dependent on decision-maker style (including prototype systems) are not as easily analyzed with the structured approach of JAD.

As the analyst involved with the JAD sessions, you should receive the notes of the scribe and prepare a specifications document based on what happened at the meeting. Systematically present the management objectives as well as the scope and boundaries of the project. Specifics of the system, including details on screen and report layouts, should also be included.

#### Potential Benefits of Using JAD in Place of Traditional Interviewing

There are four major potential benefits that you, the users, and your systems analysis team should consider when you weigh the possibilities of using joint application design. The first potential benefit is time savings over traditional one-on-one interviews. Some organizations have estimated that JAD sessions have provided a 15 percent time savings over the traditional approach.

Hand-in-hand with time savings is the rapid development possible via JAD. Because user interviews are not accomplished serially over a period of weeks or months, the development can proceed much more quickly.

A third benefit to weigh is the possibility of improved ownership of the information system. As analysts, we are always striving to involve users in meaningful ways and to encourage users to take early ownership of the systems we are designing. Due to its interactive nature and high visibility, JAD helps users become involved early in systems projects and treats their feedback seriously. Working through a JAD session eventually helps reflect user ideas in the final design.

A final benefit of participating in JAD sessions is the creative development of designs. The interactive character of JAD has a great deal in common with brainstorming techniques that generate new ideas and new combinations of ideas because of the dynamic and stimulating environment. Designs can evolve through facilitated interactions, rather than in relative isolation.

#### Potential Drawbacks of Using JAD

There are three drawbacks or pitfalls that you should also weigh when making a decision on whether to do traditional one-on-one interviews or to use JAD. The first drawback is that JAD requires the commitment of a large block of time from all participants. Because JAD requires a

two-to-four-day commitment, it is not possible to do any other activities concurrently or to time-shift any activities, as is typically done in one-on-one interviewing.

A second pitfall occurs if preparation for the JAD sessions is inadequate in any regard or if the follow-up report and documentation of specifications is incomplete. In these instances resulting designs could be less than satisfactory. Many variables need to come together correctly for JAD to be successful. Conversely, many things can go wrong. The success of designs resulting from JAD sessions is less predictable than that achieved through standard interviews.

Finally, the necessary organizational skills and organizational culture may not be sufficiently developed to enable the concerted effort required to be productive in a JAD setting. In the end you will have to judge whether the organization is truly committed to, and prepared for, this approach.

## USING QUESTIONNAIRES

The use of questionnaires is an information-gathering technique that allows systems analysts to study attitudes, beliefs, behavior, and characteristics of several key people in the organization who may be affected by the current and proposed systems. Attitudes are what people in the organization say they want (in a new system, for instance); beliefs are what people think is actually true; behavior is what organizational members do; and characteristics are properties of people or things.

Responses gained through questionnaires (also called surveys) using closed questions can be quantified. If you are surveying people via email or the Web, you can use software to turn electronic responses directly into data tables for analysis using a spreadsheet application or statistical software packages. Responses to questionnaires using open-ended questions are analyzed and interpreted in other ways. Answers to questions on attitudes and beliefs are sensitive to the wording chosen by the systems analyst.

Through the use of questionnaires, the analyst may be seeking to quantify what was found in interviews. In addition, questionnaires may be used to determine how widespread or limited a sentiment expressed in an interview really is. Conversely, questionnaires can be used to survey a large sample of system users to sense problems or raise important issues before interviews are scheduled.

Throughout this chapter, we compare and contrast questionnaires with interviews. There are many similarities between the two techniques, and perhaps the ideal would be to use them in conjunction with each other, either following up unclear questionnaire responses with an interview or designing the questionnaire based on what is discovered in the interview. Each technique, however, has its own specific functions, and it is not always necessary or desirable to use both.

### Planning for the Use of Questionnaires

At first glance questionnaires may seem to be a quick way to gather massive amounts of data about how users assess the current system, about what problems they are experiencing with their work, and about what people expect from a new or modified system. Although it is true that you can gather a lot of information through questionnaires without spending time in face-to-face interviews, developing a useful questionnaire takes extensive planning time in its own right. When you decide to survey users via email or the Web, you face additional planning considerations concerning confidentiality, authentication of identity, and problems of multiple responses.

You must first decide what you are attempting to gain through using a survey. For instance, if you want to know what percentage of users prefers a FAQ page as a means of learning about new software packages, a questionnaire might be the right technique. If you want an in-depth analysis of a manager's decision-making process, an interview is a better choice.

Here are some guidelines to help you decide whether the use of questionnaires is appropriate. Consider using questionnaires if:

1. The people you need to question are widely dispersed (different branches of the same corporation).
2. A large number of people are involved in the systems project, and it is meaningful to know what proportion of a given group (for example, management) approves or disapproves of a particular feature of the proposed system.
3. You are doing an exploratory study and want to gauge overall opinion before the systems project is given any specific direction.

4. You wish to be certain that any problems with the current system are identified and addressed in follow-up interviews.

Once you have determined that you have good cause to use a questionnaire and have pinpointed the objectives to be fulfilled through its use, you can begin formulating questions.

## Writing Questions

The biggest difference between the questions used for most interviews and those used on questionnaires is that interviewing permits interaction between the questions and their meanings. In an interview the analyst has an opportunity to refine a question, define a muddy term, change the course of questioning, respond to a puzzled look, and generally control the context.

Few of these opportunities are possible on a questionnaire. Thus, for the analyst, questions must be transparently clear, the flow of the questionnaire cogent, the respondent's questions anticipated, and the administration of the questionnaire planned in detail. (A respondent is the person who responds to or answers the questionnaire.)

The basic question types used on the questionnaire are open-ended and closed, as discussed for interviewing. Due to the constraints placed on questionnaires, some additional discussion of question types is warranted.

**OPEN-ENDED QUESTIONS.** Recall that open-ended questions (or statements) are those that leave all possible response options open to the respondent. For example, open-ended questions on a questionnaire might read, "Describe any problems you are currently experiencing with output reports" or "In your opinion, how helpful are the user manuals for the current system's accounting application?"

When you write open-ended questions for a questionnaire, anticipate what kind of response you will get. For instance, if you ask a question such as, "How do you feel about the system?" the responses are apt to be too broad for accurate interpretation or comparison. Therefore, even when you write an open-ended question, it must be narrow enough to guide respondents to answer in a specific way. (Examples of open-ended questions can be found in Figure 4.10.)

Open-ended questions are particularly well suited to situations in which you want to get at organizational members' opinions about some aspect of the system, whether product or process. In such cases you will want to use open-ended questions when it is impossible to list effectively all the possible responses to the question.

**CLOSED QUESTIONS.** Recall that closed questions (or statements) are those that limit or close the response options available to the respondent. For example, in Figure 4.11 the statement in question 23 ("Below are the six software packages currently available. Please check the software package(s) you personally use most frequently") is closed. Notice that respondents are not asked why the package is preferred, nor are they asked to select more than one, even if that is a more representative response.

Closed questions should be used when the systems analyst is able to list effectively all the possible responses to the question and when all the listed responses are mutually exclusive, so that choosing one precludes choosing any of the others.

Use closed questions when you want to survey a large sample of people. The reason becomes obvious when you start imagining how the data you are collecting will look. If you use only open-ended questions for hundreds of people, correct analysis and interpretation of their responses becomes impossible without the aid of a computerized content analysis program.

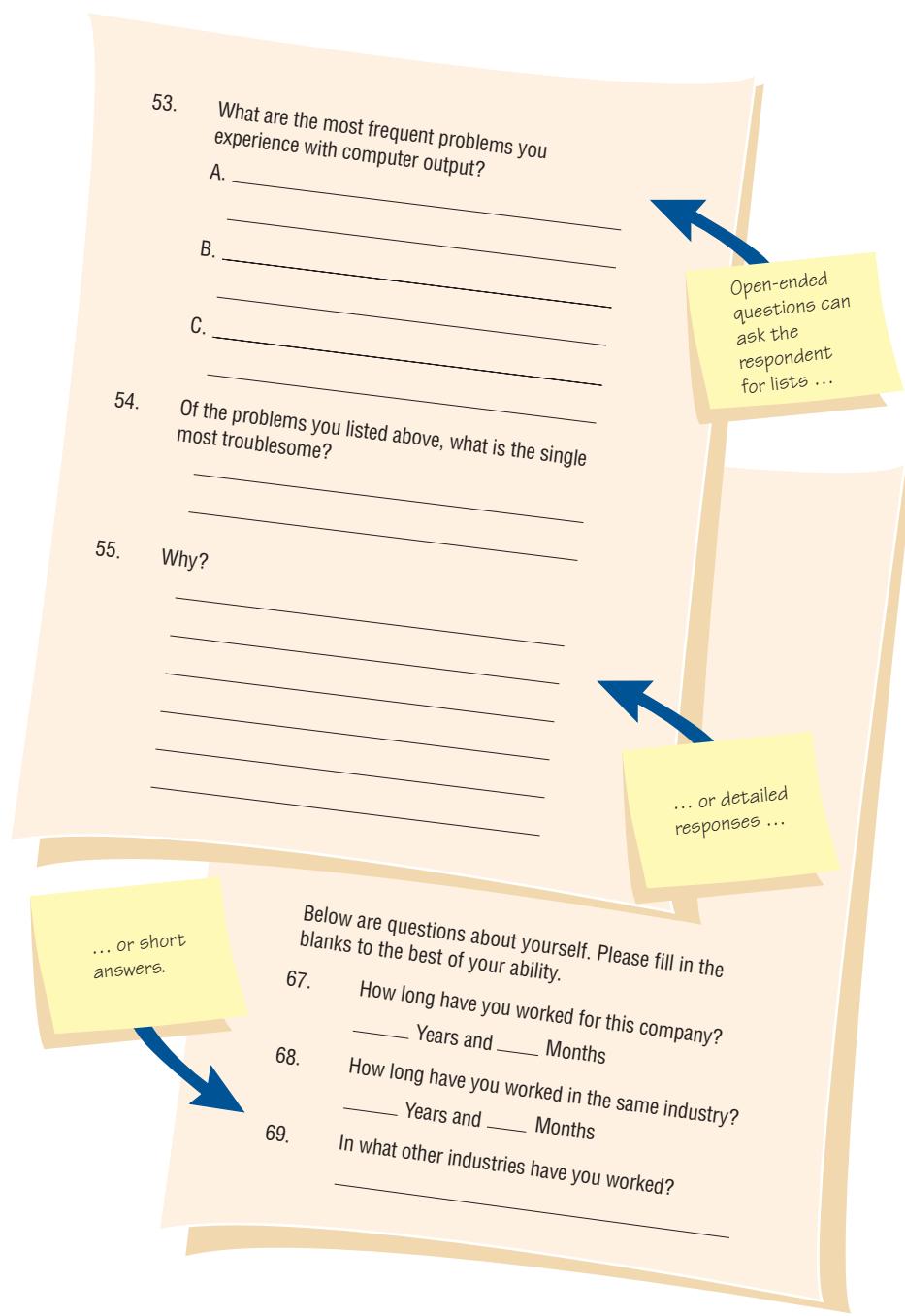
There are trade-offs involved in choosing either open-ended or closed questions for use on questionnaires. Figure 4.12 summarizes these trade-offs. Notice that responses to open-ended questions can help analysts gain rich, exploratory insights as well as breadth and depth on a topic. Although open-ended questions can be written easily, responses to them are difficult and time consuming to analyze.

When we refer to the writing of closed questions with either ordered or unordered answers, we often refer to the process as scaling. The use of scales in surveys is discussed in detail in a later section.

**WORD CHOICE.** Just as with interviews, the language of questionnaires is an extremely important aspect of their effectiveness. Even if the systems analyst has a standard set of questions

**FIGURE 4.10**

Open-ended questions used for questionnaires.



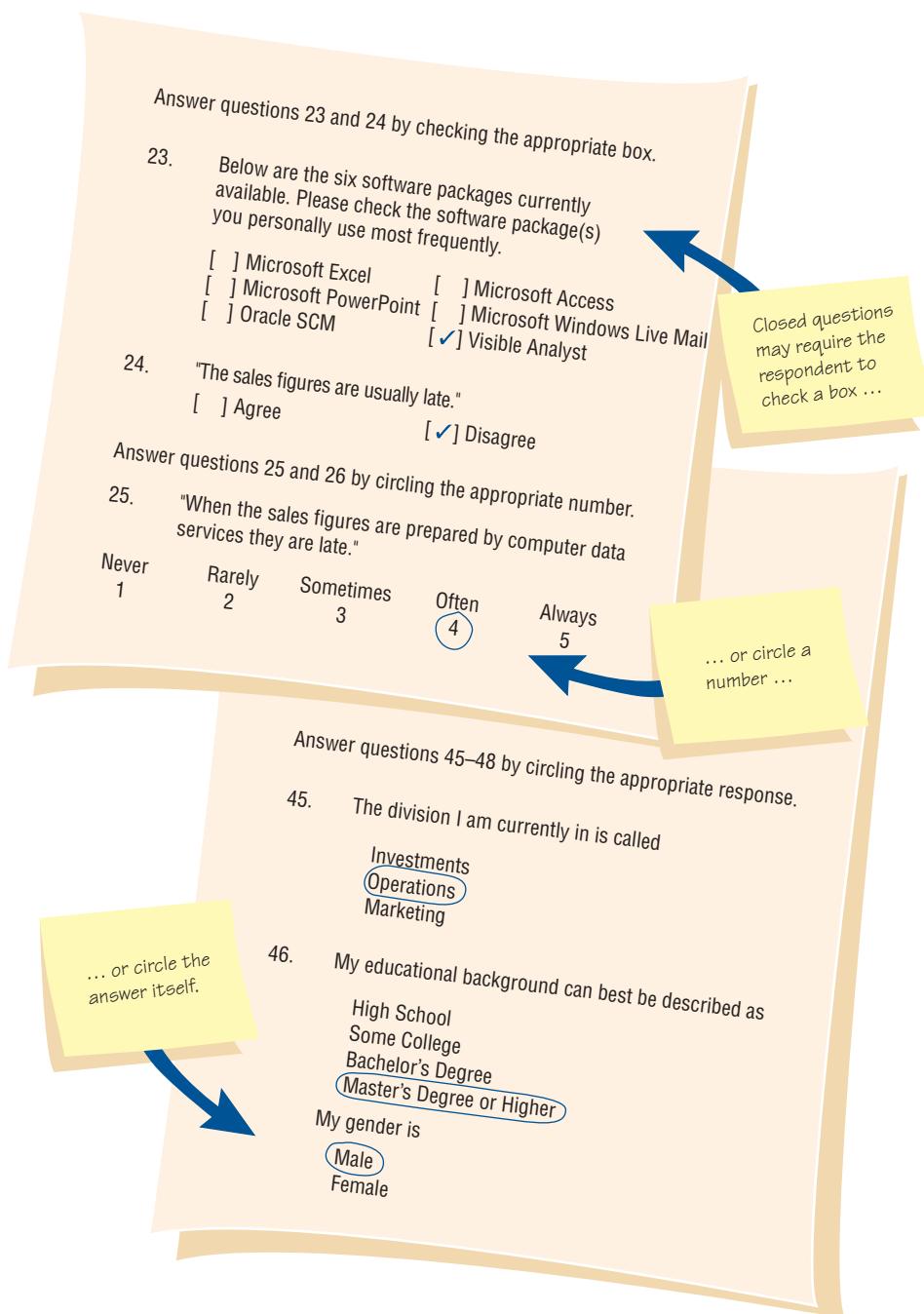
concerning systems development, it is wise to write them to reflect the business's own terminology.

Respondents appreciate the efforts of someone who bothers to write a questionnaire reflecting their own language usage. For instance, if the business uses the term *supervisors* instead of *managers*, or *units* rather than *departments*, incorporating the preferred terms in the questionnaire helps respondents relate to the meaning of the questions. Responses will be easier to interpret accurately, and respondents will be more enthusiastic overall.

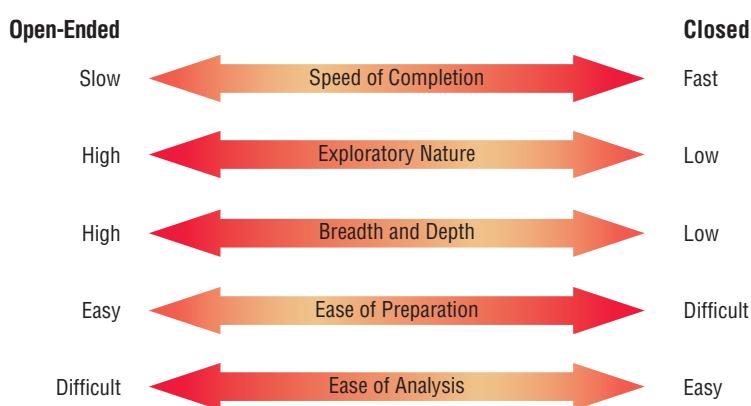
To check whether language used on the questionnaire is that of the respondents, try some sample questions on a pilot (test) group. Ask them to pay particular attention to the appropriateness of the wording and to change any words that do not ring true.

Here are some guidelines to use when choosing language for your questionnaire:

1. Use the language of respondents whenever possible. Keep wording simple.
2. Work at being specific rather than vague in wording. Avoid overly specific questions as well.

**FIGURE 4.11**

Closed questions on questionnaires help ensure responses.

**FIGURE 4.12**

Trade-offs between the use of open-ended and closed questions on questionnaires.

3. Keep questions short.
4. Do not patronize respondents by talking down to them through low-level language choices.
5. Avoid bias in wording. Avoiding bias also means avoiding objectionable questions.
6. Target questions to the correct respondents (that is, those who are capable of responding). Don't assume too much knowledge.
7. Ensure that questions are technically accurate before including them.
8. Use software to check whether the reading level is appropriate for the respondents.

### Using Scales in Questionnaires

Scaling is the process of assigning numbers or other symbols to an attribute or characteristic for the purpose of measuring that attribute or characteristic. Scales are often arbitrary and may not be unique. For example, temperature is measured in a number of ways; the two most common are the Fahrenheit scale (where water freezes at 32 degrees and boils at 212 degrees) and the Celsius scale (where freezing occurs at 0 degrees and boiling at 100 degrees).

**MEASUREMENT.** There are two different forms of measurement scales commonly used by systems analysts:

1. nominal scales and
2. interval scales.

Nominal scales are used to classify things. A question such as:

***What type of software do you use the most?***

- 1 = A Word Processor
- 2 = A Spreadsheet
- 3 = A Database
- 4 = An Email Program

uses a nominal scale. Obviously, nominal scales are the weakest forms of measurement. Generally, all the analyst can do with them is obtain totals for each classification.

Interval scales possess the characteristic that the intervals between each of the numbers are equal. Due to this characteristic, mathematical operations can be performed on the questionnaire data, resulting in a more complete analysis. Examples of interval scales are the Fahrenheit and Celsius scales, which measure temperature.

The foregoing example of the Information Center is definitely not that of an interval scale, but by anchoring the scale on either end, the analyst may want to assume the respondent perceives the intervals to be equal:

***How useful is the support given by the Technical Support Group?***

<i>Not Useful at All</i>					<i>Extremely Useful</i>
1	2	3	4	5	

If the systems analyst makes this assumption, more quantitative analysis is possible.

**VALIDITY AND RELIABILITY.** There are two measures of performance in constructing scales: validity and reliability. The systems analyst should be aware of these concerns.

Validity is the degree to which the question measures what the analyst intends to measure. For example, if the purpose of the questionnaire is to determine whether the organization is ready for a major change in computer operations, do the questions measure that?

Reliability measures consistency. If the questionnaire was administered once and then again under the same conditions and if the same results were obtained both times, the instrument is said to have external consistency. If the questionnaire contains subparts and these parts have equivalent results, the instrument is said to have internal consistency. Both external and internal consistency are important.

**CONSTRUCTING SCALES.** The actual construction of scales is a serious task. Careless construction of scales can result in one of the following problems:

1. Leniency.
2. Central tendency.
3. Halo effect.

Leniency is a problem caused by respondents who are easy raters. A systems analyst can avoid the problem of leniency by moving the “average” category to the left (or right) of center.

Central tendency is a problem that occurs when respondents rate everything as average. The analyst can improve the scale (1) by making the differences smaller at the two ends, (2) by adjusting the strength of the descriptors, or (3) by creating a scale with more points.

The halo effect is a problem that arises when the impression formed in one question carries into the next question. For example, if you are rating an employee about whom you have a very favorable impression, you may give a high rating in every category or trait, regardless of whether or not it is a strong point of the employee’s. The solution is to place one trait and several employees on each page, rather than one employee and several traits on a page.

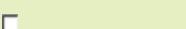
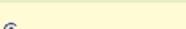
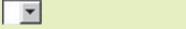
## Designing the Questionnaires

Many of the same principles that are relevant to the design of forms for data input (as covered in Chapter 12) are important here as well. Although the intent of the questionnaire is to gather information on attitudes, beliefs, behavior, and characteristics whose impact may substantially alter users’ work, respondents are not always motivated to respond. Remember that organizational members as a whole tend to receive too many surveys, many of which are often ill-conceived and trivial.

A well-designed, relevant questionnaire can help overcome some of this resistance to respond. Here are some rules for designing a good questionnaire:

1. Allow ample white space.
2. Allow ample space to write or type in responses.
3. Make it easy for respondents to clearly mark their answers.
4. Be consistent in style.

When you design questionnaires for the Web, apply the same rules you use when designing paper questionnaires. Most software packages allow you to insert one of the commonly used data entry formats shown in Figure 4.13. Following the four guidelines should help you gain a better response rate to the questionnaire.

Name	Appearance	Purpose
One-line text box		Used to obtain a small amount of text and limit the answer to a few words
Scrolling text box		Used to obtain one or more paragraphs of text
Check box		Used to obtain a yes-no answer (e.g., Do you wish to be included on the mailing list?)
Radio button		Used to obtain a yes-no or true-false answer
Drop-down menu		Used to obtain more consistent results (Respondent is able to choose the appropriate answer from a predetermined list [e.g., a list of state abbreviations])
Push button		Most often used for an action (e.g., a respondent pushes a button marked “Submit” or “Clear”)

**FIGURE 4.13**

When designing a Web survey, keep in mind that there are different ways to capture responses.



## CONSULTING OPPORTUNITY 4.4

### The Unbearable Questionnaire

“I’m going to go into a depression or at least a slump if someone doesn’t figure this out soon,” say Penny Stox, office manager for Carbon, Carbon, & Rippy, a large brokerage firm. Penny is sitting across a conference table from you and two of her most productive account executives, By Lowe and Sal Hy. You are all mulling over the responses to a questionnaire that has been distributed among the firm’s account executives, which is shown in Figure 4.C1.

“We need a crystal ball to understand these,” By and Sal call out together.

“Maybe it reflects some sort of optimistic cycle, or something,” Penny says as she reads more of the responses. “Who designed this gem, anyway?”

“Rich Kleintz,” By and Sal call out in unison.

“Well, as you can see, it’s not telling us anything!” Penny exclaims.

Penny and her staff are dissatisfied with the responses they have received on the unbearable questionnaire, and they feel that the responses are unrealistic reflections of the amount of information account executives want. In a paragraph, state why these problems are occurring. On a separate sheet, change the scaling of the questions to avoid these problems.

Circle the appropriate number for each source of information described.

<b>1. Industry Reports</b>				
Less 1	2	About the Same 3	4	More 5
<b>2. Trend Analysis</b>				
Less 1	2	About the Same 3	4	More 5
<b>3. Computer-Generated Graphs</b>				
Less 1	2	About the Same 3	4	More 5
<b>4. Investment Advisory Services</b>				
Less 1	2	About the Same 3	4	More 5
<b>5. Point and Figure Charts</b>				
Less 1	2	About the Same 3	4	More 5
<b>6. Computerized Portfolio Analysis</b>				
Less 1	2	About the Same 3	4	More 5
<b>7. Hot Tips</b>				
Less 1	2	About the Same 3	4	More 5

*We need to change this questionnaire.  
-Penny*

**FIGURE 4.C1**

Questionnaire developed for the brokerage firm of Carbon, Carbon, & Rippy by Rich Kleintz.



## CONSULTING OPPORTUNITY 4.5

### Order in the Courts

**I**“I love my work,” Tennys says, beginning the interview with a volley. “It’s a lot like a game. I keep my eye on the ball and never look back,” he continues. Tennyson “Tennys” Courts is a manager for Global Health Spas, Inc., which has popular health and recreation spas worldwide.

“Now that I’ve finished my MBA, I feel like I’m on top of the world with Global,” Tennys says. “I think I can really help this outfit shape up with its computers and health spas.”

Tennys is attempting to help your systems group, which is developing a system to be used by all 80 outlets (where currently each group

handles its paperwork in its own way). “Can I bounce this off you?” he asks Terri Towell, a member of your team of systems analysts. “It’s a questionnaire I designed for distribution to all spa managers.” Ever the good sport, Terri tells Tennys that she’d love to take a look at the form. But back in the office, Terri puts the ball in your court. Systematically critique Tennys’s technique as depicted in Figure 4.C2, and explain to him point by point what it needs to be a matchless questionnaire with a winning form. Building on your critique, tell Tennys what he should do to rewrite the form as a Web survey instead.

#### QUESTIONNAIRE FOR ALL MANAGERS OF HEALTH SPAS

\*\*\*URGENT\*\*\*FILL OUT IMMEDIATELY AND RETURN PERSONALLY TO YOUR DIVISION MANAGER. YOUR NEXT PAYCHECK WILL BE WITHHELD UNTIL IT IS CONFIRMED THAT YOU HAVE TURNED THIS IN.

In 10 words or fewer, what complaints have you lodged about the current computer system in the last six months to a year? Are there others who feel the same way in your outlet as you do? Who? List their names and positions.

- 1.
- 2.
- 3.
- 4.
- 5.
- 6.
- 7.

Terri  
Please help  
me improve this  
form.  
Tennys

What is the biggest problem you have when communicating your information requirements to headquarters? Describe it briefly.

How much computer downtime did you experience last year?

1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 -

Is there any computer equipment you never use?

Description      Serial Number

Do you want it removed? Agree      Neutral      Disagree

In your opinion, what’s next as far as computers and Global Health Spas are concerned?

Thanks for filling this out. • • • • • • • • • • •

**FIGURE 4.C2**

Questionnaire developed for managers of Global Health Spas by Tennys Courts.

**QUESTION ORDER.** There is no best way to order questions on the questionnaire. Once again, as you order questions, you must think about your objectives in using the questionnaire and then determine the function of each question in helping you to achieve your objectives. It is also important to see the questionnaire through the respondent’s eyes. Some guidelines for ordering questions are:

1. Place questions that are important to respondents first.
2. Cluster items of similar content together.
3. Introduce less controversial questions first.

You want respondents to feel as unthreatened by and interested in the questions being asked as possible, without getting overwrought about a particular issue.

## Administering Questionnaires

**RESPONDENTS.** Deciding who will receive the questionnaire is handled in conjunction with the task of setting up objectives for its results. Sampling, which is covered in Chapter 5, helps the systems analyst to determine what sort of representation is necessary and hence what kind of respondents should receive the questionnaire.

Recipients are often chosen as representative because of their rank, length of service with the company, job duties, or special interest in the current or proposed system. Be sure to include enough respondents to allow for a reasonable sample in the event that some questionnaires are not returned or some response sheets are incorrectly completed and thus must be discarded.

**METHODS OF ADMINISTERING THE QUESTIONNAIRE.** The systems analyst has several options for administering the questionnaire, and the choice of administration method is often determined by the existing business situation. Options for administering the questionnaire include the following:

1. Convening all concerned respondents together at one time.
2. Personally handing out blank questionnaires and taking back completed ones.
3. Allowing respondents to self-administer the questionnaire at work and drop it in a centrally located box.
4. Mailing questionnaires to employees at branch sites and supplying a deadline, instructions, and return postage.
5. Administering the questionnaire electronically either via email or on the Web.

Each of these five methods has advantages and disadvantages. Most commonly, respondents are allowed to self-administer the questionnaire. Response rates with this method are a little lower than with the other methods, because people may forget about the form, lose it, or purposely ignore it. Self-administration, however, allows people to feel that their anonymity is ensured and may result in less guarded answers from some respondents. Both email and Web surveys fall into the category of self-administered questionnaires.

Administering the questionnaire electronically, either via email or posted on the Web, is one way to quickly reach current system users. Costs of duplication are minimized. In addition, responses can be made at the convenience of the respondent and then can be automatically collected and stored electronically. Some software permits respondents to begin answering a survey, save their answers, and return to it for completion if they are interrupted. Reminders to respondents can be easily and inexpensively sent via email, as can notifications to the analyst about when the respondent has opened the email. Some software now turns email data into data tables for use in spreadsheet or statistical analysis software. One of the popular services for creating and administering online surveys used by consultants can be found at SurveyMonkey.com, [www.surveymonkey.com](http://www.surveymonkey.com), a Portland, Oregon, company started in 1999, which recently added email marketing services called MailChimp to their product offerings.

Research shows that respondents are willing to answer questions about highly sensitive matters via the Internet. Thus, questions that may be difficult to pose in person regarding systems problems may be acceptable to ask on a Web survey.

## SUMMARY

This chapter covers three of the key interactive methods for information gathering that the systems analyst can use, including interviewing, JAD, and construction of questionnaires. During the process of interviewing analysts, listen for HCI concerns relating to ergonomics, aesthetics, usability, and usefulness, as well as goals, feelings, opinions, and informal procedures in interviews with organizational decision makers. Interviews are planned question-and-answer dialogues between two people. Analysts use the interview to develop their relationship with a client, to observe the workplace, and to collect data. Interviews should preferably be conducted in person.

The five steps to take in planning the interview are to read background material, establish interviewing objectives, decide whom to interview, prepare the interviewee, and decide on question types and structure.

Questions are of two basic types: open-ended or closed. Open-ended questions leave open all response options for the interviewee. Closed questions limit the possible options for response. Probes or follow-up questions can be either open-ended or closed, but they ask the respondent for a more detailed reply.

Interviews can be structured in three basic ways: pyramid, funnel, or diamond. Pyramid structures begin with detailed, closed questions and broaden to more generalized questions. Funnel structures begin with



## HYPERCASE® EXPERIENCE 4.2

“**Y**ou’ve probably noticed by now that not everyone enjoys filling out questionnaires at MRE. We seem to get more questionnaires than most organizations. I think it’s because many of the employees, especially those from the old Training Unit, value the contributions of questionnaire data in our work with clients. When you examine the questionnaire that Snowden distributed, you’ll probably want not only to look at the results but also to critique it from a methods standpoint. I always feel strongly that we can improve our internal performance so that eventually we can better serve our clients. The next time we construct a questionnaire, we want to be able to improve three things: the reliability of the data, the validity of the data, and the response rate we get.”

### HYPERCASE Questions

1. What evidence of questionnaires have you found at MRE? Be specific about what you have found and where.
2. Critique the questionnaire that Snowden circulated. What can be done to improve its reliability, validity, and response rate? Provide three practical suggestions.
3. Write a short questionnaire to follow up on some aspects of the merger between Management Systems and the Training Unit at MRE that are still puzzling you. Be sure to observe all the guidelines for good questionnaire design.
4. Redesign the questionnaire you wrote in question 3 so that it can be used as a Web survey.

open-ended, general questions and then funnel down to more specific, closed questions. Diamond-shaped structures combine the strengths of the other two structures, but they take longer to conduct. Trade-offs are involved when deciding how structured to make interview questions and question sequences.

To cut both the time and cost of personal interviews, analysts may want to consider joint application design (JAD) instead. Using JAD, analysts can both analyze human information requirements and design a user interface with users in a group setting. Careful assessment of the particular organizational culture will help the analyst judge whether JAD is suitable.

By using questionnaires (surveys), systems analysts can gather data on HCI concerns, attitudes, beliefs, behavior, and characteristics from key people in the organization. Surveys are useful if people in the organization are widely dispersed, many people are involved with the systems project, exploratory work is necessary before recommending alternatives, or there is a need for problem sensing before interviews are conducted.

Once objectives for the survey are set, the analyst can begin writing either open-ended or closed questions. Ideally, the questions should be simple, specific, short, free of bias, not patronizing, technically accurate, addressed to those who are knowledgeable, and written at an appropriate reading level. The systems analyst may want to use scales either to measure the attitudes or characteristics of respondents or to have respondents act as judges for the subject of the questionnaire. Scaling is the process of assigning numbers or other symbols to an attribute or characteristic.

Consistent control of the questionnaire format and style can result in a better response rate. Web surveys can be designed to encourage consistent responses. In addition, the meaningful ordering and clustering of questions is important for helping respondents understand the questionnaire. Surveys can be administered in a variety of ways, including electronically via email or the Web, or with the analyst present in a group of users.

## KEYWORDS AND PHRASES

bipolar closed questions  
central tendency  
closed questions  
diamond-shaped structure  
funnel structure  
halo effect  
human-computer interaction (HCI)  
informal procedures  
interval scale  
interviewee feelings  
interviewee goals

interviewee opinions  
joint application design (JAD)  
leniency  
nominal scale  
open-ended questions  
probes  
pyramid structure  
questionnaire  
reliability  
survey respondents  
validity

## REVIEW QUESTIONS

1. What kinds of information should be sought in interviews?
2. List the five steps in interview preparation.
3. Define what is meant by open-ended interview questions. Give eight benefits and five drawbacks of using them.
4. When are open-ended questions appropriate for use in interviewing?
5. Define what is meant by closed interview questions. Give six benefits and four drawbacks of using them.
6. When are closed questions appropriate for use in interviewing?
7. What is a probing question? What is the purpose of using a probing question in interviews?
8. Define what is meant by pyramid structure. When is it useful to employ it in interviews?
9. Define what is meant by funnel structure. When is it useful to employ it in interviews?
10. Define what is meant by diamond-shaped structure. When is it useful to employ it in interviews?
11. Define joint application design (JAD).
12. List the situations that warrant use of JAD in place of personal organizational interviews.
13. List the potential benefits of using joint application design.
14. List the three potential drawbacks of using JAD as an alternative to personal interviews.
15. What kinds of information is the systems analyst seeking through the use of questionnaires or surveys?
16. List four situations that make the use of questionnaires appropriate.
17. What are the two basic question types used on questionnaires?
18. List two reasons why a systems analyst would use a closed question on a questionnaire.
19. List two reasons why a systems analyst would use an open-ended question on a questionnaire.
20. What are the seven guidelines for choosing language for the questionnaire?
21. Define what is meant by scaling.
22. What are two kinds of information or scales that are most commonly used by systems analysts?
23. What are nominal scales used for?
24. Give an example of an interval scale.
25. When should the analyst use interval scales?
26. Define reliability as it refers to the construction of scales.
27. Define validity as it refers to the construction of scales.
28. List three problems that can occur because of careless construction of scales.
29. What are four actions that can be taken to ensure that the questionnaire format is conducive to a good response rate?
30. Which questions should be placed first on the questionnaire?
31. Why should questions on similar topics be clustered together?
32. What is an appropriate placement of controversial questions?
33. List five methods for administering the questionnaire.
34. What considerations are necessary when questionnaires are Web-based?

## PROBLEMS

1. As part of your systems analysis project to update the automated accounting functions for Xanadu Corporation, a maker of digital cameras, you will interview Leo Blum, the chief accountant. Write four to six interview objectives covering his use of information sources, information formats, decision-making frequency, desired qualities of information, and decision-making style.
  - a. In a paragraph, write down how you will approach Leo to set up an interview.
  - b. State which structure you will choose for this interview. Why?
  - c. Leo has four subordinates who also use the system. Would you interview them also? Why or why not?
  - d. Would you also try to interview customers (visitors to the Web site)? Are there better ways to get the opinions of customers? Why or why not?
  - e. Write three open-ended questions that you will email to Leo prior to your interview. Write a sentence explaining why it is preferable to conduct an interview in person rather than via email.
2. Here are five questions written by one of your systems analysis team members. Her interviewee is the local manager of LOWCO, an outlet of a national discount chain, who has asked you to work on a management information system to provide inventory information. Review these questions for your team member.
  1. When was the last time you thought seriously about your decision-making process?
  2. Who are the trouble makers in your store, I mean the ones who will show the most resistance to changes in the system that I have proposed?
  3. Are there any decisions you need more information about to make them?
  4. You don't have any major problems with the current inventory control system, do you?

5. Tell me a little about the output you'd like to see.
  - a. Rewrite each question to be more effective in eliciting information.
  - b. Order your questions in either a pyramid, funnel, or diamond-shaped structure, and label the questions with the name of the structure you used.
  - c. What guidelines can you give your team member for improving her interviewing questions for the future? Make a list of them.
3. Ever since you walked through the door, your interviewee, Max Hugo, has been shuffling papers, looking at his watch, and drumming on his desk with his fingers. Based on what you know about interviews, you guess that Max is nervous because of the other work he needs to do. In a paragraph, describe how you would deal with this situation so that the interview can be accomplished with Max's full attention. (Max cannot reschedule the interview for a different day.)
4. Write a series of six *closed* questions that cover the subject of decision-making style for the manager described in Problem 2.
5. Write a series of six *open-ended* questions that cover the subject of decision-making style for the manager described in Problem 2.
6. Examine the interview structure presented in the sequencing of the following questions:
  1. How long have you been in this position?
  2. What are your key responsibilities?
  3. What reports do you receive?
  4. How do you view the goals of your department?
  5. How would you describe your decision-making process?
  6. How can that process best be supported?
  7. How frequently do you make those decisions?
  8. Who is consulted when you make a decision?
  9. What is the one decision you make that is essential to departmental functioning?
    - a. What structure is being used? How can you tell?
    - b. Restructure the interview by changing the sequence of the questions (you may omit some if necessary). Label the reordered questions with the name of the structure you have used.
7. The following is the first interview report filed by one of your systems analysis team members: "In my opinion, the interview went very well. The subject allowed me to talk with him for an hour and a half. He told me the whole history of the business, which was very interesting. The subject also mentioned that things have not changed all that much since he has been with the firm, which is about 16 years. We are meeting again soon to finish the interview, because we did not have time to go into the questions I prepared."
  - a. In two paragraphs, critique the interview report. What critical information is missing?
  - b. What information is extraneous to the interview report?
  - c. If what is reported actually occurred, what three suggestions do you have to help your teammate conduct a better interview next time?
8. Cab Wheeler is a newly hired systems analyst with your group. Cab has always felt that questionnaires are a waste. Now that you will be doing a systems project for MegaTrucks, Inc., a national trucking firm with branches and employees in 130 cities, you want to use a questionnaire to elicit some opinions about the current and proposed systems.
  - a. Based on what you know about Cab and MegaTrucks, give three persuasive reasons why he should use a survey for this study.
  - b. Given your careful arguments, Cab has agreed to use a questionnaire but strongly urges that all questions be open-ended so as not to constrain the respondents. In a paragraph, persuade Cab that closed questions are useful as well. Be sure to point out trade-offs involved with each question type.
9. "Every time we get consultants in here, they pass out some goofy questionnaire that has no meaning to us at all. Why don't they bother to personalize it, at least a little?" asks Ray Dient, head of emergency systems. You are discussing the possibility of beginning a systems project with Pohattan Power Company (PPC) of Far Meltway, New Jersey.
  - a. What steps will you follow to customize a standardized questionnaire?
  - b. What are the advantages of adapting a questionnaire to a particular organization? What are the disadvantages?
10. A sample question from the draft of the Pohattan Power Company questionnaire reads:  
I have been with the company:  
20-upwards years  
10–15 years upwards  
5–10 years upwards  
less than a year  
Check one that most applies.

- a. What kind of a scale is the question's author using?
  - b. What errors have been made in the construction of the question, and what might be the possible responses?
  - c. Rewrite the question to achieve clearer results.
  - d. Where should the question you've written appear on the questionnaire?
11. Also included on the PPC questionnaire is this question:
- When residential customers call, I always direct them to our Web site to get an answer.

<i>Sometimes</i>	<i>Never</i>	<i>Always</i>	<i>Usually</i>
1	2	3	4

- a. What type of scale is this one intended to be?
  - b. Rewrite the question and possible responses to achieve better results.
12. Figure 4.EX1 is a questionnaire designed by an employee of Green Toe Textiles, which specializes in manufacturing men's socks. Di Wooly wrote the questionnaire because, as the office manager at headquarters in Juniper, Tennessee, she is concerned with the proposed purchase and implementation of a new computer system.

**FIGURE 4.EX1**

Questionnaire developed by Di Wooly.

**Hi! All Employees**

What's new? According to the grapevine, I hear we're in for a new computer. Here are some questions for you to think about.

a. How long have you used the old computer? \_\_\_\_\_

b. How often does it go down? \_\_\_\_\_

c. Who repairs it for you? \_\_\_\_\_

d. When was the last time you suggested a new improvement to the computer system and it was put into use? What was it? \_\_\_\_\_

e. When was the last time you suggested a new improvement to the computer system and nobody used it? What was it? \_\_\_\_\_

f. Do you use a VDT or printer or both? \_\_\_\_\_

g. How fast do you type? \_\_\_\_\_

h. How many people need to access the database regularly at your branch? Is there anyone not using the computer now who would like to? \_\_\_\_\_

- a. Provide a one-sentence critique for each question given.
  - b. In a paragraph, critique the layout and style in terms of white space used, room for responses, ease of responding, and so on.
13. Based on what you surmise Ms. Wooly is trying to get through the questionnaire, rewrite and reorder the questions (use both open-ended and closed questions) so that they follow good practice and result in useful information for the systems analysts. Indicate next to each question that you write whether it is open-ended or closed, and write a sentence indicating why you have written the question this way.
14. Redesign the questionnaire you created for Ms. Wooly in Problem 13 for use on email. Write a paragraph saying what changes were necessary to accommodate email users.
15. Redesign the questionnaire you created for Ms. Wooly in Problem 13 as a Web survey. Write a paragraph saying what changes were necessary to accommodate Web users.

## GROUP PROJECTS

- With your group members, role-play a series of interviews with various system users at Maverick Transport. Each member of your group should choose one of the following roles: company president, information technology director, dispatcher, customer service agent, or truck driver. Those group members playing roles of Maverick Transport employees should attempt to briefly describe their job responsibilities, goals, and informational needs.

Remaining group members should play the roles of systems analysts and devise interview questions for each employee. If there are enough people in your group, each analyst may be assigned to interview a different employee. Those playing the roles of systems analysts should work together to develop common questions that they will ask, as well as questions tailored to each individual employee. Be sure to include open-ended, closed, and probing questions in your interviews.

Maverick Transport is attempting to change from outdated and unreliable technology to more state-of-the-art, dependable technology. The company is seeking to move from dumb terminals attached to a mainframe because it wants to use PCs in some way, and is also interested in investigating a satellite system for tracking freight and drivers. In addition, the company is interested in pursuing ways to cut down on the immense storage requirements and difficult access of the troublesome handwritten, multipart forms that accompany each shipment.

- Conduct all five interviews in a role-playing exercise. If there are more than 10 people in your group, permit two or more analysts to ask questions.
- With your group, write a plan for a JAD session that takes the place of personal interviews. Include relevant participants, suggested setting, and so on.
- Using the interview data you gained from the group exercise on Maverick Transport in Project 1, meet with your group to brainstorm the design of a questionnaire for the hundreds of truck drivers that Maverick Transport employs. Recall that Maverick is interested in implementing a satellite system for tracking freight and drivers. There are other systems that may affect the drivers as well. As your group constructs the questionnaire, consider the drivers' likely level of education and any time constraints the drivers are under for completing such a form.
- Using the interview data you gained from the group exercise on Maverick Transport in Project 1, your group should meet to design an email or Web questionnaire for surveying the company's 20 programmers (15 of whom have been hired in the past year) about their skills, ideas for new or enhanced systems, and so on. Investigate the Web survey options available at SurveyMonkey.com. As your group constructs the programmer survey, consider what you have learned about users in the other interviews as well as what vision the director of information technology holds for the company.

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## EPISODE 4

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# I'll Listen Now, Ask Questions Later

"I've scheduled preliminary interviews with five key people. Because you've been so busy with Visible Analyst, I decided to do the first round of interviews myself," Anna tells Chip as they begin their morning meeting.

"That's fine with me," Chip says. "Just let me know when I can fill in. Who will you be talking to first? Dot?"

"No secret there, I guess," replies Anna. "She's critical to the success of the system. Her word is it when it comes to whether a project will fly or not."

"Who else?" asks Chip.

"I'll see who Dot refers me to, but I set up appointments with Mike Crowe, the hardware and maintenance expert; Cher Ware, the software specialist; and Paige Prynter, CPU's financial analyst."

"Don't forget Hy Perteks," says Chip.

"Right. The Computing Support Center will be important to our project," says Anna. "Let me call and see when he's available."

After a brief phone conversation with Hy, Anna turns once again to Chip.

"He'll meet with me later today," Anna confirms.

After completing her interviews, Anna sits at her desk, reviewing the interview summaries and the memos that were gathered during the summer. Several stacks of papers are neatly filed in expansion folders.

"We have so much information," she remarks to Chip, "yet I sense that we are only working with the tip of the iceberg. I don't have a solid feeling for the difficulties of faculty members and research staff. Are there additional problems we haven't heard about?"

Chip looks up from his work of trying to extract key points for defining the problems. "I wonder if we should do more interviews, or perhaps gather more documents," he says.

"But how many interviews should we conduct and who should we interview?" Anna replies. "Suppose we interview several staff members and base the new system on the results. We could interview the wrong people and design a system to satisfy only their needs, missing key problems that the majority of faculty and staff need to have solved."

"I see what you mean," Chip answers. "Perhaps we should design a questionnaire and survey the faculty and research staff."

"Great idea!" Anna says. "How should we decide which questions to include on the survey?"

"Let's speak with some key people and base the survey on the results. A good starting point would be Hy Perteks, because he is always talking with the faculty and staff. I'll give him a call and arrange a meeting," Chip says.

Chip arranged the meeting for the following morning. It would be held in a conference room adjacent to the Computing Support Center.

"Thanks for meeting with us on such short notice," Chip opens. "We're thinking about surveying the faculty and research staff to obtain additional information that will help us define the system concerns."

"I think it's a tremendous idea," Hy replies. "I would also like to find out what type of software should be available in the Computing Support Center and the type of training we should provide. Information about the major package types used should be obtained," Hy continues. "Web creation and video software is essential. We should find out which package each user likes and, equally important, which version of the package. I know that many are using Dreamweaver and others are using Freeway Pro. Database software also varies although many are using Access. Same for video creation, with Camtasia being the most popular."

"Another consideration would be what type of specialized software is used by groups of faculty members," muses Hy. "Many of the people in the math department are using Mathcad. Others are using various software packages for a number of courses. For instance, the information science people are using Visio, but a few are using Visible Analyst. I've also heard that we're getting some biology and astronomy software. And the art department uses Macs almost exclusively. Many of the faculty are getting heavily into software for image construction, such as Photoshop and Flash."

"Other than software packages and versions, what types of information should we capture?" asks Chip.

"I would like to know what level of expertise each person has," responds Hy. "No doubt, some are beginners, whereas others have a good knowledge but have not mastered all the features of a particular package. Some are experts. They know the software inside and out. I'm interested in the beginners and intermediate users, because we should be providing different training for them. Knowing who's an expert helps, too."

"Is there anything else you feel we should find out about in the survey?" asks Chip.

"The only other thing that I worry about are problems that result in a faculty or staff member not using the software," Hy replies.

"What do you mean?" asks Chip.

"Well, suppose a person has the software but it is installed incorrectly or displays some sort of security or access rights message," replies Hy. "I've had some inquiries about this matter recently. One person said that they were working with Windows Vista with their data on a USB hard drive, and it would not grant them access rights. There's a faculty member in math, Rhoda Booke, who has consistently shown interest in hardware and software issues. I've helped her a number of times, and she's always friendly and grateful. You should interview her for sure."

"Thanks once again for all your help," says Chip. "We'll get back to you later with the results of the survey."

Anna arranges a meeting with Rhoda and explains the nature of the project and why she was selected as a faculty representative. The meeting was held in a small conference room in the math department.

"We'd like to have the faculty perspective on problems encountered with computers and the associated software," says Anna. "Our goal is to provide the faculty with the best possible resources with the least number of problems."

"I'm really glad to be a part of the project," exclaims Rhoda. "I've been using classroom software for about 10 years or so, and what a learning experience it has been! Thank goodness that Hy is available as a resource. I've taken hours of his time, and it's been well worth the effort. I feel much more productive, and the students are using software that helps them grasp the material more thoroughly."

"That's good, but are there some difficulties that you've been experiencing?" asks Chip.

"Well, becoming familiar with the software is a major hurdle. I spent a good portion of last summer, when I wasn't working on my book, learning how to use some of the classroom software for both algebra and calculus. The stuff's great, but I got stuck several times and had to call for help. It's necessary to understand the software to prepare lesson plans and explain to the students how to use it."

"How about problems with installing the software or hardware?" Anna asks.

"Oh, yes!" exclaims Rhoda. "I tried to install the software, and it went smoothly until the part where I went to receive updates from their Web site, and there were some problems with registration," laughs Rhoda.

"Then there were setup problems," Rhoda continues. "I needed to figure out what to install on the network and what to include on the local hard drive. Some of the laptops gave us 'Not enough memory' error messages, and we learned that they had never been updated. The physics faculty had the same problem."

"Are there any other concerns you feel that we should include on our survey to the faculty and research staff?" Chip asks.

"It would be useful to know who is using the same software in different departments and what software is supplied by which vendor. Perhaps if we purchase many packages from one vendor, we could get a larger discount for software. The department software budget is already overwhelmed," Rhoda says.

"Thanks for all your help," Anna says. "If you think of any additional questions we should include on the survey, please do not hesitate to call us."

Back in their office, the analysts start compiling a list of the issues to be contained on the survey.

"We certainly need to ask about the software in use and about training needs," remarks Anna. "We should also address the problems that are occurring."

"Agreed," replies Chip. "I feel that we should include questions on software packages, vendors, versions, level of expertise, and training concerns. What I'm not so sure about is how to obtain information on problems the faculty and staff are encountering. How should we approach these issues?"

"Well," replies Anna, "we should focus on matters with which they are familiar. We might ask questions about the type of problems that are occurring, but certainly not technical ones. And the survey should not ask any questions that we could easily look up answers to, such as 'Who is the vendor for the software?'"

"I see," replies Chip. "Let's divide the questions into categories. Some would be closed questions and some would be open-ended. Then there's the matter of which structure to use."

"We'll use Zoomerang to administer the survey on the Web," continues Anna. "Along with email reminders about the cutoff date for the survey."

### EXERCISES

The first three exercises require that you visit the Web site to obtain the text of the interviews with CPU staff members. Please visit the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall) and look for the “CPU Interviews.”

- E-1. Analyze the five interviews. In a paragraph, discuss what type of structure each interview had.
- E-2. List each interview, 1 through 5, and then write a paragraph for each, discussing ways that Anna might improve on her interviews for next time.
- E-3. Analyze the questions used in the five interviews. In a paragraph, discuss the question types used and whether they were appropriate for getting needed information.
- E-4. From the list of concerns presented earlier in this chapter, select the issues that would best be phrased as closed questions.
- E-5. From the list of concerns, select the issues that would best be phrased as open-ended questions.
- E-6. On the basis of Exercises E-4 and E-5, design a questionnaire to be sent to the faculty and research staff.
- E-7. Pilot your questionnaire by having other students in class fill it out. On the basis of their feedback and your capability to analyze the data you receive, revise your questionnaire.

# CHAPTER 5

## Information Gathering: Unobtrusive Methods

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Recognize the value of unobtrusive methods for information gathering.
2. Understand the concept of sampling for human information requirements analysis.
3. Construct useful samples of people, documents, and events for determining human information requirements.
4. Create an analyst's playscript to observe decision-maker activities.
5. Apply the STROBE technique to observe and interpret the decision maker's environment and interaction with technologies.



Just by being present in an organization, the systems analyst changes it. However, unobtrusive methods such as sampling, investigation, and observing a decision maker's behavior and interaction with his or her physical environment are less disruptive than other ways of eliciting human information requirements. Unobtrusive methods are considered to be insufficient information-gathering methods when used alone. Rather, they should be used in conjunction with one or many of the interactive methods studied in the previous chapter. This is called a multiple methods approach. Using both interactive and unobtrusive methods in approaching the organization is a wise practice that will result in a more complete picture of human information requirements.

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### SAMPLING

Sampling is the process of systematically selecting representative elements of a population. When these selected elements are examined closely, it is assumed that the analysis will reveal useful information about the population as a whole.

The systems analyst has to make a decision on two key issues. First, there are many reports, forms, output documents, memos, and Web sites that have been generated by people in the organization. Which of these should the systems analyst pay attention to, and which should the systems analyst ignore?

Second, a great many employees can be affected by the proposed information system. Which people should the systems analyst interview, seek information from via questionnaires, or observe in the process of carrying out their decision-making roles?

## The Need for Sampling

There are many reasons a systems analyst would want to select either a representative sample of data to examine or representative people to interview, question, or observe. They include:

1. Containing costs.
2. Speeding up the data gathering.
3. Improving effectiveness.
4. Reducing bias.

Examining every scrap of paper, talking with everyone, and reading every Web page from the organization would be far too costly for the systems analyst. Copying reports, asking employees for valuable time, and duplicating unnecessary surveys would result in much needless expense.

Sampling helps accelerate the process by gathering selected data rather than all data for the entire population. In addition, the systems analyst is spared the burden of analyzing data from the entire population.

Effectiveness in data gathering is an important consideration as well. Sampling can help improve effectiveness if information that is more accurate can be obtained. Such sampling is accomplished, for example, by talking to fewer employees but asking them questions that are more detailed. In addition, if fewer people are interviewed, the systems analyst can afford the time to follow up on missing or incomplete data, thus improving the effectiveness of data gathering.

Finally, data gathering bias can be reduced by sampling. When the systems analyst interviews an executive of the corporation, for example, the executive is involved with the project, because this person has already given a certain amount of time to the project and would like it to succeed. When the systems analyst asks for an opinion about a permanent feature of the installed information system, the executive interviewed may provide a biased evaluation, because there is little possibility of changing it.

## Sampling Design

A systems analyst must follow four steps to design a good sample:

1. Determine the data to be collected or described.
2. Determine the population to be sampled.
3. Choose the type of sample.
4. Decide on the sample size.

These steps are described in detail in the following subsections.

**DETERMINING THE DATA TO BE COLLECTED OR DESCRIBED.** The systems analyst needs a realistic plan about what will be done with the data once they are collected. If irrelevant data are gathered, then time and money are wasted in the collection, storage, and analysis of useless data.

The duties and responsibilities of the systems analyst at this point are to identify the variables, attributes, and associated data items that need to be gathered in the sample. The objectives of the study must be considered as well as the type of data-gathering method (investigation, interviews, questionnaires, observation) to be used. The kinds of information sought when using each of these methods are discussed in more detail in this and subsequent chapters.

**DETERMINING THE POPULATION TO BE SAMPLED.** Next, the systems analyst must determine what the population is. In the case of hard data, the systems analyst needs to decide, for example, if the last two months are sufficient, or if an entire year's worth of reports are needed for analysis.

Similarly, when deciding whom to interview, the systems analyst has to determine whether the population should include only one level in the organization or all the levels, or maybe the analyst should even go outside of the system to include the reactions of customers, vendors, suppliers, or competitors. These decisions are explored further in the chapters on interviewing, questionnaires, and observation.

**CHOOSING THE TYPE OF SAMPLE.** The systems analyst can use one of four main types of samples, as pictured in Figure 5.1. They are convenience, purposive, simple, and complex. Convenience samples are unrestricted, nonprobability samples. A sample could be called a convenience sample if, for example, the systems analyst posts a notice on the company's intranet asking for everyone

Not Based on Probability	Based on Probability
Sample elements are selected directly without restrictions	Convenience
Sample elements are selected according to specific criteria	Purposive

 The systems analyst should use a complex random sample if possible.

**FIGURE 5.1**

Four main types of samples the analyst has available.

interested in working with the new sales performance reports to come to a meeting at 1 P.M. on Tuesday the 12th. Obviously, this sample is the easiest to arrange, but it is also the most unreliable. A purposive sample is based on judgment.

A systems analyst can choose a group of individuals who appear knowledgeable and who are interested in the new information system. Here the systems analyst bases the sample on criteria (knowledge about and interest in the new system), but it is still a nonprobability sample. Thus, purposive sampling is only moderately reliable. If you choose to perform a simple random sample, you need to obtain a numbered list of the population to ensure that each document or person in the population has an equal chance of being selected. This step often is not practical, especially when sampling involves documents and reports. The complex random samples that are most appropriate for the systems analyst are (1) systematic sampling, (2) stratified sampling, and (3) cluster sampling.

In the simplest method of probability sampling, systematic sampling, the systems analyst would, for example, choose to interview every  $k$ th person on a list of company employees. This method has certain disadvantages, however. You would not want to use it to select every  $k$ th day for a sample because of the potential periodicity problem. Furthermore, a systems analyst would not use this approach if the list were ordered (for example, a list of banks from the smallest to the largest), because bias would be introduced.

Stratified samples are perhaps the most important to the systems analyst. Stratification is the process of identifying subpopulations, or strata, and then selecting objects or people for sampling in these subpopulations. Stratification is often essential if the systems analyst is to gather data efficiently. For example, if you want to seek opinions from a wide range of employees on different levels of the organization, systematic sampling would select a disproportionate number of employees from the operational control level. A stratified sample would compensate for this. Stratification is also called for when the systems analyst wants to use different methods to collect data from different subgroups. For example, you may want to use a survey to gather data from middle managers, but you might prefer to use personal interviews to gather similar data from executives.

Sometimes the systems analyst must select a group of people or documents to study. This process is referred to as cluster sampling. Suppose an organization had 20 help desks scattered across the country. You may want to select one or two of these help desks under the assumption that they are typical of the remaining ones.

**DECIDING ON THE SAMPLE SIZE.** Obviously, if everyone in the population viewed the world the same way or if each of the documents in a population contained exactly the same information as every other document, a sample size of one would be sufficient. Because that is not the case, it is necessary to set a sample size greater than one but less than the size of the population itself.

It is important to remember that the absolute number is more important in sampling than the percentage of the population. We can obtain satisfactory results sampling 20 people in 200 or 20 people in 2,000,000.

### The Sample Size Decision

The sample size often depends on the cost involved or the time required by the systems analyst, or even the time available by people in the organization. This subsection gives the systems analyst some guidelines for determining the required sample size under ideal conditions, for example, to determine what percentage of input forms contain errors, or alternatively what proportion of people to interview.

The systems analyst needs to follow seven steps, some of which involve subjective judgments, to determine the required sample size:

1. Determine the attribute (in this case, the type of errors to look for).
2. Locate the database or reports in which the attribute can be found.
3. Examine the attribute. Estimate  $p$ , the proportion of the population having the attribute.
4. Make the subjective decision regarding the acceptable interval estimate,  $i$ .
5. Choose the confidence level and look up the confidence coefficient ( $z$  value) in a table.
6. Calculate  $\sigma_p$ , the standard error of the proportion, as follows:

$$\sigma_p = \frac{i}{z}$$

7. Determine the necessary sample size,  $n$ , using the following formula:

$$n = \frac{p(1-p)}{\sigma_p^2} + 1$$

The first step, of course, is to determine which attribute you will be sampling. Once this is done, you can find out where this data is stored, perhaps in a database, on a form, or in a report.

It is important to estimate  $p$ , the proportion of the population having the attribute, so that you set the appropriate sample size. Many textbooks on systems analysis suggest using a heuristic of 0.25 for  $p(1-p)$ . This value almost always results in a sample size larger than necessary because 0.25 is the maximum value of  $p(1-p)$ , which occurs only when  $p = 0.50$ . When  $p = 0.10$ , as is more often the case,  $p(1-p)$  becomes 0.09, resulting in a much smaller sample size.

Steps 4 and 5 are subjective decisions. The acceptable interval estimate of  $\pm 0.10$  means that you are willing to accept an error of no more than 0.10 in either direction from the actual proportion,  $p$ . The confidence level is the desired degree of certainty, say, for example, 95 percent. Once the confidence level is chosen, the confidence coefficient (also called a  $z$  value) can be looked up in a table like the one found in this chapter.

Steps 6 and 7 complete the process by taking the parameters found or set in steps 3 through 5 and entering them into two equations to eventually solve for the required sample size.

#### EXAMPLE

The foregoing steps can best be illustrated by an example. Suppose the A. Semblly Company, a large manufacturer of shelving products, asks you to determine what percentage of orders contain errors. You agree to do this job and perform the following steps. You:

1. Determine that you will be looking for orders that contain mistakes in names, addresses, quantities, or model numbers.
2. Locate copies of order forms from the past six months.
3. Examine some of the order forms and conclude that only about 5 percent (0.05) contain errors.
4. Make a subjective decision that the acceptable interval estimate will be  $\pm 0.02$ .
5. Choose a confidence level of 95 percent. Look up the confidence coefficient ( $z$  value) in Figure 5.2. The  $z$  value equals 1.96.
6. Calculate  $\sigma_p$  as follows:

$$\sigma_p = \frac{i}{z} = \frac{0.02}{1.96} = 0.0102$$

7. Determine the necessary sample size,  $n$ , as follows:

$$n = \frac{p(1-p)}{\sigma_p^2} + 1 = \frac{0.05(0.95)}{(0.0102)(0.0102)} + 1 = 458$$



## CONSULTING OPPORTUNITY 5.1

### Trapping a Sample

**R**eal or fake? Fake or real? Who would have thought it, even five years ago?" howls Sam Pelt, a furrier who owns stores in New York; Washington, D.C.; Beverly Hills; and Copenhagen. Sylva Foxx, a systems analyst with her own consulting firm, is talking with Sam for the first time. Currently, P & P, Ltd. (which stands for Pelt and Pelt's son) is using a PC that supports package software for a select customer mailing list, accounts payable and accounts receivable, and payroll.

Sam is interested in making some strategic decisions that will ultimately affect the purchasing of goods for his four fur stores. He feels that although the computer might help, other approaches should also be considered.

Sam continues, "I think we should talk to all the customers when they come in the door. Get their opinions. You know, some of them are getting very upset about wearing fur from endangered species. They're very environmentally minded. They prefer fake to real, if they can save a baby animal. Some even like fakes better, calling them 'fun furs.' And I can charge almost the same for a good look-alike."

"It's a very fuzzy proposition, though. If I get too far away from my suppliers of pelts, I may not get what I want when I need it. They see the fake fur people as worms, worse than moths! If I deal with them, the real fur men might not talk to me. They can be animals. On the other hand, I feel strange showing fakes in my stores. All these years, we've prided ourselves on having only the genuine article."

Sam continues, in a nearly seamless monologue, "I want to talk to each and every employee, too."

Sylva glances at him furtively and begins to interrupt. "But that will take months, and purchasing may come apart at the seams unless they know soon what—"

Pelt interrupts, "I don't care how long it takes, if we get the right answers. But they have to be right. Not knowing how to solve this dilemma about fake furs is making me feel like a leopard without its spots."

Sylva talks to Sam Pelt a bit longer and then ends the interview by saying, "I'll talk it all over with the other analysts at the office and let you know what we come up with. I think we can outfox the other furriers if we use software to help us sample opinions, rather than trapping unsuspecting customers into giving an opinion. But I'll let you know what they say. This much is for sure: If we can sample and not talk to everybody before making a decision, every coat you sell will have a silver lining."

As one of the systems analysts who is part of Sylva Foxx's firm, suggest some ways that Sam Pelt can use software on the PC he has to adequately sample the opinions of his customers, store managers, buyers, and any others you feel will be instrumental in making the strategic decision regarding the stocking of fake furs in what has always been a real fur store. Suggest a type of sample for each group and justify it. The constraints you are subject to include the need to act quickly so as to remain competitive, the need to retain a low profile so that competing furriers are unaware of your fact gathering, and the need to keep costs of data gathering to a reasonable level.

The conclusion, then, is to set the sample size at 458. Obviously, a greater confidence level or a smaller acceptable interval estimate would require a larger sample size. If we keep the acceptable interval estimate the same but increase the confidence level to 99 percent (with a  $z$  value of 2.58), the necessary sample size becomes 1,827, a figure much larger than the 458 we originally decided to sample.

Confidence Level	Confidence Coefficient (z value)
99%	2.58
98	2.33
97	2.17
96	2.05
95	1.96
90	1.65
80	1.28
50	0.67

**FIGURE 5.2**

A table of area under a normal curve can be used to look up a value once the systems analyst decides on the confidence level.

**DETERMINING SAMPLE SIZE WHEN INTERVIEWING.** There are no magic formulas to help the systems analyst set the sample size for interviewing. The overriding variable that determines how many people the systems analyst should interview in depth is the time an interview takes. A true in-depth interview and follow-up interview is very time consuming for both the interviewer and the participant.

A good rule of thumb is to interview at least three people on every level of the organization and at least one from each of the organization's functional areas (as described in Chapter 2) who will work directly with a new or updated system. Remember also that one does not have to interview more people just because it is a larger organization. If the stratified sample is done properly, a small number of people will adequately represent the entire organization.

## INVESTIGATION

Investigation is the act of discovery and analysis of data. While investigating evidence in an organization, the analyst acts like Sherlock Holmes, the fabled detective from 221B Baker Street.

As the systems analyst works to understand users, their organization, and its information requirements, it will become important to examine different types of hard data that offer information unavailable through any other method of data gathering. Hard data reveal where the organization has been and where its members believe it is going. To piece together an accurate picture, the analyst needs to examine both quantitative and qualitative hard data.

### Analyzing Quantitative Documents

Many quantitative documents are available for interpretation in any business, and they include reports used for decision making, performance reports, records, and a variety of forms. All these documents have a specific purpose and audience for which they are targeted.

**REPORTS USED FOR DECISION MAKING.** A systems analyst needs to obtain some of the documents that are used in running the business. These documents are often paper reports regarding the status of inventory, sales, or production. Many of these reports are not complex, but they serve mainly as feedback for quick action. For example, a sales report may summarize the amount sold and the type of sales. In addition, sales reports might include graphical output comparing revenue and income over a set number of periods. Such reports enable the decision maker to spot trends easily.

Production reports include recent costs, current inventory, recent labor, and plant information. Beyond these key reports, many summary reports are used by decision makers to provide background information, spot exceptions to normal occurrences, and afford strategic overviews of organizational plans.

**PERFORMANCE REPORTS.** Most performance reports take on the general form of actual versus intended performance. One important function of performance reports is to assess the size of the gap between actual and intended performance. It is also important to be able to determine if that gap is widening or narrowing as an overall trend in whatever performance is being measured. Figure 5.3 shows a clear improvement in sales performance over two to three months. The analyst will want to note if performance measurement is available and adequate for key organizational areas.

**RECORDS.** Records provide periodic updates of what is occurring in the business. If the record is updated in a timely fashion by a careful recorder, it can provide much useful information to the analyst. Figure 5.4 is a manually completed payment record for an apartment rental. There are several ways that the analyst can inspect a record, many of which are indicative of their usability:

1. Checking for errors in amounts and totals.
2. Looking for opportunities for improving the recording form design.
3. Observing the number and type of transactions.
4. Watching for instances in which the computer can simplify the work (i.e., calculations and other data manipulation).

**DATA CAPTURE FORMS.** Before you set out to change the information flows in the organization, you need to be able to understand the system that is currently in place. You or one of your team



## CONSULTING OPPORTUNITY 5.2

### A Rose by Any Other Name...Or Quality, Not Quantities

**I** think we have everything we need. I've sampled financial statements, sales figures for each branch, wastage for each shop—we have it all. With all these numbers, we should be able to figure out how to keep Fields in the green, or at least at the forefront of the flower business. We can even show Seymour Fields himself how his new computer system can make it all happen," says Rod Golden, a junior systems analyst working for a medium-sized consulting group.

The firm, under the supervision of its head systems analyst, Clay Potts, has been working on a systems project for the entire chain of 15 successful florist shops and indoor floral markets called Fields. Each of three Midwestern cities has five Fields outlets.

"Although it's just a budding enterprise now, eventually we want to grow with offshoots to half a dozen states," says Seymour Fields, the owner. "I want to reap the benefits of all the happiness we've sown so far. I think we can do it by playing my hunches about what is the best time to purchase flowers at each European market we buy from, and then we should prune back our purchases."

"Over the past three years, I've written lots of memos to our managers about this plan. They've written some good ones back, too. I think we're ready to stake out some territory on this soon," continues Seymour, painting a rosy picture of Fields's future.

"I agree," says Rod. "When I come back from my analysis of these figures," he says, indicating a large stack of material he has unearthed from Fields field offices, "we'll be able to deliver."

Three weeks later, Rod returns to Clay with wilting confidence. "I don't know what to make of all this. I can't seem to get at what's causing the company's growth, or how it's managed. They've been expanding, but I've been through all the figures, and nothing really seems to make sense yet."

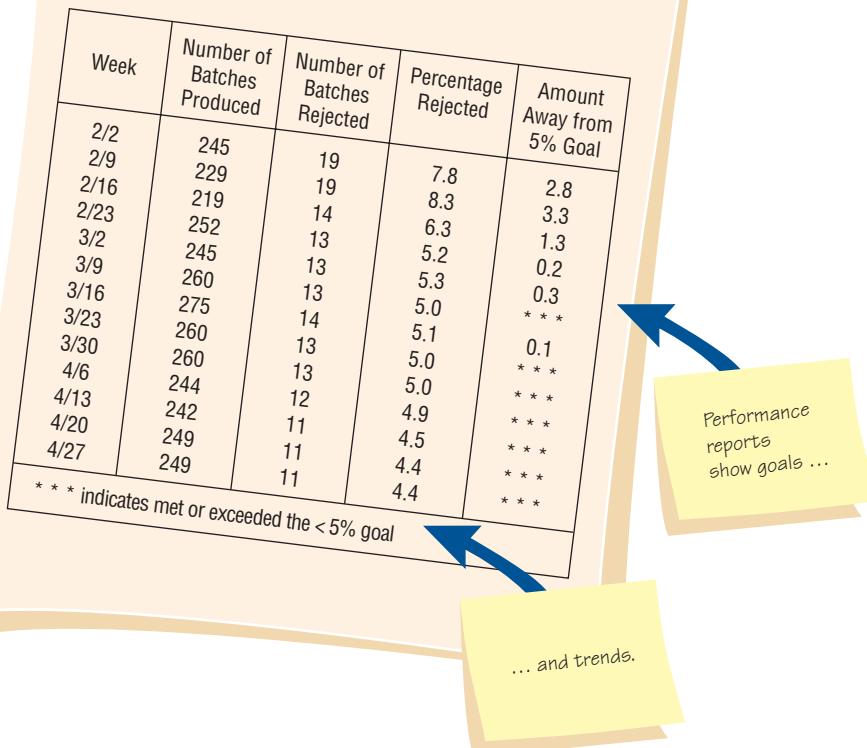
Clay listens empathetically, then says, "You've given me a germ of an idea. What we need is some cross-pollination, a breath of fresh air. We need to dig a little deeper. Did you examine anything but their bottom line?"

Rod looks startled and replies, "No, I—uh—what do you mean?"

How can Clay Potts tactfully explain to Rod Golden that examination of qualitative as well as quantitative documents could be important to delivering an accurate assessment of Fields's potential to be a more fruitful enterprise? In a paragraph, recommend some specific documents that should be read. List the specific steps Rod should follow in evaluating qualitative documents obtained from Fields. Write a paragraph to explain how qualitative documents help in presenting an overall account of Fields's success.

**FIGURE 5.3**

A performance report showing improvement.



**FIGURE 5.4**

A manually completed payment record.

PROJ. NAME		OAK. FC		#	562	KEY SIGNATURE										
RENT POTENTIAL				1175/0	81299	DEPOSIT POTENTIAL		PRORATE		15.00						
Base Rent	Refrigerator	Furniture	A/C	Util.	HMSR	TV	Maid	Total Rent	Secur-ity	Clean-ing	31175/0	81299	31700	Days	Daily Rate	Totals
855		55						910			H/S dep	H/S rent		4	30.33	15.00
								200	115						910	39
PAYMENT RECORD: Tot. 31175/0 + 81299 + Rent = 910															Deposits 31.65	340
TOTAL INITIAL PAYMENT REQUIRED:															1430.52	
Memo Only	Date Due	Date Paid	Receipt Number	Paid to Noon	Total Rent	Secur-ity	Clean-ing	31700	31175/0	Dates	Amt.	Other Descr.	Amt.	Amount Paid	Balance Due	
TV 10/13 MO!	9/28	9/28	106642	9/30	031.32	202	115	44.20	25				44.82	15	1430.52	0
	10/1	10/13	107503	10/31	910									910	0	
CH/59-16	11/1	11/1	10935	11/16	485.23									485.23	0	
Bill 1 MO	11/17	11/18	11200	11/23	2123									212.31	0	
Prorated																
H/S should be created toward refund deposit																
Orig. Move-in Date	8-28				d same	Exp.	NAME	Kendall	X#	1						
BLDG. #															1st	

*Note: Handwritten annotations are present throughout the form, including 'Check for errors.' above the header, 'Look for opportunities for improvement in design.' on the right side, 'Observe the number and type of transactions.' pointing to the transaction section, and 'Watch for places the computer can simplify the work.' pointing to the payment required section.*

members may want to collect and catalog a blank copy of each form (official or unofficial) that is in use. (Sometimes businesses have a person already charged with forms management, who would be your first source for forms in use.)

Blank forms, along with their instructions for completion and distribution, can be compared with filled-in forms to see if any data items are consistently left blank on the forms; whether the people who are supposed to receive the forms actually do get them; and if they follow standard procedures for using, storing, and discarding them. Remember to print out any Web-based forms that require users to print them. Alternatively, electronic versions that can be submitted via the Web or email can be identified and stored in a database for later inspection.

To proceed when creating a catalog of forms to help you understand the information flow currently in use in the business:

1. Collect examples of all the forms in use, whether officially sanctioned by the business or not (official versus bootleg forms).
2. Note the type of form (whether printed in-house, handwritten, computer-generated in-house, online forms, Web fill-in forms, printed externally and purchased, etc.).
3. Document the intended distribution pattern.
4. Compare the intended distribution pattern with who actually receives the form.

Although this procedure is time consuming, it is useful. Another approach is to sample data capture forms that have already been completed. Remember to check databases that store consumer data when sampling input from ecommerce transactions. The analyst must keep in mind

Farmfresh Reorder of Shorted Dairy Products																					
Date _____	Store Name _____	Store Number _____																			
Item Requested	Cases	Item Requested	Cases																		
Milk (1/2 gals.)	_____	Milk (quarts)	_____																		
Whole	_____	2%	_____																		
2%	_____	1%	_____																		
1%	_____	Skim	_____																		
Skim	_____	Buttermilk	_____																		
Buttermilk	_____	Chocolate	_____																		
Chocolate	_____																				
Yogurt	_____																				
Plain	_____																				
Vanilla	_____																				
Peach	_____																				
Blueberry	_____																				
Boysenberry	_____																				
Strawberry	_____																				
Ice Cream	_____																				
Deluxe Pints	_____																				
Deluxe 1/2 Gallons	_____																				
Skinny Minnies	_____																				
Requested by (employee number) _____	Total Cases Ordered _____																				
Reason for Shortage _____																					
Driver Number _____	Route Number _____																				
<table border="1"> <tr> <td>Store _____</td> <td>Date _____</td> <td>Driver _____</td> </tr> <tr> <td><b>Product shorted</b></td> <td></td> <td><b>Cases needed</b></td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>_____</td> <td>_____</td> <td>_____</td> </tr> <tr> <td>Dairy manager's initials _____</td> <td></td> <td></td> </tr> </table>		Store _____	Date _____	Driver _____	<b>Product shorted</b>		<b>Cases needed</b>	_____	_____	_____	_____	_____	_____	_____	_____	_____	Dairy manager's initials _____				
Store _____	Date _____	Driver _____																			
<b>Product shorted</b>		<b>Cases needed</b>																			
_____	_____	_____																			
_____	_____	_____																			
_____	_____	_____																			
Dairy manager's initials _____																					

**FIGURE 5.5**

Questions to ask about official and bootleg forms that are already filled out.

Official form can overwhelm people by asking for too much information.

There may be no logical order to the form.

Is the total really needed?

"Bootleg" forms arise to simplify the problem.

many particular questions, as illustrated in Figure 5.5. They include the following aspects of HCI relating to usability, aesthetics, and usefulness:

1. Is the form filled out in its entirety? If not, what items have been omitted, and are they consistently omitted? Why?
2. Are there forms that are never used? Why? (Check the design and appropriateness of each form for its purported function.)
3. Are all copies of forms circulated to the proper people or filed appropriately? If not, why not? Can people who must access online forms do so?
4. If there is a paper form that is offered as an alternative to a Web-based form, compare the completion rates for both.
5. Are "unofficial" forms being used on a regular basis? (Their use might indicate a problem in standard procedures or may indicate political battles in the organization.)

## Analyzing Qualitative Documents

Qualitative documents include email messages, memos, signs on bulletin boards and in work areas, Web pages, procedure manuals, and policy handbooks. Many of these documents are rich in details revealing the expectations for behavior of others that their writers hold and the ways in which users expect to interact with information technologies.

Although many systems analysts are apprehensive about analyzing qualitative documents, they need not be. Several guidelines can help analysts take a systematic approach to this sort of analysis. Many of these relate to the affective, emotional, and motivational aspects of HCI, as well as interpersonal relationships in the organization.

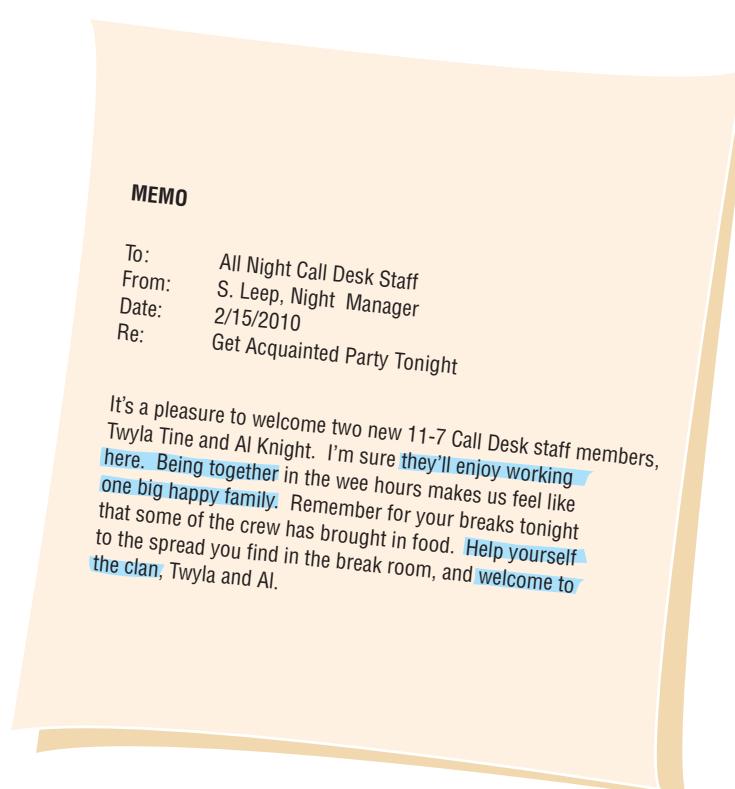
1. Examine documents for key or guiding metaphors.
2. Look for insiders versus outsiders or an “us against them” mentality.
3. List terms that characterize good or evil and appear repeatedly in documents.
4. Look for the use of meaningful messages and graphics posted on common areas or on Web pages.
5. Recognize a sense of humor, if present.

Examining documents for key or guiding metaphors is done because language shapes behavior; thus, the metaphors we employ are critical. For example, an organization that discusses employees as “part of a great machine” or “cogs in a wheel” might be taking a mechanistic view of the organization. Notice that the guiding metaphor in the memo in Figure 5.6 is, “We’re one big happy family.” The analyst can use this information to predict the kinds of metaphors that will be persuasive in the organization. Obviously, if one department is battling another, it may be impossible to gain any cooperation on a systems project until the politics are resolved in a satisfactory manner. Assessing the use of humor provides a quick and accurate barometer of many HCI, interpersonal, and organizational variables, including which subculture a person belongs to and what kind of morale exists.

**MEMOS.** Along with the five preceding guidelines, the analyst should also consider who sends memos and who receives them. Typically, most information flows downward and horizontally rather than upward in organizations, and extensive email systems mean messages are sent to many

### FIGURE 5.6

Analysis of memos provides insight into the metaphors that guide the organization’s thinking.





## HYPERCASE® EXPERIENCE 5.1

“We’re glad you find MRE an interesting place to consult. According to the grapevine, you’ve been busy exploring the home office. I know, there’s so much going on. We find it hard to keep track of everything ourselves. One thing we’ve made sure of over the years is that we try to use the methods that we believe in. Have you seen any of our reports? How about the data that were collected on one of Snowden’s questionnaires? He seems to favor questionnaires over any other method. Some people resent them, but I think you can learn a lot from the results. Some people have been good about cooperating on these projects. Have you met Kathy Blandford yet?”

### HYPERCASE Questions

1. Use clues from the case to evaluate the Training Unit’s computer experience and its staff’s feeling about the PSRS.

What do you think the consensus is in the Training Unit toward a computerized project tracking system?

2. What reports and statements are generated by the Training Unit during project development? List each with a brief description.
3. According to the interview results, what are the problems with the present project tracking system in the Training Unit?
4. Describe the “project management conflict” at MRE. Who is involved? Why is there a conflict?
5. How does the Management Systems Unit keep track of project progress? Briefly describe the method or system.

work groups and individuals. Memos reveal a lively, continuing dialogue in the organization. Analysis of memo content will provide you with a clear idea of the values, attitudes, and beliefs of organizational members.

**SIGNS OR POSTERS ON BULLETIN BOARDS OR IN WORK AREAS.** Although signs may seem incidental to what is happening in the organization, they serve as subtle reinforcers of values to those who read them. Slogans posted such as “Quality Is Forever” or “Safety First” give the analyst a sense of the official organizational culture.

**CORPORATE WEB SITES.** Web sites used for business-to-consumer (B2C) ecommerce as well as those used for business-to-business (B2B) transactions should also be viewed by the analyst. Examine the contents for metaphors, humor, use of design features (such as color, graphics, animation, and hyperlinks), and the meaning and clarity of any messages provided. Think about the Web site from three dimensions: technical, aesthetic, and managerial. Are there discrepancies between the stated goals of the organization and what is presented to the intended viewer? How much customization of the Web site is available for each user? How much personalization of the Web site is possible? If you are not designing ecommerce sites for the organization, how does what you see on its Web site affect the systems you are investigating? Remember to note the level of interactivity of the Web site or sites, the accessibility of the messages, and the security level.

**MANUALS.** Other qualitative documents the analyst should examine are organizational manuals, including manuals for computer operating procedures and online manuals. Manuals should be analyzed following the five guidelines spelled out previously. Remember that manuals present the “ideal,” the way machines and people are expected to behave. It is important to recall that printed manuals are rarely kept current and are sometimes relegated to a shelf, unused.

**POLICY HANDBOOKS.** The last type of qualitative document we consider is the policy handbook. Although these documents typically cover broad areas of employee and corporate behavior, you can be primarily concerned with those that address policies about computer services, use, access, security, and charges. Examining policies allows the systems analyst to gain an awareness of the values, attitudes, and beliefs guiding the corporation.

## OBSERVING A DECISION MAKER'S BEHAVIOR

Observing decision makers, their physical environment, and their interaction with their physical, ergonomic environment is an important unobtrusive method for the systems analyst. Through observing activities of decision makers, the analyst seeks to gain insight about what is actually done, not just what is documented or explained. In addition, through observation of the decision maker, the analyst attempts to see firsthand the relationships that exist between decision makers and other organizational members. Observation of decision makers' interactions with technologies can also reveal important clues regarding HCI concerns, such as how well the system fits with the user.

### Observing a Typical Manager's Decision-Making Activities

Managers' workdays have been described as a series of interruptions punctuated by short bursts of work. In other words, pinning down what a manager "does" is a slippery proposition even under the best of circumstances. For the systems analyst to grasp adequately how managers characterize their work, interactive interviews and questionnaires are used. Observation, however, allows the analyst to see firsthand how managers gather, process, share, and use information and technology to get work done.

Although it is possible to describe and document how managers make decisions using boxes and arrows, we are primarily describing humans and their activities. Therefore, we suggest that systems analysts use a more humanistic approach to describe what managers do. This method is called the analyst's playscript. With this technique the "actor" is the decision maker who is observed "acting" or making decisions. In setting up a playscript, the actor is listed in the left-hand column and all his or her actions are listed in the right-hand column, as shown in Figure 5.7. All activities are recorded with action verbs, so that a decision maker would be described as "talking," "sampling," "corresponding," and "deciding."

Playscript is an organized and systematic approach that demands the analyst be able to understand and articulate the action taken by each observed decision maker. This approach eventually assists the systems analyst in determining what information is required for major or frequent decisions made by the observed people. For instance, from the quality assurance manager example in the playscript, it becomes clear that even though this decision maker is on the middle management level, he or she still requires a fair amount of external information to perform the required activities of this specific job.

## OBSERVING THE PHYSICAL ENVIRONMENT

Observing the activities of decision makers is just one way to assess their information requirements. Observing the physical environment where decision makers work also reveals much about their human information requirements. Most often, such observing means systematically examining the offices of decision makers, because offices constitute their primary workplace. Decision makers influence and are in turn influenced by their physical environments and by their interactions with the technology that takes place there. Many HCI concerns can be identified through structured observation and confirmed with other techniques, such as interviews or questionnaires.

### Structured Observation of the Environment (STROBE)

Film critics sometimes use a structured form of criticism called *mise-en-scène* analysis to systematically assess what is in a single shot of the film. They look at editing, camera angle, set decor, and the actors and their costumes to find out how they are shaping the meaning of the film as intended by the director. Sometimes the film's *mise-en-scène* will contradict what is said in the dialogue. For information requirements analysis, the systems analyst can take on a role similar to that of the film critic. It often is possible to observe the particulars of the surroundings that will confirm or negate the organizational narrative (also called "stories" or "dialogue") that is found through interviews or questionnaires.

The method for *STRuctured OBservation of the Environment* is referred to as STROBE. Successful application of STROBE requires that an analyst explicitly observe seven concrete ele-

**FIGURE 5.7**

A sample page from the analyst's playscript describing decision making.

<b>Playscript Analysis</b>	Company: Solid Steel Shelving Analyst: L. Brackett	
<b>Decision Maker (Actor)</b>	<b>Information-Related Activity (Script)</b>	
Quality Assurance Manager	Asks shop floor supervisor for the day's production report	
Shop Floor Supervisor	Prints out daily computerized production report	
Quality Assurance Manager	Discusses recurring problems in production runs with quality assurance (QA) manager	Reads production report
	Compares current report with other reports from the same week	Inputs data from daily production run into QA model on computer
Shop Floor Supervisor	Observes onscreen results of QA model	Calls steel suppliers to discuss deviations from quality standards
Quality Assurance Manager	Attends meeting on new quality specifications with quality assurance manager and vice president of production	Drafts letter to inform suppliers on new quality specifications agreed on in meeting
Vice President of Production	Sends draft to vice president via email	Reads drafted letter
Quality Assurance Manager	Returns corrections and comments via email	Reads corrected letter on email
	Rewrites letter to reflect changes	

ments commonly found in offices. The seven observable elements and some key questions that may arise are listed in Figure 5.8. These elements can reveal much about the way a decision maker gathers, processes, stores, and shares information, as well as about the decision maker's credibility in the workplace.

**OFFICE LOCATION.** One of the first elements a systems analyst should observe is the location of a particular decision maker's office with respect to other offices. Accessible offices tend to increase interaction frequency and informal messages, whereas inaccessible offices tend to decrease the interaction frequency and increase task-oriented messages. Offices distributed along the perimeter of the building usually result in a report or memo being held up in one of the offices, whereas office clusters encourage information sharing. It is also likely that the people whose

**FIGURE 5.8**

Seven concrete observable elements of STROBE and examples of questions an analyst may want to ask.

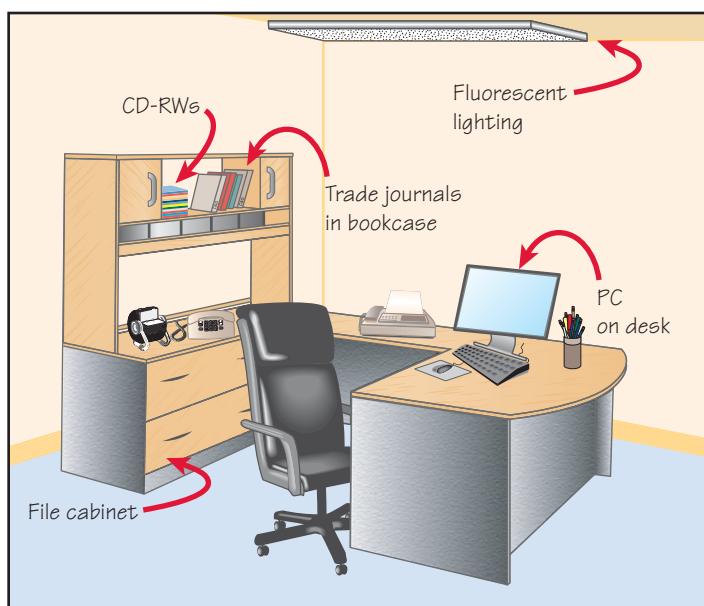
Observable Element	Questions an Analyst Might Investigate
Office location	Who has the corner office? Are the key decision makers dispersed over separate floors?
Desk placement	Does the placement of the desk encourage communication? Does the placement demonstrate power?
Stationary equipment	Does the decision maker prefer to gather and store information personally? Is the storage area large or small?
Props	Is there evidence that the decision maker uses a PC, smartphone, or tablet computer in the office?
External information sources	Does the decision maker get much information from external sources such as trade journals or the Web?
Office lighting and color	Is the lighting set up to do detailed work or more appropriate for casual communication? Are the colors warm and inviting?
Clothing worn by decision makers	Does the decision maker show authority by wearing conservative suits? Are employees required to wear uniforms?

offices are separated from others may tend to view the organization differently and so drift further apart from other organization members in their objectives.

**DESK PLACEMENT.** Placement of a desk in the office can provide clues to the exercise of power by the decision maker. Executives who enclose a visitor in a tight space with the visitor's back to the wall while allowing themselves a lot of room put themselves into the strongest possible power position. An executive who positions his or her desk facing the wall with a chair at the side for a visitor is probably encouraging participation and equal exchanges. The systems analyst should notice the arrangement of the office furniture and in particular the placement of the desk. Figure 5.9 shows an example of desk placement as well as many of the other elements of STROBE, such as props, stationary office equipment, lighting, color, and external sources of information.

**FIGURE 5.9**

Observe a decision maker's office for clues concerning his or her personal storage, processing, and sharing of information.





## CONSULTING OPPORTUNITY 5.3

### Don't Bank on Their Self-Image or Not Everything Is Reflected in a Mirror

**I**"I don't want any power here," demurs Dr. Drew Charles, medical director of the regional blood center where your systems group has just begun a project. "I'm up to my neck in work just keeping the regional physicians informed so they follow good blood-banking practices," he says, as he shields his eyes from the bright sunlight streaming into his office. He clicks off the display connected to his PC and turns his attention to you and the interview.

Dr. Charles is dressed in a conservative, dark wool suit and is wearing a red-striped silk necktie. He continues, "In fact, I don't make decisions. I'm here purely in a positive support role." He pulls out the organizational chart shown in Figure 5.C1 to illustrate his point. "It is as clear as a fracture. The chief administrator is the expert on all administrative matters. I am the medical consultant only."

Dr. Charles's office is stacked high not only with medical journals such as *Transfusion* but also with yellowed copies of old *BYTE* magazines and the latest issues of *Business Week*. Each *Business Week* is opened to a different page, as if the doctor were in the process of devouring each morsel of information. The overflow journals, however, are not stored meticulously on metal bookshelves as expected. In sharp contrast to the gleaming new equipment you saw being used in the donor rooms, the journals are piled a foot high on an old blood-donating bed that has been long retired from its intended use.

Next, you decide to interview the chief administrator, Craig Bunker, to whom Dr. Charles has alluded. Fifteen minutes after the scheduled start of your appointment, Bunker's secretary, Dawn Upshaw, finally allows you to enter his office. Bunker, who has just finished a phone call, is dressed in a light-blue sport coat, checkered slacks, light-blue shirt, and a necktie. "How are you doing? I've just been checking around to see how everything's perking along," Bunker says by way of introduction. He is outgoing and very friendly.

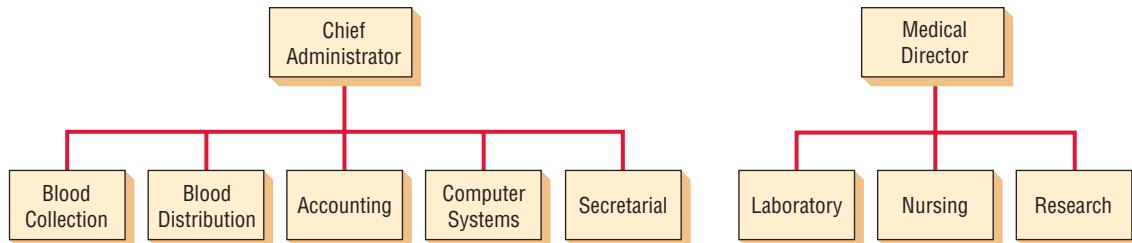
As you glance around the room, you notice that there are no filing cabinets, nor is there a PC such as the one Dr. Charles was using. There are lots of photos of Craig Bunker's family, but the only item resembling a book or magazine is the center's newsletter, *Bloodline*. As the interview begins in earnest, Bunker cheerfully launches into stories about the Pennsylvania Blood Center, where he held the position of assistant administrator six years ago.

Finally, you descend the stairs to the damp basement level of the Heath Lambert Mansion. The bloodmobiles have just returned, and processed blood has been shipped to area hospitals. You decide to talk with Sang Kim, a bloodmobile driver; Jenny McLaughlin, the distribution manager; and Roberta Martin, a lab technician who works the night shift.

Roberta begins, "I don't know what we'd do without the doctor." In the same vein, though, Sang feeds the conversation by remarking, "Yeah, he helped us by thinking up a better driving schedule last week."

Jenny adds, "Dr. Charles is invaluable in setting the inventory levels for each hospital, and if it wasn't for him, we wouldn't have our new software, let alone our new network."

As one of the systems analysis team members assigned to the blood center project, develop an anecdotal checklist using STROBE to help you systematically interpret the observations you made about the offices of Dr. Charles and Craig Bunker. Consider any disparities between a decision maker's clothing, what a decision maker states, and what is said by others; between office location and what is stated; and between office equipment and policies stated. In addition, in a paragraph, suggest possible follow-up interviews and observations to help settle any unresolved questions.



**FIGURE 5.C1**

Organizational chart of the regional blood center.

**STATIONARY OFFICE EQUIPMENT.** File cabinets, bookshelves, and other large equipment for storing items are all included in the category of stationary office equipment. If there is no such equipment, it is likely the decision maker stores very few items of information personally. If there is an abundance of such equipment, it is presumed the decision maker stores and values much information.

**PROPS.** The term *props* (an abbreviation of the theatre/film term *properties*) refers to all the small equipment used to process information, including smartphones, calculators, PCs, pens, pencils,

and rulers. The presence of handhelds, calculators, and PCs suggests that a decision maker who possesses such equipment is more likely to use it personally than one who must leave the room to use it.

**EXTERNAL INFORMATION SOURCES.** A systems analyst needs to know what type of information is used by the decision maker. Observation of the type of publications stored in the office can reveal whether the decision maker is looking for external information (found in trade journals, news items about other companies in the industry, and so on) or relies more on internal information (company reports, intraoffice correspondence, policy handbooks). The analyst should also observe whether the decision maker prefers to get external information from the Web.

**OFFICE LIGHTING AND COLOR.** Lighting and color play an important role in how a decision maker gathers information. An office lighted with warm, incandescent lighting indicates a tendency toward more personal communication. An executive in a warmly lit office will gather more information informally, whereas another organizational member working in a brightly lit, brightly colored office may gather information through more formal memos and official reports.

**CLOTHING WORN BY DECISION MAKERS.** Much has been written about the clothing worn by executives and others in authority. The systems analyst can gain an understanding of the credibility exhibited by managers in the organization by observing the clothing they wear on the job. The two-piece suit for a man or the skirted suit for a woman represents the maximum authority, according to some researchers who have studied perceptions of executive appearance. Casual dressing by leaders tends to open the door for more participative decision making, but such attire often results in some loss of credibility in the organization if the predominant culture values traditional, conservative clothing.

Through the use of STROBE, the systems analyst can gain a better understanding of how managers gather, process, store, and use information. A summary of the characteristics exhibited by decision makers and the corresponding observable elements is shown in Figure 5.10.

### Applying Strobe

One way to implement STROBE is through the use of an anecdotal checklist with meaningful shorthand symbols. This approach to STROBE was useful in ascertaining the information requirements for four key decision makers in a franchise clothing store.

As Figure 5.11 shows, five shorthand symbols were used by the systems analysts to evaluate how observation of the STROBE elements compared with the organizational narrative generated through interviews. The five symbols are as follows:

1. A check mark means the narrative is confirmed.
2. An “X” means the narrative is reversed.
3. An oval or eye-shaped symbol serves as a cue for the systems analyst to look further.

**FIGURE 5.10**

A summary of decision-maker characteristics that correspond to observable elements in the physical environment.

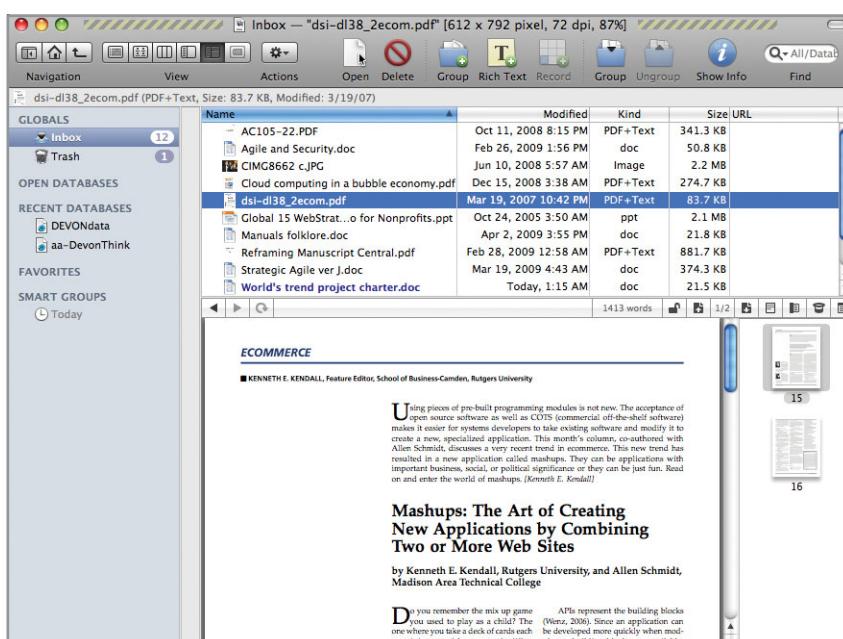
Characteristics of Decision Makers	Corresponding Elements in the Physical Environment
Gathers information informally	Warm, incandescent lighting and colors
Seeks extraorganizational information	Trade journals present in office
Processes data personally	PCs, or tablet computers present in office
Stores information personally	Equipment/files present in office
Exercises power in decision making	Desk placed for power
Exhibits credibility in decision making	Wears authoritative clothing
Shares information with others	Office easily accessible



## MAC APPEAL

Collecting data unobtrusively seems easy until one realizes that all the data collected must be organized, stored, and retrieved for analysis. The simplest solution is software called Yojimbo from Bare Bones software. It is inexpensive and easy to use. Just drag the items you want to collect into Yojimbo and search for them when you want to retrieve them. A more structured approach is to use an application like DEVONthink Professional Office. The metaphor of an office is a bit ambitious, because using the application is more like tossing all sorts of data in a desk drawer, then figuring out how to organize it at a later date. DEVONthink accepts Microsoft Word, Excel, and PowerPoint files as well as anything from iWork. It can keep track of bookmarks and Web pages, images, and PDF files. A built-in OCR reader helps input pages directly.

When it is time to access the information, DEVONthink can help a systems analyst search, classify, and show relationships among items with the help of artificial intelligence. DEVONthink doesn't help an analyst determine the sample size or keep track of errors, but it does help collect, store, retrieve, use, and share information gathered by the analyst.



The screenshot shows the DEVONthink interface. On the left is a sidebar with navigation links: GLOBALS (Inbox, Trash), OPEN DATABASES (DEVONdata, aa-DevonThink), FAVORITES, and SMART GROUPS (Today). The main area has a toolbar with icons for Navigation, View, Actions, Open, Delete, Group, Rich Text, Record, Group, Ungroup, Show Info, and Find. A central table lists files in the 'Inbox' database:

Name	Modified	Kind	Size	URL
AC105-22.PDF	Oct 11, 2008 8:15 PM	PDF+Text	341.3 KB	
Agile and Security.doc	Feb 26, 2009 1:56 PM	doc	50.8 KB	
CIMG8662.cJPG	Jun 10, 2008 8:57 AM	Image	2.2 MB	
Cloud computing in a bubble economy.pdf	Dec 15, 2008 3:38 AM	PDF+Text	274.7 KB	
<b>dsl-dl38_2ecom.pdf</b>	<b>Mar 19, 2007 10:42 PM</b>	<b>PDF+Text</b>	<b>83.7 KB</b>	
Global 15 WebStrat...o for Nonprofits.ppt	Oct 24, 2005 3:50 AM	ppt	2.1 MB	
Manuals folklore.doc	Apr 2, 2009 3:55 PM	doc	21.8 KB	
Reframing Manuscript Central.pdf	Feb 28, 2009 12:58 AM	PDF+Text	881.7 KB	
Strategic Agile ver J.doc	Mar 19, 2009 4:43 AM	doc	374.3 KB	
World's trend project charter.doc	Today, 1:15 AM	doc	21.5 KB	

The preview pane below shows a document titled "ECOMMERCE" by Kenneth E. Kendall, with a snippet of text about mashups.

**FIGURE 5.MAC**

DEVONthink Professional Office from DEVONtechnologies.

4. A square means observation of the STROBE elements modifies the narrative.
5. A circle means the narrative is supplemented by what is observed.

When STROBE is implemented in this manner, the first step is to write down key organizational themes growing out of interviews. Then the elements of STROBE are observed and recorded. When narrative and observations are then compared, one of the five appropriate symbols is used to characterize the relationship. The analyst thus creates a table that first documents and then aids in the analysis of observations.

**FIGURE 5.11**

An anecdotal list with symbols for use in applying STROBE.

Anecdotal List with Symbols for Applying STROBE			
Narrative Portrayed by Organization Members	Office Location and Equipment	Office Lighting, Color, and Graphics	Clothing of the Decision Maker
Information is readily flowing on all levels.	✗	●	●
Adams says, "I figure out the percentages myself."	✗	●	●
Vinnie says, "I like to read up on these things."	✓	●	●
Ed says, "The right hand doesn't always know what the left hand is doing."	eye	●	●
Adams says, "Our company doesn't change much."	●	✓	●
The operations staff works all night sometimes.	●	eye	●
Vinnie says, "We do things the way Mr. Adams wants to."	●	●	●
Julie says, "Stanley doesn't seem to care sometimes."	●	●	□
	●	●	✓
	●	●	●
	●	●	●
	●	●	●
	●	●	●
	●	●	●

**Key**

- ✓ Confirm the narrative
- ✗ Negate or reverse the narrative
- eye Cue to look further
- Modify the narrative
- Supplement the narrative

## SUMMARY

This chapter has covered unobtrusive methods for information gathering, including sampling; investigation of quantitative and qualitative data in current and archived forms; and the observation of the decision maker's activities through the use of the analyst's playscript, as well as observation of the decision maker's physical environment through the use of STROBE.

The process of systematically selecting representative elements of a population is called sampling. The purpose of sampling is to select and study documents such as invoices, sales reports, and memos, or perhaps to select and interview, give surveys to, or observe members of the organization. Sampling can reduce cost, speed data gathering, potentially make the study more effective, and possibly reduce the bias in the study.

A systems analyst must follow four steps in designing a good sample. First, there is a need for determining the population itself. Second, the type of sample must be decided. Third, the sample size is calculated. Finally, the data that need to be collected or described must be planned.



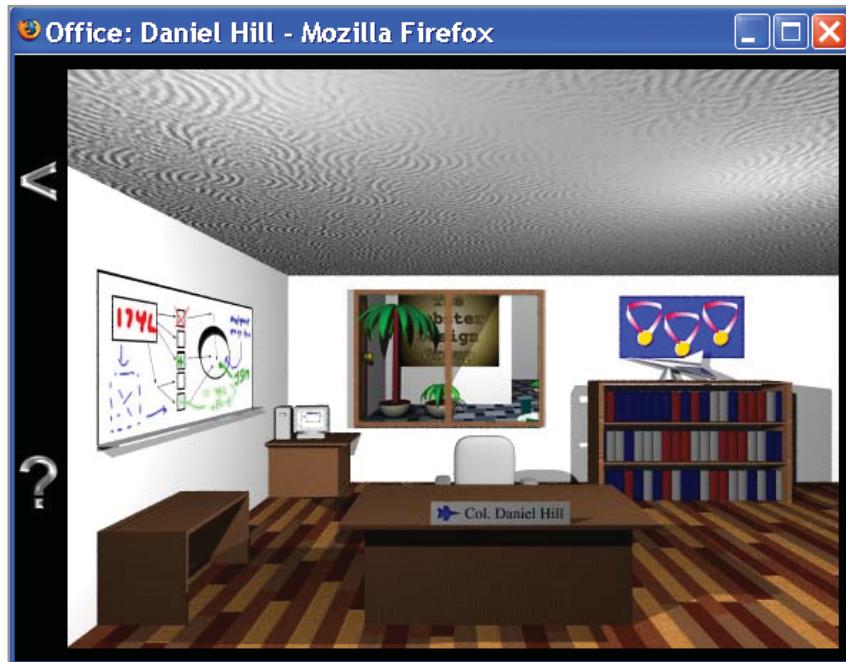
## HYPERCASE® EXPERIENCE 5.2

**“W**e’re proud of our building here in Tennessee. In fact, we used the architectural firm of I. M. Paid to carry the same theme, blending into the local landscape while still reaching out to our clients throughout all the branches. We get lots of people coming through just to admire the building once they catch on to where it is exactly. In fact, by Tennessee standards, we get so many sightseers that it might as well be the pyramids! Well, you can see for yourself as you go through. The East Atrium is my favorite place: plenty of light, a huge skylight overhead. Yet it has always fascinated me that the building and its furnishings might tell a story quite different from the one its occupants tell.

“Sometimes employees complain that the offices all look the same. The public rooms are spectacular, though. Even the canteen is inviting. Most people can’t say that about their cafeterias at work. You’ll notice that we all personalize our offices, anyway. So even if the offices were of the ‘cookie cutter’ kind, their occupants’ personalities seem to take over as soon as they have been here a while. What have you seen? Was there anything that surprised you so far?”

### HYPERCASE Questions

1. Use STROBE to compare and contrast Evans’s and Ketcham’s offices. What sort of conclusion about each person’s use of information technology can you draw from your observations? How compatible do Evans and Ketcham seem in terms of the systems they use? What other clues to their storage, use, and sharing of information can you discover based on your observations of their offices?
2. Carefully examine Kathy Blandford’s office. Use STROBE to confirm, reverse, or negate what you have learned during your interview with her. List anything you found out about Ms. Blandford from observing her office that you did not know from the interview.
3. Carefully examine the contents of the MRE reception area using STROBE. What inferences can you make about the organization? List them. What interview questions would you like to ask, based on your observations of the reception area? Make a list of people you would like to interview and the questions you would ask each of them.



**FIGURE 5.HC1**

There are hidden clues in HyperCase. Use STROBE to discover them.

The types of samples useful to a systems analyst are convenience samples, purposive samples, simple random samples, and complex random samples. The last type includes the subcategories of systematic sampling and stratified sampling. There are several guidelines to follow when determining sample size.

Systems analysts need to investigate current and archival data and forms, which reveal where the organization has been and where its members believe it is going. Both quantitative and qualitative documents

need to be analyzed. Because documents are persuasive messages, it must be recognized that changing them might well change the organization.

Analysts use observation as an information-gathering technique. Through observation they gain insight into what is actually done as users interact with information technology. One way to describe how decision makers behave is to use an analyst's playscript that documents each of the major players' activities.

In addition to observing a decision maker's behavior, the systems analyst should observe the decision maker's surroundings for important clues as to how well the system fits the user. One method is Structured Observation of the Environment (STROBE). A systems analyst uses STROBE in the same way that a film critic uses a method called *mise-en-scène* analysis to analyze a shot in a film.

Several concrete elements in the decision maker's environment can be observed and interpreted. These elements include (1) office location, (2) placement of the decision maker's desk, (3) stationary office equipment, (4) props such as handheld devices and PCs, (5) external information sources such as trade journals and use of the Web, (6) office lighting and color, and (7) clothing worn by the decision maker. STROBE can be used to gain a better understanding of how decision makers actually gather, process, store, and share information in order to get their work done.

## KEYWORDS AND PHRASES

analyst's playscript

business-to-business (B2B) ecommerce

business-to-consumer (B2C) ecommerce

clothing worn by decision makers

cluster sampling

complex random sample

confidence level

convenience sample

corporate Web sites

desk placement

external information sources

office lighting and color

office location

props (handheld devices and PCs)

purposive sample

sample population

sampling

simple random sample

stationary office equipment

stratified sampling

STROBE

systematic observation

systematic sampling

## REVIEW QUESTIONS

1. Define what is meant by sampling.
2. List four reasons why the systems analyst would want to sample data or select representative people to interview.
3. What are the four steps to follow to design a good sample?
4. List the three approaches to complex random sampling.
5. Define what is meant by stratification of samples.
6. What effect on sample size does using a greater confidence level have when sampling attribute data?
7. What is the overriding variable that determines how many people the systems analyst should interview in depth?
8. What information about the decision maker does the analyst seek to gain from observation?
9. List five steps to help the analyst observe the decision maker's typical activities.
10. In the technique known as the analyst's playscript, who is the actor?
11. In the analyst's playscript, what information about managers is recorded in the right-hand column?
12. Noting that the idea of STROBE originally came from the world of film, what does the systems analyst's role resemble?
13. List the seven concrete elements of the decision maker's physical environment that can be observed by the systems analyst using STROBE.

## PROBLEMS

1. Cheyl Stake is concerned that too many forms are being filled out incorrectly. She feels that about 8 percent of all the forms have an error.
  - a. How large a sample size should Ms. Stake use to be 99 percent certain she will be within 0.02?
  - b. How large a sample size should Ms. Stake use to be 90 percent certain she will be within 0.02?
  - c. Explain the difference between parts a and b in words.
  - d. Suppose Ms. Stake will accept a confidence level of 95 percent that she will be within 0.02. What will the sample size of forms be now?

2. “I see that you have quite a few papers there. What all do you have in there?” asks Betty Kant, head of the MIS task force that is the liaison group between your systems group and Sawder’s Furniture Company. You are shuffling a large bundle of papers as you prepare to leave the building.

“Well, I’ve got some financial statements, production reports from the last six months, and some performance reports that Sharon gave me that cover goals and work performance over the last six months,” you reply as some of the papers fall to the floor. “Why do you ask?”

Betty takes the papers from you and puts them on the nearest desk. She answers, “Because you don’t need all this junk. You’re here to do one thing, and that’s talk to us, the users. Bet you can’t read one thing in there that’ll make a difference.”

- a. The only way to convince Betty of the importance of each document is to tell her what you are looking for in each one. Use a paragraph to explain what each kind of document contributes to the systems analyst’s understanding of the business.
- b. While you are speaking with Betty, you realize you actually need other quantitative documents as well. List any you are missing.

3. You’ve sampled the email messages that have been sent to several middle managers of Sawder’s Furniture Company, which ships build-your-own particleboard furniture across the country. Here is one that repeats a message found in several other memos:

To: Sid, Ernie, Carl

From: Imogene

Re: Computer/printer supplies

Date: November 10, 2009

It has come to my attention that I have been waging a war against requests for computer and printer supplies (writable CDs, toner, paper, etc.) that are all out of proportion to what has been negotiated for in the current budget. Because we’re all good soldiers here, I hope you will take whatever our supply sergeant says is standard issue. Please, no “midnight requisitioning” to make up for shortages. Thanks for being GI in this regard; it makes the battle easier for us all.

- a. What metaphor(s) is (are) being used? List the predominant metaphor and other phrases that play on that theme.
- b. If you found repeated evidence of this idea in other email messages, what interpretation would you have? Use a paragraph to explain.
- c. In a paragraph, describe how the people in your systems analysis group can use the information from the email messages to shape their systems project for Sawder’s.
- d. In interviews with Sid, Ernie, and Carl, there has been no mention of problems with obtaining enough computer and printer supplies. In a paragraph, discuss why such problems may not come up in interviews and discuss the value of examining email messages and other memos in addition to interviewing.

4. “Here’s the main policy manual we’ve put together over the years for system users,” says Al Bookbinder, as he blows the dust off the manual and hands it to you. Al is a document keeper for the systems department of Prechter and Gumbel, a large manufacturer of health and beauty aids. “Everything any user of any part of the system needs to know is in what I call the Blue Book. I mean it’s chockablock with policies. It’s so big, I’m the only one with a complete copy. It costs too much to reproduce it.” You thank Al and take the manual with you. When you read through it, you are astonished at what it contains. Most pages begin with a message such as: “This page supersedes page 23.1 in manual Vol. II. Discard previous inserts; do not use.”

- a. List your observations about the frequency of use of the Blue Book.
- b. How user friendly are the updates in the manual? Write a sentence explaining your answer.
- c. Write a paragraph commenting on the wisdom of having all-important policies for all systems users in one book.
- d. Suggest a solution that incorporates the use of online policy manuals for some users.

5. “I think I’ll be able to remember most everything he does,” says Ceci Awll. Ceci is about to interview Biff Welldon, vice president of strategic planning of OK Corral, a steak restaurant chain with 130 locations. “I mean, I’ve got a good memory. I think it’s much more important to listen to what he says than to observe what he does anyway.” As one of your systems analysis team members, Ceci has been talking with you about the desirability of writing down her observations of Biff’s office and activities during the interview.

- a. In a paragraph, persuade Ceci that listening is not enough in interviews and that observing and recording those observations are also important.
- b. Ceci seems to have accepted your idea that observation is important but still doesn’t know what to observe. Make a list of items and behaviors to observe, and in a sentence beside each behavior, indicate what information Ceci should hope to gain through observation of it.

6. “We’re a progressive company, always looking to be ahead of the power curve. We’ll give anything a whirl if it’ll put us ahead of the competition, and that includes every one of us,” says I. B. Daring, an executive with Michigan Manufacturing (2M). You are interviewing him as a preliminary step in a systems project, one in which his subordinates have expressed interest. As you listen to I. B., you look around his office to see that most of the information he has stored on shelves can be classified as internal procedures manuals. In addition, you notice a PC on a back table of I. B.’s office. The display screen is covered with dust, and the manuals stacked beside the PC are still encased in their original shrink-wrap. Even though you know that 2M uses an intranet, no cables are visible going to or from I. B.’s PC. On the wall behind I. B.’s massive mahogany desk you see five framed oil portraits of 2M’s founders, all clustered around a gold plaque bearing the corporate slogan, which states, “Make sure you’re right, then go ahead.”
- a. What is the organizational narrative or storyline as portrayed by I. B. Daring? Rephrase it in your own words.
  - b. List the elements of STROBE that you have observed during your interview with I. B.
  - c. Next to each element of STROBE that you have observed, write a sentence on how you would interpret it.
  - d. Construct a table with the organizational story line down the left-hand side of the page and the elements of STROBE across the top. Using the symbols from the “anecdotal list” application of STROBE, indicate the relationship between the organizational story line as portrayed by I. B. and each element you have observed (that is, indicate whether each element of STROBE confirms, reverses, causes you to look further, modifies, or supplements the narrative).
  - e. Based on your observations of STROBE and your interview, state in a paragraph what problems you are able to anticipate in getting a new system approved by I. B. and others. In a sentence or two, discuss how your diagnosis might have been different if you had only talked to I. B. over the phone or had read his written comments on a systems proposal.

## GROUP PROJECTS

1. Assume your group will serve as a systems analysis and design team for a project designed to computerize or enhance the computerization of all business aspects of a 15-year-old, national U.S. trucking firm called Maverick Transport. Maverick is a less-than-a-truckload (LTL) carrier. The people in management work from the philosophy of just in time (JIT), in which they have created a partnership that includes the shipper, the receiver, and the carrier (Maverick Transport) for the purpose of transporting and delivering the materials required just in time for their use on the production line. Maverick maintains 626 tractors for hauling freight, and has 45,000 square feet of warehouse space and 21,000 square feet of office space.
  - a. Along with your group members, develop a list of sources of archival data that should be checked when analyzing the information requirements of Maverick.
  - b. When this list is complete, devise a sampling scheme that would permit your group to get a clear picture of the company without having to read each document generated in its 15-year history.
2. Arrange to visit a local organization that is expanding or otherwise enhancing its information systems. To allow your group to practice the various observation methods described in this chapter, assign either of these two methods to each team member: (1) developing the analyst’s playscript, or (2) using STROBE. Many of these strategies can be employed during one-on-one interviews, whereas some require formal organizational meetings. Try to accomplish several objectives during your visit to the organization by scheduling it at an appropriate time, one that permits all team members to try their assigned method of observation. Using multiple methods such as interviewing and observation (often simultaneously) is the only cost-effective way to get a true, timely picture of the organization’s information requirements.
3. The members of your group should meet and discuss their findings after completing Project 2. Were there any surprises? Did the information garnered through observation confirm, reverse, or negate what was learned in interviews? Were any of the findings from the observational methods in direct conflict with each other? Work with your group to develop a list of ways to address any puzzling information (for example, by doing follow-up interviews).

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## EPISODE 5

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Seeing Is Believing

"Chip, I know the interviews took a long time, but they were worth it," Anna says defensively as Chip enters her office with a worried look on his face.

"I'm sure of that," Chip says. "You really made a good impression on them. People have stopped me in the hall and said they're glad we're working on the new system. I'm not worried about the interviews themselves. But I was concerned that we didn't have time to discuss observations before you did them."

"Rest assured, I was all eyes," Anna laughs. "I used a technique called STROBE, or Structured Observation of the Environment, to see our decision maker's habitats systematically. You'll be interested in these notes I wrote up for each person I interviewed," says Anna, as she hands Chip her written, organized observations from each interview.

### EXERCISES

These exercises require that you visit the Web site to obtain observations of the decision makers' offices. Please visit the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall) and look for "CPU Observations of Decision Makers' Offices."

- E-1. Based on Anna's written observation of Dot's office and clothing, use STROBE to analyze Dot as a decision maker. In two paragraphs, compare and contrast what you learned in Dot's interview and what you learned via STROBE.
- E-2. After examining Anna's written observations about Mike Crowe's office, use STROBE to analyze Mike as a decision maker. What differences (if any) did you see between Mike in his interview and Mike in Anna's observations? Use two paragraphs to answer.
- E-3. Use STROBE to analyze Anna's written observations about Cher Ware and Paige Prynter. Use two paragraphs to compare and contrast the decision-making style of each person as it is revealed by his or her offices and clothing.
- E-4. Use STROBE to analyze Anna's written observations about Hy Perteks. Now compare your analysis with Hy's interview. Use two paragraphs to discuss whether STROBE confirms, negates, reverses, or serves as a cue to look further in Hy's narrative. (Include any further questions you would ask Hy to clarify your interpretation.)

# CHAPTER 6

## Agile Modeling and Prototyping

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand the roots of agile modeling in prototyping and the four main types of prototyping.
2. Use prototyping for human information requirements gathering.
3. Understand the concept of RAD for use in human information requirements gathering and interface design.
4. Understand agile modeling and the core practices that differentiate it from other development methodologies.
5. Learn the importance of values critical to agile modeling.
6. Understand how to improve efficiency for users who are knowledge workers using either structured methods or agile modeling.



This chapter explores agile modeling, which is a collection of innovative, user-centered approaches to systems development. You will learn the values and principles, activities, resources, practices, processes, and tools associated with agile methodologies. Agile approaches have their roots in prototyping, so this chapter begins with prototyping to provide a proper context for understanding, and then takes up the agile approach in the last half of the chapter.

Prototyping of information systems is a worthwhile technique for quickly gathering specific information about users' information requirements. Generally speaking, effective prototyping should come early in the SDLC, during the requirements determination phase.

Prototyping is included at this point in the text to underscore its importance as an information-gathering technique. When using prototyping in this way, the systems analyst is seeking initial reactions from users and management to the prototype, user suggestions about changing or cleaning up the prototyped system, possible innovations for it, and revision plans detailing which parts of the system need to be done first or which branches of an organization to prototype next.

One special instance of prototyping that uses an object-oriented approach is called rapid application development (RAD). Prototyping and RAD can also be used as an alternative method to SDLC.



## PROTOTYPING

As the systems analyst presenting a prototype of the information system, you are keenly interested in the reactions of users and management to the prototype. You want to know in detail how they react to working with the prototype and how good the fit is between their needs and the prototyped features of the system. Reactions are gathered through observation, interviews, and feedback sheets (possibly questionnaires) designed to elicit each person's opinion about the prototype as he or she interacts with it.

Information gathered in the prototyping phase allows the analyst to set priorities and redirect plans inexpensively, with a minimum of disruption. Because of this feature, prototyping and planning go hand-in-hand.

### Kinds of Prototypes

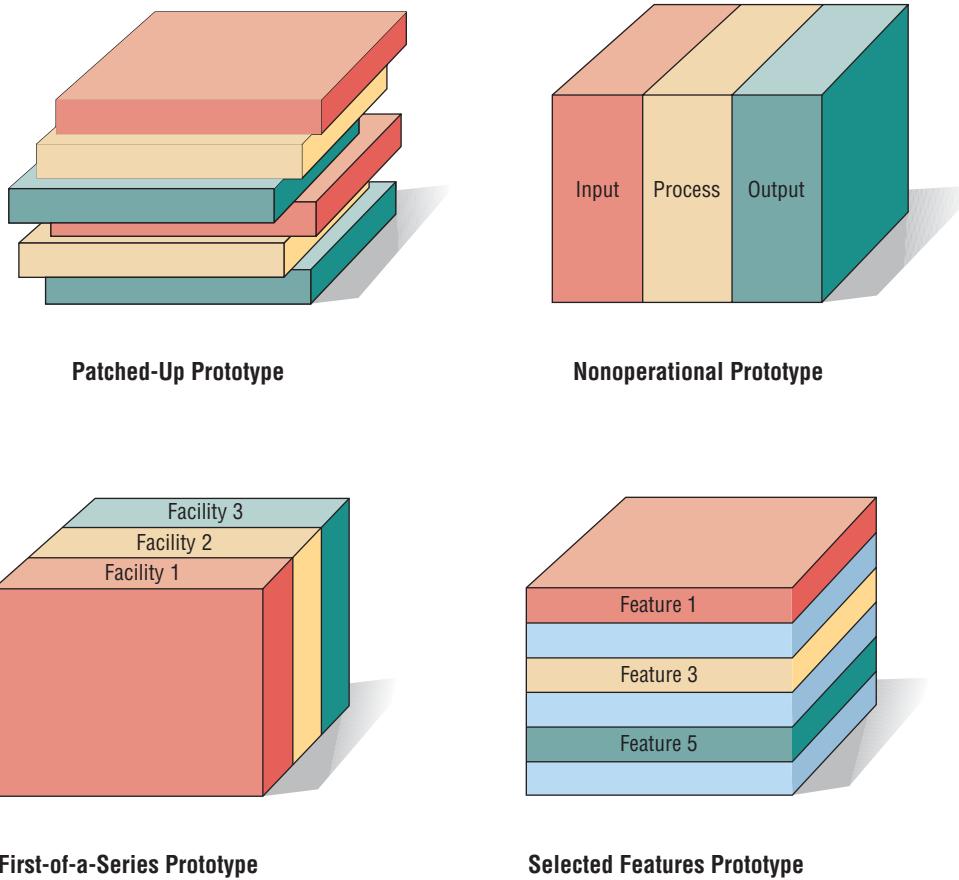
The word *prototype* is used in many different ways. Rather than attempting to synthesize all these uses into one definition or trying to mandate one correct approach to the somewhat controversial topic of prototyping, we illustrate how each of several conceptions of prototyping may be usefully applied in a particular situation, as shown in Figure 6.1.

**PATCHED-UP PROTOTYPE.** The first kind of prototyping has to do with constructing a system that works but is patched up or patched together. In engineering this approach is referred to as breadboarding: creating a patched-together, working model of an (otherwise microscopic) integrated circuit.

An example in information systems is a working model that has all the necessary features but is inefficient. In this instance of prototyping, users can interact with the system, getting accustomed to the interface and types of output available. The retrieval and storage of information may be inefficient, however, because programs were written rapidly with the objective of being workable rather than efficient.

**FIGURE 6.1**

Four kinds of prototypes (clockwise, starting from the upper left).



**NONOPERATIONAL PROTOTYPE.** The second conception of a prototype is that of a nonworking scale model that is set up to test certain aspects of the design. An example of this approach is a full-scale model of an automobile that is used in wind tunnel tests. The size and shape of the auto are precise, but the car is not operational. In this case only features of the automobile essential to wind tunnel testing are included.

A nonworking scale model of an information system might be produced when the coding required by the applications is too extensive to prototype but when a useful idea of the system can be gained through the prototyping of the input and output only. In this instance, processing, because of undue cost and time, would not be prototyped. Users could still make decisions on the utility of the system, based on their use of prototyped input and output.

**FIRST-OF-A-SERIES PROTOTYPE.** A third conception of prototyping involves creating a first full-scale model of a system, often called a pilot. An example is prototyping the first airplane of a series, then seeing if it flies before building a second. The prototype is completely operational and is a realization of what the designer hopes will be a series of airplanes with identical features.

This type of prototyping is useful when many installations of the same information system are planned. The full-scale working model allows users to experience realistic interaction with the new system, but it minimizes the cost of overcoming any problems that it presents. For example, when a retail grocery chain intends to use electronic data interchange (EDI) to check in suppliers' shipments in a number of outlets, a full-scale model might be installed in one store so users could work through any problems before the system is implemented in all the others.

**SELECTED FEATURES PROTOTYPE.** A fourth conception of prototyping concerns building an operational model that includes some, but not all, of the features that the final system will have. An analogy would be a new retail shopping mall that opens before the construction of all shops is complete.

When prototyping information systems in this way, some, but not all, essential features are included. For example, users may view a system menu on a screen that lists six features: add a record, update a record, delete a record, search a record for a key word, list a record, or scan a record. In the prototyped system, however, only three of the six may be available for use, so that the user may add a record (feature 1), delete a record (feature 3), and list a record (feature 5). User feedback can help analysts understand what is working and what isn't. It can also help with suggestions on what features to add next.

When this kind of prototyping is done, the system is accomplished in modules so that if the features that are prototyped are evaluated by users as successful, they can be incorporated into the larger, final system without undertaking immense work in interfacing. Prototypes done in this manner are part of the actual system. They are *not* just a mock-up as in nonoperational prototyping considered previously. Unless otherwise mentioned, all further references to prototyping in this chapter refer to the selected-features prototype.

## Prototyping as an Alternative to the SDLC

Some analysts argue that prototyping should be considered as an alternative to the SDLC. Recall that the SDLC, introduced in Chapter 1, is a logical, systematic approach to follow in the development of information systems.

Complaints about going through the SDLC process center around two interrelated concerns. The first concern is the extended time required to go through the development life cycle. As the investment of analyst time increases, the cost of the delivered system rises proportionately.

The second concern about using the SDLC is that user requirements change over time. During the long interval between the time that user requirements are analyzed and the time that the finished system is delivered, user requirements are evolving. Thus, because of the extended development cycle, the resulting system may be criticized for inadequately addressing current user information requirements.

A corollary of the problem of keeping up with user information requirements is the suggestion that users cannot really know what they do or do not want until they see something tangible. In the traditional SDLC, it often is too late to change an unwanted system once it is delivered.

To overcome these problems, some analysts propose that prototyping be used as an alternative to the SDLC. When prototyping is used in this way, the analyst effectively shortens the time

between ascertainment of human information requirements and delivery of a workable system. In addition, using prototyping instead of the traditional SDLC might overcome some of the problems of accurately identifying user information requirements.

Drawbacks to supplanting the SDLC with prototyping include prematurely shaping a system before the problem or opportunity being addressed is thoroughly understood. Also, using prototyping as an alternative may result in producing a system that is accepted by specific groups of users but that is inadequate for overall system needs.

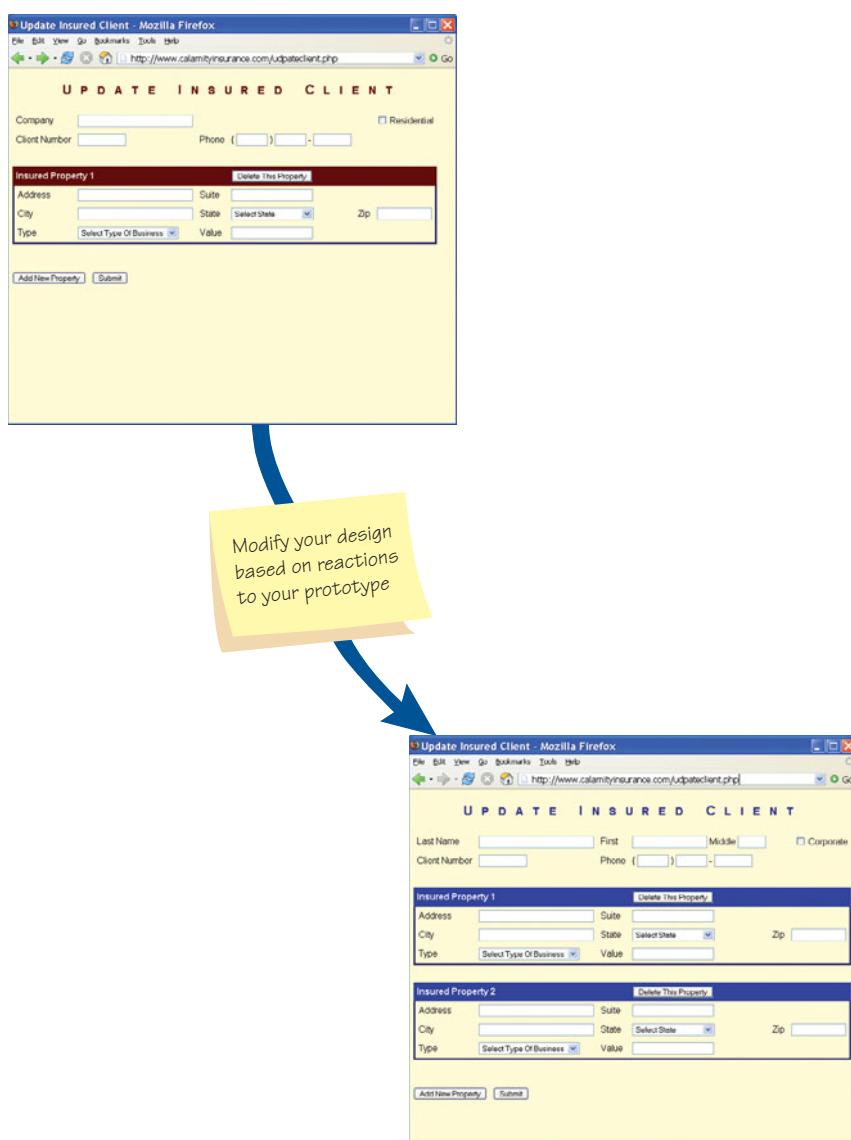
The approach we advocate here is to use prototyping as a part of the traditional SDLC. In this view prototyping is considered as an additional, specialized method for ascertaining users' information requirements as they interact with prototypes and provide feedback for the analyst.

## DEVELOPING A PROTOTYPE

Prototyping is a superb way to elicit feedback about the proposed system and about how readily it is fulfilling the information needs of its users, as depicted in Figure 6.2. The first step of prototyping is to estimate the costs involved in building a module of the system. If costs of programmers' and analysts' time as well as equipment costs are within the budget, building of the prototype can proceed. Prototyping is an excellent way to facilitate the integration of the information system into the larger system and culture of the organization.

**FIGURE 6.2**

Analysts should modify their original screen designs based on user reactions to the prototype.





## CONSULTING OPPORTUNITY 6.1

### Is Prototyping King?

“As you know, we’re an enthusiastic group. We’re not a dynasty yet, but we’re working on it,” Paul LeGon tells you. Paul (introduced in Consulting Opportunity 2.3), at 24 years of age, is the “boy king” of Pyramid, Inc., a small but successful independent book-publishing firm that specializes in paperback books outside of the publishing mainstream. As a systems analyst, you have been hired by Pyramid, Inc., to help develop a computerized warehouse inventory and distribution information system.

“We’re hiring lots of workers,” Paul continues, as if to convince you of the vastness of Pyramid’s undertaking. “And we feel Pyramid is positioned perfectly as far as our markets in the north, south, east, and west are concerned.

“My assistant, Ceil Toom, and I have been slaving away, thinking about the new system. And we’ve concluded that what we really need is a prototype. As a matter of fact, we’ve tunneled through a lot of material. Our fascination with the whole idea has really pyramided.”

As you formulate a response to Paul, you think back over the few weeks you’ve worked with Pyramid, Inc. You think that the business problems its information system must resolve are very straightforward. You also know that the people in the company are on a limited budget and cannot afford to spend like kings. Actually, the entire project is quite small.

Ceil, building on what Paul has said, tells you, “We don’t mean to be too wrapped up with it, but we feel prototyping represents the new world. And that’s where we all want to be. We know we need a prototype. Have we convinced you?”

Based on Paul’s and Ceil’s enthusiasm for prototyping and what you know about Pyramid’s needs, would you support construction of a prototype? Why or why not? Formulate your decision and response in a letter to Paul LeGon and Ceil Toom. Present a justification for your decision based on overall criteria that should be met to justify prototyping.

### Guidelines for Developing a Prototype

Once the decision to prototype has been made, four main guidelines must be observed when integrating prototyping into the requirements determination phase of the SDLC:

1. Work in manageable modules.
2. Build the prototype rapidly.
3. Modify the prototype in successive iterations.
4. Stress the user interface.

As you can see, the guidelines suggest ways of proceeding with the prototype that are necessarily interrelated. Each guideline is explained in the following subsections.

**WORKING IN MANAGEABLE MODULES.** When prototyping some of the features of a system into a workable model, it is imperative that the analyst work in manageable modules. One distinct advantage of prototyping is that it is not necessary or desirable to build an entire working system for prototype purposes.

A manageable module is one that allows users to interact with its key features but can be built separately from other system modules. Module features that are deemed less important are purposely left out of the initial prototype. As you will see later in this chapter, this is very similar to the agile approach that emphasizes small releases.

**BUILDING THE PROTOTYPE RAPIDLY.** Speed is essential to the successful prototyping of an information system. Recall that one complaint voiced against following the traditional SDLC is that the interval between requirements determination and delivery of a complete system is far too long to address evolving user needs effectively.

Analysts can use prototyping to shorten this gap by using traditional information-gathering techniques to pinpoint salient information requirements, and then quickly make decisions that bring forth a working model. In effect the user sees and uses the system very early in the SDLC instead of waiting for a finished system to gain hands-on experience.

Putting together an operational prototype both rapidly and early in the SDLC allows the analyst to gain valuable insight into how the remainder of the project should go. By showing users very early in the process how parts of the system actually perform, rapid prototyping guards against overcommitting resources to a project that may eventually become unworkable. Later,



## CONSULTING OPPORTUNITY 6.2

### Clearing the Way for Customer Links

**W**orld's Trend (see Chapter 7 for a detailed corporate description) is building a Web site on which to sell clearance merchandise usually sold through the Web and through its catalog operation. As a newly hired Web consultant, Lincoln Cerf finds himself in a very cold, wintry city, fighting his way through several inches of snow to meet with one of the systems team members, Mary Maye, at World's Trend headquarters.

Mary welcomes Lincoln, saying, "At least the weather doesn't seem to affect our Web sales! They're brisk no matter what." Lincoln groans appreciatively at her weak attempt at humor, smiles, and says, "I gathered from your email last week that you are trying to determine the type of information that needs to be displayed on our clearance Web site."

Mary replies, "Yes, I'm trying to get it organized in the best possible way. Our customers are all so busy. I know photos of all our merchandise can take a long time to appear on the page if a customer is accessing the Web via a slower modem from home." Mary continues by saying, "Linc, I'm not even that concerned about how to design our clearance site at this time. I am worried, though, about how much information we need to include on a page. For example, when items are on clearance, not all colors and sizes are available. Which do you think

is better, to include some basic information and let the customer click a button to ask for more information, or to be as complete as possible on one page? If I use the linking method, then I could fit more items on the screen . . . but it might be too orderly. Customers like the look and feel of a sale in which merchandise is kind of jumbled together."

Linc continues her line of thought, saying, "Yeah, I wonder how customers want the information organized. Have you actually watched them use the Web? I mean, do they look for shoes when they buy a suit? If so, should shoes appear on the suit page or be linked in some way?"

Mary comments, "Those are my questions, too. Then I wonder if we should just try this approach for men's clothes first, before we implement it for women's clothing. What if men's and women's approaches to shopping on the Web are different?"

As a third member of the World's Trend Web site development group, respond in a brief written report to Lincoln and Mary about whether you should use a prototype to elicit recommendations from potential customers about the proposed Web site. What type of prototype is appropriate? Consider each form of prototype and explain why each type would apply (or would not apply) to this problem. Devote a paragraph to each explanation.

when RAD is discussed, you again see the importance of rapid systems building. In addition, agile modeling also builds on the practice of quick turnaround times.

**MODIFYING THE PROTOTYPE.** A third guideline for developing the prototype is that its construction must support modifications. Making the prototype modifiable means creating it in modules that are not highly interdependent. If this guideline is observed, less resistance is encountered when modifications in the prototype are necessary.

The prototype is generally modified several times, going through several iterations. Changes in the prototype should move the system closer to what users say is important. Each modification necessitates another evaluation by users.

The prototype is not a finished system. Entering the prototyping phase with the idea that the prototype will require modification is a helpful attitude that demonstrates to users how necessary their feedback is if the system is to improve.

**STRESSING THE USER INTERFACE.** The user's interface with the prototype (and eventually the system) is very important. Because what you are really trying to achieve with the prototype is to get users to further articulate their information requirements, they must be able to interact easily with the system's prototype. They should be able to see how the prototype will enable them to accomplish their tasks. For many users the interface is the system. It should not be a stumbling block.

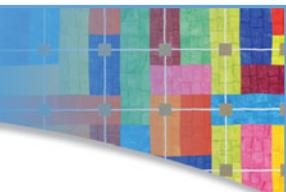
Although many aspects of the system will remain undeveloped in the prototype, the user interface must be well developed enough to enable users to pick up the system quickly and not be put off. Online, interactive systems using GUI interfaces are ideally suited to prototypes. Chapter 14 describes in detail the considerations that are important in designing HCI.

### Disadvantages of Prototyping

As with any information-gathering technique, there are several disadvantages to prototyping. The first is that it can be quite difficult to manage prototyping as a project in the larger systems effort.



## CONSULTING OPPORTUNITY 6.3



### To Hatch a Fish

“Just be a little patient. I think we need to add a few more features before we turn it over to them. Otherwise, this whole prototype will sink, not swim,” says Sam Monroe, a member of your systems analysis team. All four members of the team are sitting together in a hurriedly called meeting, and they are discussing the prototype that they are developing for an information system to help managers monitor and control water temperature, number of fish released, and other factors at a large, commercial fish hatchery.

“They’ve got plenty to do already. Why, the system began with four features and we’re already up to nine. I feel like we’re swimming upstream on this one. They don’t need all that. They don’t even want it,” argues Belle Uga, a second member of the systems analysis team. “I don’t mean to carp, but just give them the basics. We’ve got enough to tackle as it is.”

“I think Monroe is more on target,” volunteers Wally Ide, a third member of the team, baiting Belle a little. “We have to show them our very best, even if it means being a few weeks later in hatching our prototype than we promised.”

“Okay,” Belle says warily, “but I want the two of you to tell the managers at the hatchery why we aren’t delivering the prototype. I don’t want to. And I’m not sure they’ll let you off the hook that easily.”

Monroe replies, “Well, I guess we could, but we probably shouldn’t make a big deal out of being later than we wanted. I don’t want to rock the boat.”

Wally chimes in, “Yeah. Why point out our mistakes to everyone? Besides, when they see the prototype, they’ll forget any complaints they had. They’ll love it.”

Belle finds a memo in her notebook from their last meeting with the hatchery managers and reads it aloud. “Agenda for meeting of September 22. ‘Prototyping—the importance of rapid development, putting together the user analyst team, getting quick feedback for modification. . . .’” Belle’s voice trails off, omitting the last few agenda items. In the wake of her comments, Monroe and Wally look unhappily at each other.

Monroe speaks first. “I guess we did try to get everyone primed for receiving a prototype quickly and to be involved from day one.” Noting your silence up until now, Monroe continues, “But still waters run deep. What do you think we should do next?” he asks you.

As the fourth member of the systems analysis team, what actions do you think should be taken? In a one- or two-paragraph email message to your teammates, answer the following questions: Should more features be added to the hatchery system prototype before giving it to the hatchery managers to experiment with? How important is the rapid development of the prototype? What are the trade-offs involved in adding more features to the prototype versus getting a more basic prototype to the client when it was promised? Complete your message with a recommendation.

The second disadvantage is that users and analysts may adopt a prototype as a completed system when it is in fact inadequate and was never intended to serve as a finished system. Analysts need to work to ensure that communication with users is clear regarding the timetable for interacting with and improving the prototype.

The analyst needs to weigh these disadvantages against the known advantages when deciding whether to prototype, when to prototype, and how much of the system to prototype.

### Advantages of Prototyping

Prototyping is not necessary or appropriate in every systems project, as we have seen. The advantages, however, should also be given consideration when deciding whether to prototype. The three major advantages of prototyping are the potential for changing the system early in its development, the opportunity to stop development on a system that is not working, and the possibility of developing a system that more closely addresses users’ needs and expectations.

Successful prototyping depends on early and frequent user feedback, which analysts can use to modify the system and make it more responsive to actual needs. As with any systems effort, early changes are less expensive than changes made late in the project’s development. In the later part of the chapter, you will see how the agile approach to development uses an extreme form of prototyping that requires an on-site customer to provide feedback during all iterations.

### Prototyping Using COTS Software

Sometimes the quickest way to prototype is through the modular installation of COTS software. Although the concept of COTS software can be easily grasped by looking at familiar and relatively inexpensive packages such as the Microsoft Office products, some COTS software



## CONSULTING OPPORTUNITY 6.4

### This Prototype Is All Wet

**I**t can be changed. It's not a finished product, remember," affirms Sandy Beach, a systems analyst for RainFall, a large manufacturer of fiberglass bathtub and shower enclosures for bathrooms. Beach is anxiously reassuring Will Lather, a production scheduler for RainFall, who is poring over the first hard-copy output produced for him by the prototype of the new information system.

"Well, it's okay," Lather says quietly. "I wouldn't want to bother you with anything. Let's see, . . . yes, *here* they are," he says as he finally locates the monthly report summarizing raw materials purchased, raw materials used, and raw materials in inventory.

Lather continues paging through the unwieldy computer printout. "This will be fine." Pausing at a report, he remarks, "I'll just have Miss Fawcett copy this part for the people in Accounting." Turning a few more pages, he says, "And the guy in Quality Assurance should really see this column of figures, although the rest of it isn't of much interest to him. I'll circle it and make a copy of it for him. Maybe I should phone part of this in to the warehouse, too."

As Sandy prepares to leave, Lather bundles up the pages of the reports, commenting, "The new system will be a big help. I'll make sure everybody knows about it. Anything will be better than the 'old monster' anyway. I'm glad we've got something new."

Sandy leaves Will Lather's office feeling a little lost at sea. Thinking it over, he starts wondering why Accounting, Quality Assurance, and the warehouse aren't getting what Will thinks they should. Sandy phones a few people, and he confirms that what

Lather has told him is true. They need the reports and they're not getting them.

Later in the week Sandy approaches Lather about rerouting the output as well as changing some of the features of the system. These modifications would allow Lather to get onscreen answers regarding what-if scenarios about changes in the prices suppliers are charging or changes in the quality rating of the raw materials available from suppliers (or both), as well as allow him to see what would happen if a shipment was late.

Lather is visibly upset with Sandy's suggestions for altering the prototype and its output. "Oh, don't do it on my account. It's okay really. I don't mind taking the responsibility for routing information to people. I'm always showering them with stuff anyway. Really, this is working pretty well. I would hate to have you take it away from us at this point. Let's just leave it in place."

Sandy is pleased that Lather seems so satisfied with the prototyped output, but he is concerned about Lather's unwillingness to change the prototype, because he has been encouraging users to think of it as an evolving product, not a finished one.

Write a brief report to Sandy listing changes to the prototype prompted by Lather's reactions. In a paragraph, discuss ways that Sandy can calm Lather's fears about having the prototype "taken away." Discuss in a paragraph some actions that can be taken *before* a prototype is tried out to prepare users for its evolutionary nature.

is elaborate and expensive, but highly useful. One example of rapid implementation of COTS software can be found in Catholic University's use of the ERP COTS software package called PeopleSoft, which is handling many of its Web-based functions.

Catholic University, along with a higher education consulting group and PeopleSoft, successfully undertook rapid implementation of a recruiting and admissions module of their COTS software. They launched the implementation in April 1999, and by that October they had successfully implemented recruiting and admissions for undergraduates. By November of the same year, they implemented the same functions for graduate students. Other modules of the PeopleSoft COTS software that are implemented at Catholic University include a complete online course catalog, online registration, and the capability for students to check grades, transcripts, bills, and financial aid payments online from anywhere.

#### Users' Role in Prototyping

The users' role in prototyping can be summed up in two words: honest involvement. Without user involvement there is little reason to prototype. The precise behaviors necessary for interacting with a prototype can vary, but it is clear that the user is pivotal to the prototyping process. Realizing the importance of the user to the success of the process, the members of the systems analysis team must encourage and welcome input and guard against their own natural resistance to changing the prototype.

There are three main ways a user can be of help in prototyping:

1. Experimenting with the prototype.
2. Giving open reactions to the prototype.
3. Suggesting additions to or deletions from the prototype.

**FIGURE 6.3**

An important step in prototyping is to properly record user reactions, user suggestions, innovations, and revision plans.

Prototype Evaluation Form				
Observer Name	Michael Cerveris			
System or Project Name	Date 1/06/2010			
Cloud Computing Data Center	Company or Location Aquarius Water Filters			
Program Name or Number	Prev. Maint.	Version	1	
User Name	User 1	User 2	User 3	User 4
Period Observed	Andy H. 1/06/2010	Pam H. 1/06/2010		
User Reactions	Generally favorable, got excited about project	Excellent!		
User Suggestions	Add the date when maintenance was performed.	Place a form number on top for reference. Place word WEEKLY in title.		
Innovations				
Revision Plans	Modify on 1/08/2010 Review with Andy and Pam.			

Users should be free to experiment with the prototype. In contrast to a mere list of systems features, the prototype allows users the reality of hands-on interaction. Mounting a prototype on an interactive Web site is one way to facilitate this interaction.

Another aspect of the users' role in prototyping requires that they give open reactions to the prototype. Analysts need to be present at least part of the time when experimentation is occurring. They can then observe users' interactions with the system, and they are bound to see interactions they never planned. A filled-in form for observing user experimentation with the prototype is shown in Figure 6.3. Some of the variables you should observe include user reactions to the prototype, user suggestions for changing or expanding the prototype, user innovations for using the system in completely new ways, and any revision plans for the prototype that aid in setting priorities.

A third aspect of the users' role in prototyping is their willingness to suggest additions to or deletions from the features being tried. The analyst's role is to elicit such suggestions by assuring users that the feedback they provide is taken seriously, by observing users as they interact with the system, and by conducting short, specific interviews with users concerning their experiences with the prototype. Although users will be asked to articulate suggestions and innovations for the prototype, in the end it is the analyst's responsibility to weigh this feedback and translate it into workable changes where necessary. To facilitate the prototyping process, the analyst must clearly communicate the purposes of prototyping to users, along with the idea that prototyping is valuable only when users are meaningfully involved.

## RAPID APPLICATION DEVELOPMENT

Rapid application development (RAD) is an object-oriented approach to systems development that includes a method of development as well as software tools. It makes sense to discuss RAD and prototyping in the same chapter, because they are conceptually very close. Both have as their goal the shortening of time typically needed in a traditional SDLC between the design and implementation of the information system. Ultimately, both RAD and prototyping are trying to meet

rapidly changing business requirements more closely. Once you have learned the concepts of prototyping, it is much easier to grasp the essentials of RAD, which can be thought of as a specific implementation of prototyping.

Some developers are looking at RAD as a helpful approach in new ecommerce, Web-based environments in which so-called first-mover status of a business might be important. In other words, to deliver an application to the Web before their competitors, businesses may want their development team to experiment with RAD.

### Phases of RAD

There are three broad phases to RAD that engage both users and analysts in assessment, design, and implementation. Figure 6.4 depicts these three phases. Notice that RAD involves users in each part of the development effort, with intense participation in the business part of the design.

**REQUIREMENTS PLANNING PHASE.** In the requirements planning phase, users and analysts meet to identify objectives of the application or system and to identify information requirements arising from those objectives. This phase requires intense involvement from both groups; it is not just signing off on a proposal or document. In addition, it may involve users from different levels of the organization (as covered in Chapter 2). In the requirements planning phase, when information requirements are still being addressed, you may be working with the CIO (if it is a large organization) as well as with strategic planners, especially if you are working with an ecommerce application that is meant to further the strategic aims of the organization. The orientation in this phase is toward solving business problems. Although information technology and systems may even drive some of the solutions proposed, the focus will always remain on reaching business goals.

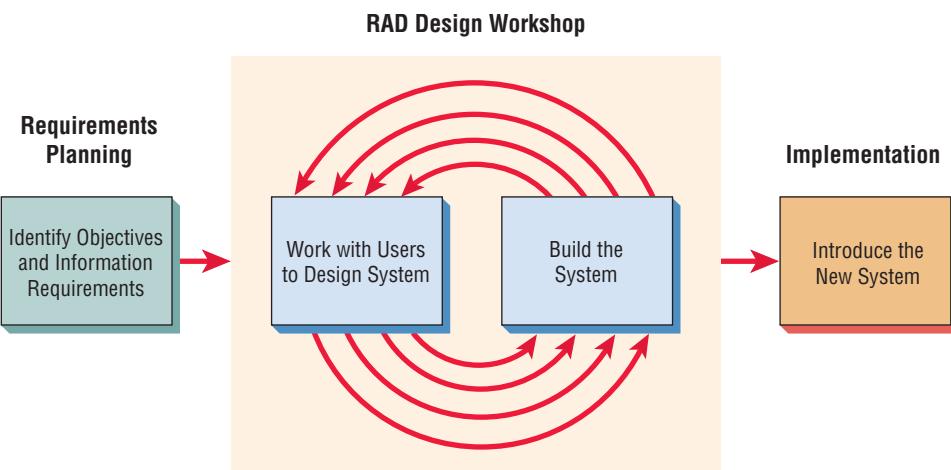
**RAD DESIGN WORKSHOP.** The RAD design workshop phase is a design-and-refine phase that can best be characterized as a workshop. When you imagine a workshop, you know that participation is intense, not passive, and that it is typically hands on. Usually participants are seated at round tables or in a U-shaped configuration of chairs with attached desks where each person can see the other and where there is space to work on a notebook computer. If you are fortunate enough to have a group decision support systems (GDSS) room available at the company or through a local university, use it to conduct at least part of your RAD design workshop.

During the RAD design workshop, users respond to actual working prototypes and analysts refine designed modules (using some of the software tools mentioned later) based on user responses. The workshop format is very exciting and stimulating, and if experienced users and analysts are present, there is no question that this creative endeavor can propel development forward at an accelerated rate.

**IMPLEMENTATION PHASE.** In the previous figure, you can see that analysts are working with users intensely during the workshop to design the business or nontechnical aspects of the system. As soon as these aspects are agreed on and the systems are built and refined, the new systems or part of systems are tested and then introduced to the organization. Because RAD can be used to create

**FIGURE 6.4**

The RAD design workshop is the heart of the interactive development process.



new ecommerce applications for which there is no old system, there is often no need to (and no real way to) run the old and new systems in parallel before implementation.

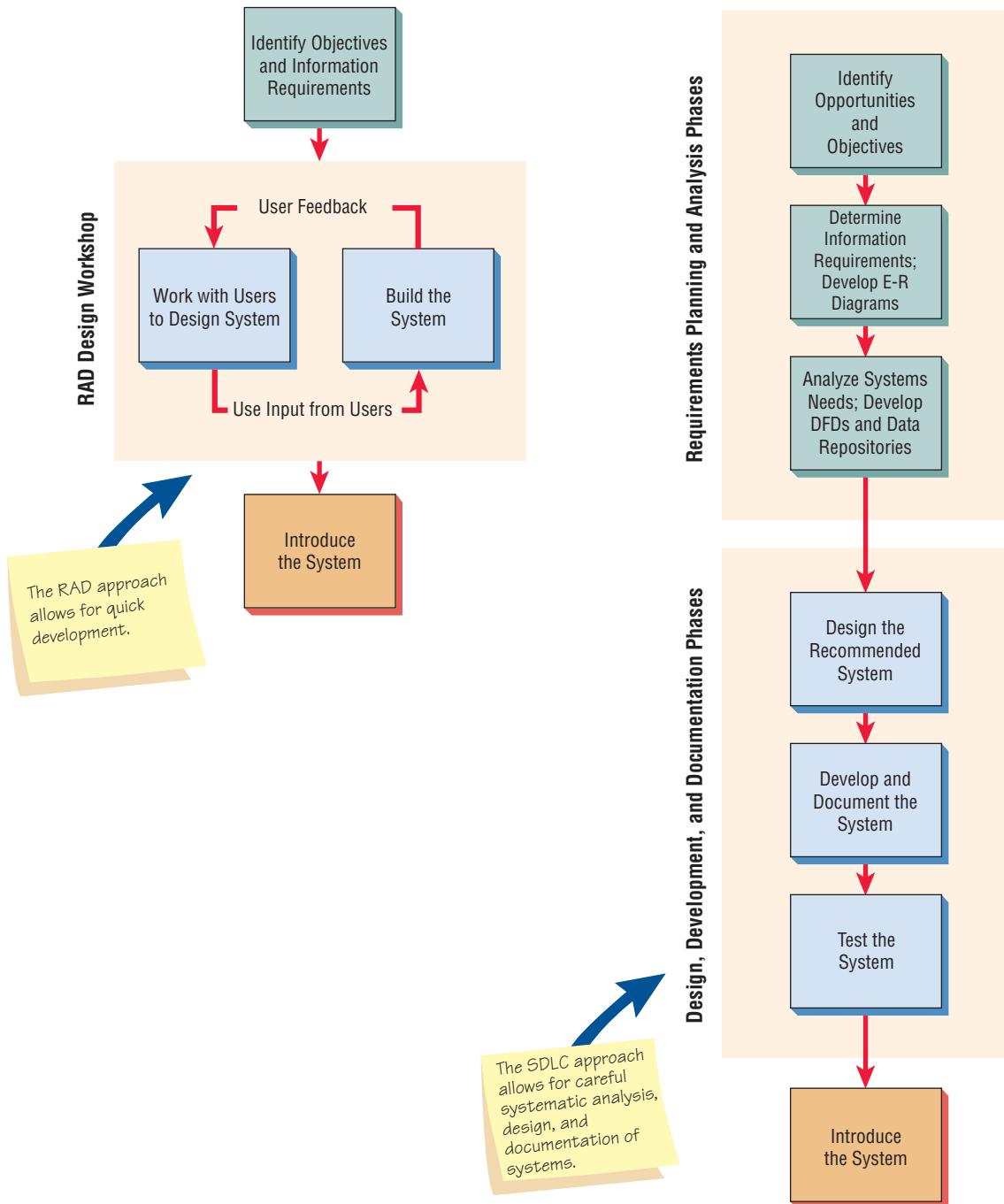
By this time, the RAD design workshop will have generated excitement, user ownership, and acceptance of the new application. Typically, change brought about in this manner is far less wrenching than when a system is delivered with little or no user participation.

### Comparing RAD to the SDLC

In Figure 6.5 you can compare the phases of the SDLC with those detailed for RAD at the beginning of this section. Notice that the ultimate purpose of RAD is to shorten the SDLC and in this way respond more rapidly to dynamic information requirements of organizations. The SDLC takes a more methodical, systematic approach that ensures completeness and accuracy and has as its intention the creation of systems that are well integrated into standard business procedures and culture.

**FIGURE 6.5**

The RAD design workshop and the SDLC approach compared.



The RAD design workshop phase is a departure from the standard SDLC design phases, because RAD software tools are used to generate screens and to exhibit the overall flow of the running of the application. Thus, when users approve this design, they are signing off on a visual model representation, not just a conceptual design represented on paper, as is traditionally the case.

The implementation phase of RAD is in many ways less stressful than others, because the users have helped to design the business aspects of the system and are well aware of what changes will take place. There are few surprises, and the change is something that is welcomed. Often when using the SDLC, there is a lengthy time during development and design when analysts are separated from users. During this period, requirements can change and users can be caught off guard if the final product is different than anticipated over many months.

**WHEN TO USE RAD.** As an analyst, you want to learn as many approaches and tools as possible to facilitate getting your work done in the most appropriate way. Certain applications and systems work will call forth certain methodologies. Consider using RAD when:

1. Your team includes programmers and analysts who are experienced with it; and
2. There are pressing business reasons for speeding up a portion of an application development; or
3. When you are working with a novel ecommerce application and your development team believes that the business can sufficiently benefit over their competitors from being an innovator if this application is among the first to appear on the Web; or
4. When users are sophisticated and highly engaged with the organizational goals of the company.

**DISADVANTAGES OF RAD.** The difficulties with RAD, as with other types of prototyping, arise because systems analysts try to hurry the project too much. Suppose two carpenters are hired to build two storage sheds for two neighbors. The first carpenter follows the SDLC philosophy, whereas the second follows the RAD philosophy.

The first carpenter is systematic, inventorying every tool, lawn mower, and piece of patio furniture to determine the correct size for the shed, designing a blueprint of the shed, and writing specifications for every piece of lumber and hardware. The carpenter builds the shed with little waste and has precise documentation about how the shed was built if anyone wants to build another just like it, repair it, or paint it using the same color.

The second carpenter jumps right into the project by estimating the size of the shed, getting a truckload of lumber and hardware, building a frame and discussing it with the owner of the property as modifications are made when certain materials are not available, and making a trip to return the lumber not used. The shed gets built faster, but if a blueprint is not drawn, the documentation never exists.

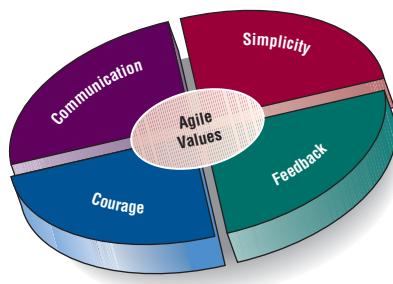
## AGILE MODELING

Agile methods are a collection of innovative, user-centered approaches to systems development. You will learn the values and principles, activities, resources, practices, processes, and tools associated with agile methodologies in the upcoming section. Agile methods can be credited with many successful systems development projects and in numerous cases even credited with rescuing companies from a failing system that was designed using a structured methodology.

### Values and Principles of Agile Modeling

The agile approach is not based just on results. It is based on values, principles, and practices. Essential to agile programming are stated values and principles that create the context for collaboration among programmers and customers. In order to be agile analysts, you must adhere to the following values and principles as developed by Beck (2000) in his work on agile modeling that he called “extreme programming” or “XP.”

**FOUR VALUES OF AGILE MODELING.** There are four values that create an environment in which both developers and businesses can be adequately served. Because there is often tension between what developers do in the short term and what is commercially desirable in the long term, it is important that you knowingly espouse values that will form a basis for acting together on a software project. The four values are communication, simplicity, feedback, and courage, as shown in Figure 6.6.

**FIGURE 6.6**

Values are crucial to the agile approach.

Let's begin with communication. Every human endeavor is fraught with possibilities for miscommunication. Systems projects that require constant updating and technical design are especially prone to such errors. Add to this tight project deadlines, specialized jargon, and the stereotype that programmers would prefer to talk to machines rather than people, and you have the potential for some serious communication problems. Projects can be delayed; the wrong problem can be solved; programmers are punished for even bringing up problems to managers; people leave or join the project in midstream without proper updates; and so the litany goes.

Typical agile practices such as pair programming (two programmers collaborating, described later in the chapter), estimating tasks, and unit testing rely heavily on good communication. Problems are fixed rapidly, holes are closed, and weak thinking is quickly strengthened through interaction with others on the team.

A second value of the agile approach is that of simplicity. When we are working on a software development project, our first inclination is to become overwhelmed with the complexity and bigness of the task. However, you cannot run until you know how to walk, nor walk until you know how to stand. Simplicity for software development means that we will begin with the simplest possible thing we can do.

The agile value of simplicity asks us to do the simplest thing today, with the understanding that it might have to be changed a little tomorrow. This requires a clear focus on the goals of the project and really is a basic value.

Feedback is the third basic value that is important when taking an extreme programming approach. When you think of feedback in this context, it is good to consider that feedback is wrapped up with the concept of time. Good, concrete feedback that is useful to the programmer, analyst, and customer can occur within seconds, minutes, days, weeks, or months, depending on what is needed, who is communicating, and what will be done with the feedback. A fellow programmer may hand you a test case that breaks the code you wrote only hours before, but that feedback is almost priceless in terms of being able to change what is not working before it is accepted and further embedded in the system.

Feedback occurs when customers create functional tests for all of the stories that programmers have subsequently implemented. (See more on user stories later in this chapter.) Critical feedback about the schedule comes from customers who compare the goal of the plan to the progress that has been made. Feedback helps programmers to make adjustments and lets the business start experiencing very early on what the new system will be like once it is fully functional.

Courage is the fourth value enunciated in agile programming. The value of courage has to do with a level of trust and comfort that must exist in the development team. It means not being afraid to throw out an afternoon or a day of programming and begin again if all is not right. It means being able to stay in touch with one's instincts (and test results) concerning what is working and what is not.

Courage also means responding to concrete feedback, acting on your teammates' hunch when they believe that they have a simpler, better way to accomplish your goal. Courage is a high-risk, high-reward value that encourages experimentation that can take the team to its goal more rapidly, in an innovative way. Courage means that you and your teammates trust each other and your customers enough to act in ways that will continuously improve what is being done on the project, even if they require throwing out code, rethinking solutions, or further simplifying approaches. Courage also implies that you, as a systems analyst, eagerly apply the practices of the agile approach.

Analysts can best reflect all of the four values through an attitude of humility. Historically, computer software was developed by experts who often thought they knew how to run a business

better than the local customers who were the true domain experts. Computer experts were often referred to as “gurus.” Some of the gurus displayed large egos and insisted on their infallibility, even when customers did not believe it. Many gurus lacked the virtue of humility.

However, maintaining a humble attitude during systems development is critical. You must continually embrace the idea that if the user is expressing a difficulty, then that difficulty must be addressed. It cannot be ignored. Agile modelers are systems analysts who make suggestions, voice opinions, but never insist that they are right 100 percent of the time. Agile modelers possess the self-confidence to allow their customers to question, critique, and sometimes complain about the system under development. Analysts learn from their customers, who have been in business a long time.

**THE BASIC PRINCIPLES OF AGILE MODELING.** In a perfect world, customers and your software development team would see eye to eye and communication would not be necessary. We would all be in agreement at all times. We know that the ideal world doesn’t exist. But how can we bring our software development projects closer to the ideal? Part of why this will not happen is that so far we are trying to operate on a vague system of shared values. They’re a good beginning, but they are really not operationalized to the point at which we can measure our success in any meaningful way. So we work to derive the basic principles that can help us check whether what we are doing in our software project is actually measuring up to the values that we share.

Agile principles are the reflections and specifications of agile values. They serve as guidelines for developers to follow when developing systems. They also serve to set agile methodologies apart from the more traditional plan-driven methodologies such as SDLC as well as object-oriented methodologies.

Agile principles were first described by Beck et al. and have evolved ever since. These principles can be expressed in a series of sayings such as:

1. Satisfy the customer through delivery of working software
2. Embrace change, even if introduced late in development
3. Continue to deliver functioning software incrementally and frequently
4. Encourage customers and analysts to work together daily
5. Trust motivated individuals to get the job done
6. Promote face-to-face conversation
7. Concentrate on getting software to work
8. Encourage continuous, regular, and sustainable development
9. Adopt agility with attention to mindful design
10. Support self-organizing teams
11. Provide rapid feedback
12. Encourage quality
13. Review and adjust behavior occasionally, and
14. Adopt simplicity.

Often you will hear agile developers communicate their point through sayings like those mentioned previously or even simpler phrases such as “model with a purpose,” “software is your primary goal,” and “travel light,” a way of saying a little documentation is good enough. Listen to these carefully. These sayings (some call them proverbs) are further discussed in Chapter 16 under an analysis and document tool called FOLKLORE. Catchy phrases are easy to understand, easy to memorize, and easy to repeat. They are very effective.

## Activities, Resources, and Practices of Agile Modeling

Agile modeling involves a number of activities that need to be completed sometime during the agile development process. This section discusses these activities, the resources, and the practices that are unique to the agile approach.

**FOUR BASIC ACTIVITIES OF AGILE DEVELOPMENT.** There are four basic activities of development that agile methods use. They are coding, testing, listening, and designing. The agile analyst needs to identify the amount of effort that will go into each activity and balance that with the resources needed to complete the project.

Coding is designated as the one activity that it is not possible to do without. One author states that the most valuable thing that we receive from code is “learning.” The process is basi-

cally this: have a thought, code it, test it, and see whether the thought was a logical one. Code can also be used to communicate ideas that would otherwise remain fuzzy or unshaped. When I see your code, I may get a new thought. Source code is the basis for a living system. It is essential for development.

Testing is the second basic activity of development. The agile approach views automated tests as critical. The agile approach advocates writing tests to check the coding, functionality, performance, and conformance. Agile modeling relies on automated tests, and large libraries of tests exist for most programming languages. These tests need to be updated as necessary during the progress of the project.

There are both long-term and short-term reasons for testing. Testing in the short term provides you with extreme confidence in what you are building. If tests run perfectly you can continue on with renewed confidence. In the long term, testing keeps a system alive and allows you to make changes longer than would be possible if no tests were written or run.

The third basic activity of development is listening. In Chapter 4, we learned about the importance of listening during interviews. In the agile approach, listening is done in the extreme. Developers use active listening to hear their programming partner. In agile modeling there is less reliance on formal, written communication, and so listening becomes a paramount skill.

The developer also uses active listening with the customer. Developers assume that they know nothing about the business they are helping, and so they must listen carefully to businesspeople to get the answers to their questions. The developer needs to come to an understanding of what effective listening is. If you don't listen, you will not know what you should code or what you should test.

The fourth basic activity in development is designing, which is a way of creating a structure to organize all the logic in the system. Designing is evolutionary, and so systems that are designed using the agile approach are conceptualized as evolving, always being designed.

Good design is often simple. Design should allow flexibility as well. Designing well permits you to make extensions to the system by making changes only in one place. Effective design locates logic near the data on which it will be operating. Above all, design should be useful to all those who will need it as the development effort proceeds, including customers as well as programmers.

**FOUR RESOURCE CONTROL VARIABLES OF AGILE MODELING.** Completing all the activities in the project on time within all the constraints is admirable, but, as you probably have realized by now, in order to accomplish this, project management is crucial. Managing a project doesn't mean simply getting all the tasks and resources together. It also means that the analyst is faced with a number of trade-offs. Sometimes cost may be predetermined, at other junctures time may be the most important factor. These resource control variables (time, cost, quality, and scope) are discussed next.

**TIME.** You need to allow enough time to complete your project. Time, however, is split into many separate pieces. You need time to listen to the customers, time to design, time to code, and time to test.

One of our friends is an owner of a Chinese restaurant. Recently, he found himself short-staffed as one of the members of his reliable crew returned to Hong Kong to get married. The owner placed himself in the kitchen so the food was served on time, but stopped greeting his customers out front in the usual way. He sacrificed the listening activity to achieve another, but in this case he found out it was hurting his business. Customers wanted the attention.

It is the same in systems development. You can create quality software, but fail to listen. You can design a perfect system, but not allow enough time to test it. Time is difficult to manage. If you find yourself running short of time, what do you do?

The agile approach challenges the notion that more time will give you the results you want. Perhaps the customer would prefer that you finish on time rather than extending the deadline to add another feature. Customers, we often find, are happy if some of the functionality is up and running on time. Our experience shows that often a customer is 80-percent satisfied with the first 20 percent of the functionality. This means that when you complete the final 80 percent of the project, the customer may be only slightly happier than he or she was after you completed the first 20 percent. The message here is be careful not to extend your deadline. The agile approach insists on finishing on time.

**COST.** Cost is the second variable we can consider adjusting. Suppose that the activities of coding, designing, testing, and listening are weighing the project down, and the resources we put

into time, scope, and quality are not sufficient, even with a normal amount devoted to cost, to balance the project. Essentially we might be required to contribute more resources that require money to balance the project.

The easiest way to increase spending (and hence costs) is to hire more people. This may appear to be the perfect solution. If we hire more programmers, we'll finish faster. Right? Not necessarily. Picture hiring two people to repair a roof and increase that number to four. Soon the people are bumping into one another. Furthermore, they need to ask each other what still needs to be done. And if there's a lightning storm, no one will be working. Going from two to four doesn't mean it will take half of the time. Consider the required increase in communication and other intangible costs when you are considering hiring more people. Remember that when new people join a team, they do not know the project or the team. They will slow the original members down, because the original members must devote time to getting new members up to speed.

Overtime doesn't help much either. It increases the cost, but the productivity doesn't always follow. Tired programmers are less effective than alert programmers. Tired programmers take a long time to complete a task, and they also make mistakes that are even more time consuming to fix.

Is there anything else we can spend our money on? Perhaps. As you read later chapters you will read about a variety of tools that support analysts and programmers. These tools are often a wise investment. Analysts, for example, use graphical packages such as Microsoft Visio to communicate ideas about the project to others, and CASE tools such as Visible Analyst also help speed up projects.

Even new hardware could be a worthwhile expenditure. Laptops and smartphones improve productivity away from the office. Larger visual displays, Bluetooth-enabled keyboards and mice, and more powerful graphics cards can also increase productivity.

**QUALITY.** The third resource control variable is quality. If ideal systems are perfect, why is so much effort placed in maintaining systems? Are we already practicing agile development by sacrificing quality in software development? In Chapter 16 we will see the importance of quality and methods (such as TQM and Six Sigma) that help ensure software quality is high.

The agile philosophy, however, does allow the analyst to adjust this resource, and perhaps put less effort into maintaining quality than otherwise would be expected. Quality can be adjusted both internally and externally. Internal quality involves testing software for factors such as functionality (Does a program do what it is supposed to do?) and conformance (Does the software meet certain conformance standards and is it maintainable?). It usually doesn't pay to tinker with internal quality.

That leaves us with external quality, or how the customer perceives the system. The customer is interested in performance. Some of the questions a customer may ask are: Does the program act reliably (or do software bugs still exist)? Is the output effective? Does the output reach me on time? Does the software run effortlessly? Is the user interface easy to understand and use?

The extreme philosophy of agile development allows some of the external quality issues to be sacrificed. In order for the system to be released on time, the customer may have to contend with some software bugs. If we want to meet our deadline, the user interface may not be perfect. We can make it better in a follow-up version.

Commercial off-the-shelf software manufacturers do sacrifice quality, and it is debatable whether this is the correct approach. So don't be surprised when your PC software applications (not to mention your operating system and Web browser) are updated often, if developers are using extreme programming as one of their agile practices.

**SCOPE.** Finally, there is scope. In the agile approach, scope is determined by listening to customers and getting them to write down their stories. Then the stories are examined to see how much can be done in a given time to satisfy the customer. Stories should be brief and easy to grasp. Stories will be described in more detail later in this chapter, but here is a brief example showing four short stories from an online air travel system. Each story is shown in bold type:

#### **Display alternative flights.**

*Prepare a list of the five cheapest flights.*

#### **Offer cheaper alternatives.**

*Suggest to customers that they travel on other days, make weekend stays, take special promotions, or use alternate airports.*

#### **Purchase a ticket.**

*Allow the customer to purchase a ticket directly using a credit card (check validity).*

**Allow the customer to choose his or her seat.**

*Direct the customer to a visual display of the airplane and ask the customer to select a seat.*

Ideally, the analyst would be able to determine how much time and money was needed to complete each of these stories and be able to set the level of quality for them as well. It is obvious that this system must not sacrifice quality, or credit card purchases may be invalid or customers may show up at the airport without reservations.

Once again agile practices allow extreme measures, so in order to maintain quality, manage cost, and complete the project on time, the agile analyst may want to adjust the scope of the project. This can be accomplished by agreeing with the customer that one or more of the stories can be delayed until the next version of the software. For example, maybe the functionality of allowing customers to choose their own seats can be put off for another time.

In summary, the agile analyst can control any of the four resource variables of time, cost, quality, and scope. Agility calls for extreme measures and places a great deal of importance on completing a project on time. In doing so, sacrifices must be made and the agile analyst will find out that the trade-offs available involve difficult decisions.

**FOUR CORE AGILE PRACTICES.** Four core practices markedly distinguish the agile approach from other approaches: short releases; the 40-hour workweek; hosting an onsite customer; and using pair programming.

1. Short releases means that the development team compresses the time between releases of their product. Rather than releasing a full-blown version in a year, using the short release practice they will shorten the release time by tackling the most important features first, releasing that system or product, and then improving it later.
2. Forty-hour workweek means that agile development teams purposely endorse a cultural core practice in which the team works intensely together during a typical 40-hour workweek. As a corollary to this practice, the culture reinforces the idea that working overtime for more than a week in a row is very bad for the health of the project and the developers. This core practice attempts to motivate team members to work intensely at the job, and then to take time off so that when they return they are relaxed and less stressed. This helps team members spot problems more readily, and prevents costly errors and omissions due to ineffectual performance or burnout.
3. Onsite customer means that a user who is an expert in the business aspect of the systems development work is onsite during the development process. This person is integral to the process, writes user stories, communicates to team members, helps prioritize and balance the long-term business needs, and makes decisions about which feature should be tackled first.
4. Pair programming is an important core practice. It means that you work with another programmer of your own choosing. You both do coding, you both run tests. Often the senior person will take the coding lead initially, but as the junior person becomes involved, whoever has the clear vision of the goal will typically do the coding for the moment. When you ask another person to work with you, the protocol of pair programming says he or she is obligated to consent. Working with another programmer helps you clarify your thinking. Pairs change frequently, especially during the exploration stage of the development process. Pair programming saves time, cuts down on sloppy thinking, sparks creativity, and is a fun way to program.

How core agile practices interrelate with and support agile development activities, resources, and values is shown in Figure 6.7.

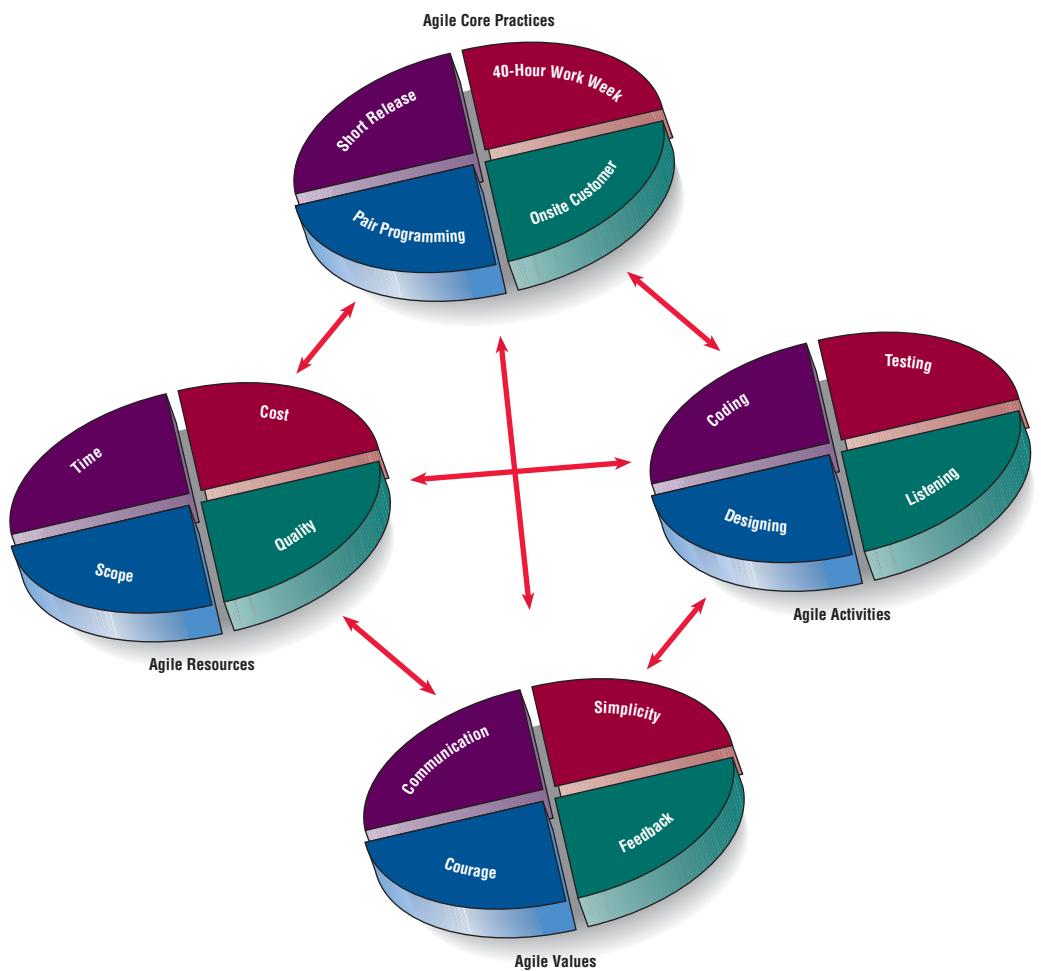
## The Agile Development Process

Modeling is a keyword in agile methods. Agile modeling seizes on the opportunity to create models. These can be logical models such as drawings of systems, or mock-ups such as the prototypes described earlier in this chapter. A typical agile modeling process would go something like this:

1. Listen for user stories from the customer.
2. Draw a logical workflow model to gain an appreciation for the business decisions represented in the user story.
3. Create new user stories based on the logical model.

**FIGURE 6.7**

The core practices are interrelated with agile modeling's resources, activities, and values.



4. Develop some display prototypes. In doing so, show the customers what sort of interface they will have.
5. Using feedback from the prototypes and the logical workflow diagrams, develop the system until you create a physical data model.

Agile is the other keyword in agile modeling. Agile implies maneuverability. Today's systems, especially those that are Web-based, pose twin demands: getting software released as soon as possible and continually improving the software to add new features. The systems analyst needs to have the ability and methods to create dynamic, context-sensitive, scalable, and evolutionary applications. Agile modeling as such is a change-embracing method.

**WRITING USER STORIES.** Even though the title of this section is “Writing User Stories,” the emphasis in the creation of user stories is on spoken interaction between developers and users, not the written communication. In user stories, the developer is seeking first and foremost to identify valuable business user requirements. Users will typically engage in conversations every day with the developers about the meaning of the user stories they have written. These frequent conversations are purposeful interactions that have as their goal the prevention of misunderstandings or misinterpretations of user requirements. Therefore, user stories serve as reminders to the developers that they must hold conversations devoted to those requirements.

The following is an example of a series of stories written for an ecommerce application for an online merchant of books, CDs, and other media products. The stories give a fairly complete picture of what is needed at each of the stages in the purchase process, but the stories are very short and easy to comprehend. The point here is to get all the needs and concerns of the online store out in the open. Although there is not enough of a story to begin programming, an agile

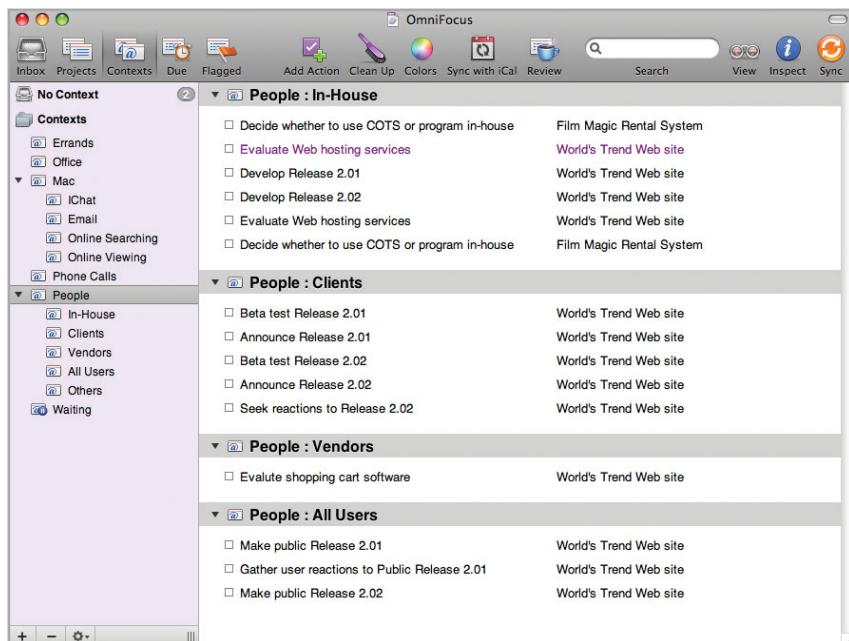


Just as agile methodologies are an alternative to the SDLC, OmniFocus is an alternative to Microsoft Project or other Gantt Chart or PERT diagram approaches.

A casual observer might think that agile methods are unstructured because systems are built without detailed specifics and documentation. A student of agile methods realizes that there is actually quite a bit of structure in the agile approach. Principles include sticking to the 40-hour workweek and coordination through pair-programming. An analyst who adopts agile techniques needs a way to set goals, keep within budget, set priorities for features, and find a way to get things done.

OmniFocus is based on an alternative task management system by David Allen, called Getting Things Done. The overriding principle is to free your mind from remembering things, so that you can concentrate on completing them. An analyst using this system would go through five actions: collect, process, organize, review, and do.

Systems analysts using OmniFocus would collect items from their Web browser, their address book or their calendar, or most applications on a Mac. The analyst can categorize it or assign it to a larger project. OmniFocus contains a planning mode so the analyst can see which task is part of a larger project and a context mode that organizes the tasks so the analyst knows all the tasks that must be done either by phone, by browsing the Web, or by using email. OmniFocus is also available as an iPhone app.



**FIGURE 6.MAC**

OmniFocus from The Omni Group.

developer might begin to see the overall picture clearly enough to begin estimating what it takes to complete the project. The stories are as follows:

#### Welcome the customer.

*If the customer has been at this site before using this same computer, welcome the customer back to the online store.*

#### Show specials on homepage.

*Show any recent books or other products that have recently been introduced. If the customer is identified, tailor the recommendations to that specific customer.*

**Search for desired product.**

*Include an effective search engine that will locate the specific product and similar products.*

**Show matching titles and availability.**

*Display the results of the search on a new Web page.*

**Allow customer to ask for greater detail.**

*Offer the customer more product details, such as sample pages in a book, more photos of a product, or to play a partial track from a CD.*

**Display reviews of the product.**

*Share the comments that other customers have about the product.*

**Place a product into a shopping cart.**

*Make it easy for the customer to click on a button that places the product into a shopping cart of intended purchases.*

**Keep purchase history on file.**

*Keep details about the customer and his or her purchases in a cookie on the customer's computer. Also keep credit card information for faster checkout.*

**Suggest other books that are similar.**

*Include photos of other books that have similar themes or were written by the same authors.*

**Proceed to checkout.**

*Confirm the identity of the customer.*

**Review the purchases.**

*Allow the customer to review the purchases.*

**Continue shopping.**

*Offer the customer a chance to make further purchases at the same time.*

**Apply shortcut methods for faster checkout.**

*If the identity of the customer is known and the delivery address matches, speed up the transaction by accepting the credit card on file and the remainder of the customer's preferences, such as shipping method.*

**Add names and shipping addresses.**

*If the purchase is a gift, allow the customer to enter the name and address of the recipient.*

**Offer options for shipping.**

*Allow the customer to choose a shipping method based on cost.*

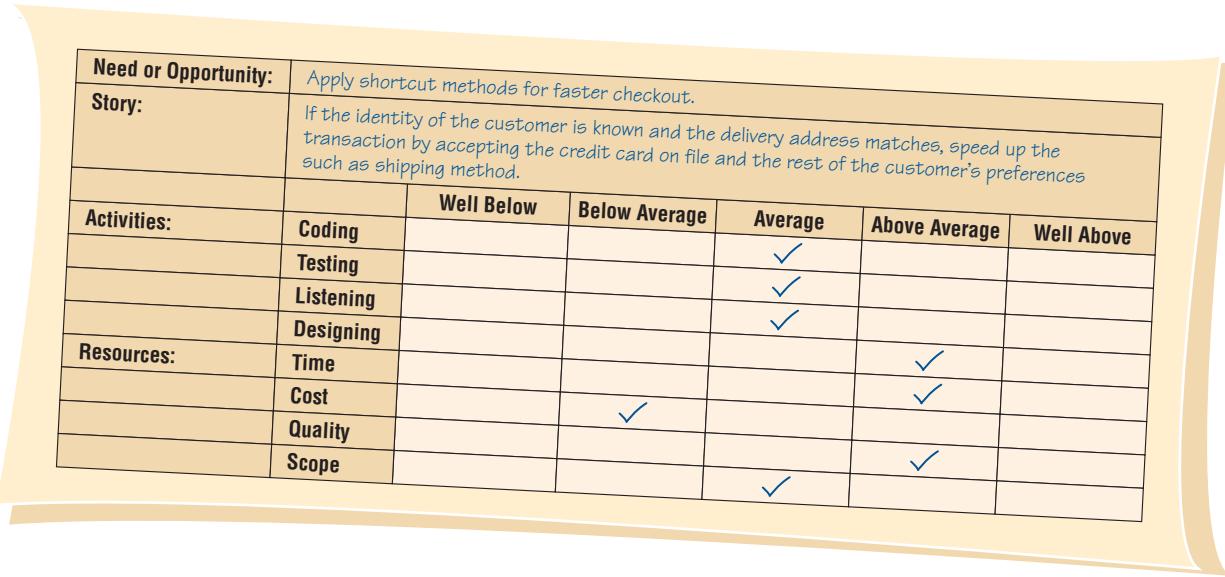
**Complete the transaction.**

*Finish the transaction. Ask for credit card confirmation if the shipping address is different from the customer's address on file.*

As you can easily see, there is no shortage of stories. The agile analyst needs to choose a few stories, complete the programming, and release a product. Once this is done, more stories are selected and a new version is released until all the stories are included in the system (or the analyst and customer agree that a particular story lacks merit, or is not pressing, and so need not be included).

An example of a user story as it might appear to an agile developer is shown in Figure 6.8. On cards (or electronically), an analyst might first identify the need or opportunity, and then follow it with a brief story description. The analyst might take the opportunity to begin thinking broadly about the activities that need to be completed as well as the resources it will take to finish the project. In this example from the online merchant, the analyst indicates that the designing activity will take above-average effort, and the time and quality resources are required to rise above average. Notice that the analyst is not trying to be more precise than currently possible on this estimate, but it is still a useful exercise.

**SCRUM.** Another agile approach is named Scrum. The word *scrum* is taken from a starting position in rugby in which the rugby teams form a huddle and fight for possession of the ball. Scrum is really about teamwork, similar to what is needed in playing a game of rugby.



The table is a satisfaction matrix for a user story. It has two main sections: 'Story' and 'Activities'. The 'Story' section contains a single row with a colspan of 6. The 'Activities' section has rows for Coding, Testing, Listening, and Designing, each with columns for Well Below, Below Average, Average, Above Average, and Well Above. Checkmarks are placed in the 'Average' column for Coding, Testing, and Listening; in the 'Above Average' column for Designing; and in the 'Well Above' column for Time and Cost.

<b>Need or Opportunity:</b>	<i>Apply shortcut methods for faster checkout.</i>					
<b>Story:</b>	<i>If the identity of the customer is known and the delivery address matches, speed up the transaction by accepting the credit card on file and the rest of the customer's preferences such as shipping method.</i>					
<b>Activities:</b>	Coding	Well Below	Below Average	Average	Above Average	Well Above
	Testing			✓		
	Listening			✓		
	Designing			✓		
<b>Resources:</b>	Time				✓	
	Cost		✓		✓	
	Quality					
	Scope			✓	✓	

**FIGURE 6.8**

Just as rugby teams will come to a game with an overall strategy, development teams begin the project with a high-level plan that can be changed on the fly as the “game” progresses. Systems development team members realize that the success of the project is most important, and their individual success is secondary. The project leader has some, but not much, influence on the detail. Rather, the tactical game is left up to the team members, just as if they were on the field. The systems team works within a strict time frame (30 days for development), just as a rugby team would play in a strict time constraint of a game.

We can describe the components of the scrum methodology as:

1. Product backlog, in which a list is derived from product specifications.
2. Sprint backlog, a dynamically changing list of tasks to be completed in the next sprint.
3. Sprint, a 30-day period in which the development team transforms the backlog into software that can be demonstrated.
4. Daily scrum, a brief meeting in which communication is the number-one rule. Team members need to explain what they did since the last meeting, whether they encountered any obstacles, and what they plan to do before the next daily scrum.
5. Demo, working software that can be demonstrated to the customer.

Scrum is indeed a high-intensity methodology. It is just one of the approaches that adopts the philosophy of agile modeling.

### Lessons Learned from Agile Modeling

Often posed as an alternative way to develop systems, the agile approach seeks to address common complaints arising over the traditional SDLC approach (for being too time-consuming, focusing on data rather than on humans, and being too costly) by being rapid, iterative, flexible, and participative in responding to changing human information requirements, business conditions, and environments.

Several agile development projects have been chronicled in books, articles, and on Web sites. Many of them were successes, some have been failures, but we can learn a great deal from studying them, as well as the agile values, principles, and core practices. Following are the six major lessons we draw from our examination of agile modeling. Figure 6.9 depicts the six lessons.

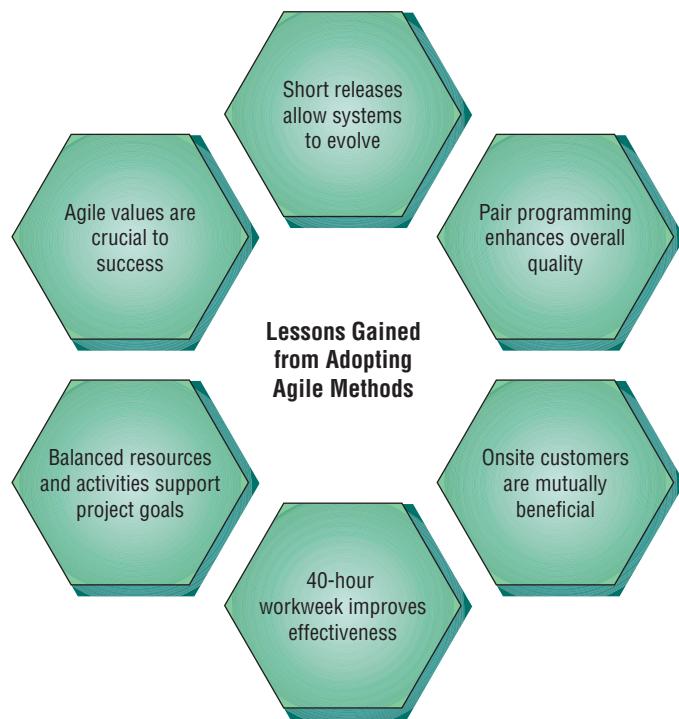
The first lesson is that short releases allow systems to evolve. Product updates are made often, and changes are incorporated quickly. In this way the system is permitted to grow and expand in ways that the customer finds useful. Through the use of short releases, the development team compresses the time between releases of their product, improving the product later as the dynamic situation demands.

The second lesson is that pair programming enhances overall quality. Although pair programming is controversial, it clearly fosters other positive activities necessary in systems development

User stories can be recorded on cards. The user story should be brief enough for an analyst to determine what systems features are needed.

**FIGURE 6.9**

There are six vital lessons that can be drawn from the agile approach to systems.



such as good communication, identifying with the customer, focusing on the most valuable aspects of the project first, testing all code as it is developed, and integrating the new code after it successfully passes its tests.

The third lesson is that onsite customers are mutually beneficial to the business and the agile development team. Customers serve as a ready reference and reality check, and the focus of the system design will always be maintained via their presence: customers become more like developers and developers empathize more fully with customers.

The fourth lesson we take from the agile approach is that the 40-hour workweek improves effectiveness. Even the hardest-hitting developers are susceptible to errors and burnout if they work too hard for too long a period. When the development team is together, however, every moment counts. Working at a sustainable pace is much more desirable for the life of the project, the life of the system, and the life of the developer! We all know the parable of the hare and the tortoise.

The fifth lesson we draw from taking the agile approach is that balanced resources and activities support project goals. Managing a project doesn't mean simply getting all resources and tasks together. It also means that the analyst is faced with a number of trade-offs. Sometimes cost may be predetermined, at other junctures time may be the most important factor. The resource control variables of time, cost, quality, and scope need to be properly balanced with the activities of coding, designing, testing, and listening.

The last lesson we take from agile modeling approaches is that agile values are crucial to success. It is essential to the overall success of the project that analysts wholeheartedly embrace the values of communication, simplicity, feedback, and courage in all the work that they do. This type of personal and team commitment enables the analyst to succeed where others, who possess similar technical competencies but who lack values, will fail. True dedication to these values is fundamental to successful development.

## COMPARING AGILE MODELING AND STRUCTURED METHODS

As you have seen, agile methods are developed quickly; they reportedly work; and users are customers who are directly involved. While it is true that projects developed by agile methods often require tweaking to work properly, agile developers admit that tweaking is part of the process. The agile approach implies many short releases with features added along the way.

## Improving Efficiency in Knowledge Work: SDLC Versus Agile

Researchers (Davis & Naumann, 1999) developed a list of seven strategies that can improve the efficiency of knowledge work: reducing interface time and errors; reducing process learning time and dual processing losses; reducing time and effort to structure tasks and format outputs; reducing nonproductive expansion of work; reducing data and knowledge search and storage time and costs; reducing communication and coordination time and costs; and reducing losses from human information overload. They believe this is important, since based on their study of a group of programmers, they claim that the best programmers are five to ten times more productive than the worst ones. They further point out this ratio is only two to one for workers in clerical or physical tasks. Their suggestion is that software can help improve many situations.

We use the standard, traditional systems development approach of structured methods to compare and contrast how structured approaches versus agile methods would implement the seven strategies proposed to improve the efficiency of knowledge workers.

While adopting more software may indeed improve performance, it is reasonable to suggest that changing an approach or methodology may also improve performance. Consequently, we will examine each aspect of knowledge work productivity through lenses from both structured and agile methodologies. Figure 6.10 lists the original seven strategies for productivity improvement and then explains what methods are used to improve the efficiency of systems development for both structured and agile methodologies.

In the upcoming sections we will compare and contrast structured approaches with the agile approach. An overarching observation about the agile methodology is that it is a human-oriented approach that permits people to create nuanced solutions that are impossible to create through formal specifications of process.

**REDUCING THE INTERFACE TIME AND ERRORS.** Systems analysts and programmers need to analyze, design, and develop systems using knowledge work tools that range from Microsoft Office to sophisticated and costly CASE tools. They also need to document as they develop systems. It is important that analysts and programmers are capable of understanding the interface they use. They need to know how to classify, code, store, and write about the data they gather. Systems developers also need to quickly access a program, enter the required information, and retrieve it when it is needed again.

**FIGURE 6.10**

How Davis and Naumann's strategies for improving efficiency can be implemented using two different development approaches.

Strategies for Improving Efficiency in Knowledge Work	Implementation Using Structured Methodologies	Implementation Using Agile Methodologies
Reduce interface time and errors	Adopting organizational standards for coding, naming, etc.; using forms	Adopting pair programming
Reduce process learning time and dual processing losses	Managing when updates are released so the user does not have to learn and use software at the same time	Ad hoc prototyping and rapid development
Reduce time and effort to structure tasks and format outputs	Using CASE tools and diagrams; using code written by other programmers	Encouraging short releases
Reduce nonproductive expansion of work	Project management; establishing deadlines	Limiting scope in each release
Reduce data and knowledge search and storage time and costs	Using structured data gathering techniques, such as interviews, observation, sampling	Allowing for an onsite customer
Reduce communication and coordination time and costs	Separating projects into smaller tasks; establishing barriers	Timeboxing
Reduce losses from human information overload	Applying filtering techniques to shield analysts and programmers	Sticking to a 40-hour workweek

Structured approaches encourage adopting standards for everything. Rules set forth include items such as, “Everyone must use Microsoft Word rather than Word Perfect.” They may be more detailed instructions to ensure clean data such as, “Always use M for Male and F for Female,” thereby ensuring that analysts do not unthinkingly choose codes of their own, such as 0 for Male and 1 for Female. These rules then become part of the data repository. Forms are also useful, requiring all personnel to document their procedures so that another programmer might be able to take over if necessary.

In an agile approach, forms and procedures work well too, but another element is added. The additional practice of pair programming assures that one programmer will check the work of another, thereby reducing the number of errors. Pair programming means that ownership of the design or software itself is shared as in a partnership. Both partners (typically one a programmer, often a senior one) will say they chose a programming partner who desired to have a quality product that is error-free. Since two people work on the same design and code, interface time is not an issue; it is an integral part of the process. The authors have noted that programmers are quite emotional when the topic of pair programming is broached.

**REDUCING THE PROCESS LEARNING TIME AND DUAL PROCESSING LOSSES.** Analysts and programmers learn specific techniques and software languages required for the completion of a current project. Inefficiencies often result when some analysts and programmers already know the products used while others still need to learn them. Typically, we ask that developers learn these products at the same time they are using them to build the system. This on-the-job training slows down the entire systems development project considerably.

A traditional, structured project requires more learning. If CASE tools were used, an analyst may need to learn the proprietary CASE tools used in the organization. The same applies to the use of a specific computer language. Documentation is also a concern.

Using an agile philosophy, the ability to launch projects without using CASE tools and detailed documentation allows the analysts and programmers to spend most of their time on system development rather than on learning specific tools.

**REDUCING THE TIME AND EFFORT TO STRUCTURE TASKS AND FORMAT OUTPUTS.** Whenever a project is started, a developer needs to determine the boundaries. In other words, the developers need to know what the deliverable will be and how they will go about organizing the project so they can complete all the necessary tasks.

A traditional approach would include using CASE tools, drawing diagrams (such as E-R diagrams and data flow diagrams), using project management software (such as Microsoft Project), writing detailed job descriptions, using and reusing forms and templates, and reusing code written by other programmers.

Systems development using an agile approach addresses the need to structure tasks by scheduling short releases. The agile philosophy suggests that system developers create a series of deadlines for many releases of the system. The first releases would possess fewer features, but, with each new release, additional features would be added.

**REDUCING THE NONPRODUCTIVE EXPANSION OF WORK.** Parkinson’s law states that “work expands so as to fill the time available for its completion.” If there are no specified deadlines, it is possible that knowledge work will continue to expand.

With traditional structured methodologies, deadlines at first seem far into the future. Analysts may use project management techniques to try to schedule the activities, but there is a built-in bias to extend earlier tasks longer than they need to be and then try to shorten tasks later on in the development. Analysts and programmers are less concerned about distant deadlines than approaching ones.

Once again, the agile approach stresses short releases. Releases can be delivered at the time promised, minus some of the features originally promised. Making all deadlines imminent pushes a realistic expectation for (at least partial) completion to the fore.

**REDUCING THE DATA AND KNOWLEDGE SEARCH AND STORAGE TIME AND COSTS.** System developers need to gather information about the organization, goals, priorities, and details about current information systems before they can proceed to develop a new system. Data-gathering methods include interviewing, administering questionnaires, observation, and investigation by examining reports and memos.

Structured methodologies encourage structured data-gathering methods. Structured techniques would normally be used to structure interviews and design the interview process. Questionnaires would be developed in a structured way, and structured observational techniques such as STROBE would encourage the analyst to specifically observe key elements and form conclusions based on the observations of the physical environment. A sampling plan would be determined quantitatively, in order for the systems analyst to select reports and memos to examine.

Knowledge searches are less structured in an agile modeling environment. The practice of having an onsite customer greatly enhances access to information. The onsite customer is present to answer questions about the organization itself, its goals, the priorities of organizational members and customers, and whatever knowledge is necessary about existing information systems. As the project continues, the picture of customer requirements becomes clearer. This approach seems relatively painless because, when the system developers want to know something, they can just ask. The downside, however, is that the onsite representative may make up information if it is unknown or unavailable or evade telling the truth for some ulterior purpose.

**REDUCING COMMUNICATION AND COORDINATION TIME AND COSTS.** Communication between analysts and users, as well as among analysts themselves, is at the heart of developing systems. Poor communication is certainly the root of multiple development problems. We know that communication increases when more people join the project. When two people work on a project, there is one opportunity for a one-to-one conversation; when three people are involved, there are three possibilities; when four are involved, there are six possibilities, and so on. Inexperienced team members need time to get up to speed, and they can slow down a project even though they are meant to help expedite it.

Traditional structured development encourages the separation of big tasks into smaller tasks. This allows more tightly knit groups and decreases the time spent communicating. Another approach involves setting up barriers. For example, customers may not be given access to programmers. This is a common practice in many industries. However, increased efficiency often means decreased effectiveness, and it has been noted that dividing up groups and setting up barriers will often introduce errors.

Agile methods, on the other hand, limit time instead of tasks. Timeboxing is used in agile methodologies to encourage completion of activities in shorter periods. Timeboxing is simply setting a time limit of one or two weeks to complete a feature or module. The agile method scrum puts a premium on time, while the developers communicate effectively as a team. Since communication is one of the four values of the agile philosophy, communication costs tend to increase rather than decrease.

**REDUCING LOSSES FROM HUMAN INFORMATION OVERLOAD.** We have long known that people do not react well in information overload situations. When telephones were an emerging technology, switchboard operators manually connected calls between two parties. It was demonstrated that this system would work until an information overload occurred, at which point the entire system broke down. When too many calls came in, the overwhelmed switchboard operator would simply stop working and give up completely on connecting callers. An analogous overload situation can occur anytime to anyone, including systems analysts and programmers.

A traditional approach would be to try to filter information to shield analysts and programmers from customer complaints. This approach allows developers to continue working on the problem without the interference and subjectivity that would normally occur.

Using an agile philosophy, analysts and programmers are expected to stick to a 40-hour workweek. This might be viewed by some as a questionable practice. How will all the work ever get done? The agile philosophy states, however, that quality work is usually done during a routine schedule, and it is only when overtime is added that problems of poor quality design and programming enter the scene. By sticking to a 40-hour work week schedule, agile methodology claims you will eventually come out ahead.

## Risks Inherent in Organizational Innovation

In consultation with users, analysts must consider the risks that organizations face when adopting new methodologies. Clearly this is part of a larger question of when is the appropriate time to upgrade human skills, adopt new organizational processes, and institute internal change.

**FIGURE 6.11**

Adopting new information systems involves balancing several risks.



In the larger sense, these are questions of a strategic dimension for organizational leadership. Specifically, we consider the case of the systems analysis team adopting agile methods in light of the risks to the organization and the eventual successful outcome for the systems development team and their clients. Figure 6.11 shows many of the variables that need to be considered when assessing the risk of adopting organizational innovation.

**ORGANIZATIONAL CULTURE.** A key consideration is the overall culture of the organization and how the culture of the development team fits within it. A conservative organizational culture with many stable features that does not seek to innovate may be an inappropriate or even inhospitable context for the adoption of agile methodologies by the systems development group. Analysts and other developers must use caution in introducing new techniques into this type of setting, since their success is far from assured, and long-standing development team members or other organizational members may be threatened by new ways of working that depart from customary, dependable approaches with proven results.

Conversely, an organization that is dependent on innovation to retain its cutting edge in its industry might be the organization most welcoming toward agile innovations in systems development methods. In this instance, the culture of the organization is already permeated with the understanding of the critical nature of many of the core principles of agile development methodologies. From the strategic level downward, the company's members have internalized the need for rapid feedback, dynamic responses to changing environments in real time, dependence on the customer for guidance and participation in problem solving, and so on.

Located between these extremes are organizations that do not rely on innovation as a key strategic strength (in other words, they are not dependent on research and development of new products or services to remain afloat) but that might still wish to adopt innovative practices in small units or groups. Indeed, such small, innovative centers or kernels might eventually drive the growth or competitive advantage of this type of organization.

**TIMING.** Organizations must ask and answer the question of when is the best time to innovate with the adoption of new systems development methodologies, when all other projects and factors (internally and externally) are taken into account. Organizations must consider the entire panoply of projects in which they are investing, look ahead at project deadlines, schedule the upgrading of physical plants, and absorb key industry and economic forecasts.

**COST.** Another risk to the adoption of agile methodologies for organizations is the cost involved in education and training of systems analysts and programmers in the new approach. This can involve either costly off-site seminars and courses or hiring consultants to work with current staff onsite. Further, opportunity costs are involved when systems developers are necessarily diverted (albeit temporarily) from ongoing projects to learn new skills. Education in itself can be costly, but an additional burden is recognized when analysts cannot earn income during their training period.

**CLIENTS' REACTIONS.** When clients (whether they are internal or external) are involved as users or initiators of information systems development efforts, reactions to the use of new methods entailed by the agile approach are also a key consideration. Some clients react with joy once the benefits of timeliness and involvement are described. Others do not want to be used for systems "experiments" with uncertain outcomes. The client-analyst relationship must be resilient enough to absorb and adapt to changes in expected behaviors. For example, the onsite presence of a client during development is a major commitment that should be thoroughly understood and agreed upon by those adopting agile methods.

**MEASURING IMPACT.** Another consideration for organizations adopting agile methodologies is how to certify and measure that the new methods are going to facilitate successful systems development. The strengths and weaknesses of traditional structured methods used to develop information systems are well-known.

While there is ample anecdotal evidence that agile methodologies are superior for development under some conditions, their history is short-lived and not yet empirically supported. Therefore, the adoption of agile methodologies carries with it the risk that systems created with them will not be successful or will not adequately interface with legacy systems. Measuring the impact of the use of agile methodologies has begun, but organizations need to be vigilant in proposing impact measurements in tandem with the adoption of new methods.

**THE INDIVIDUAL RIGHTS OF PROGRAMMERS/ANALYSTS.** Successful systems developers (analysts and programmers) exercise creativity in their approach to their work, and they deserve the right to work in the most fruitful configuration possible. It is possible that the working requirements of new agile methods (for example, pair programming) encroach upon some basic rights of creative people to work alone or in groups as the design work dictates. There is no "one best way" to design a system, module, interface, form, or Web page. In the instance of systems developers, creativity, subjectivity, and the right to achieve design objectives through numerous individual paths need to be balanced against the organizational adoption of innovative approaches such as agile methodologies.

As you can see, adopting organizational innovations poses many risks to the organization as well as to individuals. We examined risks to the organization as a whole as well as to those posed to the individual systems analyst who is caught up in the organization's desire to innovate.

## SUMMARY

Prototyping is an information-gathering technique useful for supplementing the traditional SDLC; however, both agile methods and human-computer interaction share roots in prototyping. When systems analysts use prototyping, they are seeking user reactions, suggestions, innovations, and revision plans to make improvements to the prototype, and thereby modify system plans with a minimum of expense and disruption. The four major guidelines for developing a prototype are to (1) work in manageable modules, (2) build the prototype rapidly, (3) modify the prototype, and (4) stress the user interface.

Although prototyping is not always necessary or desirable, it should be noted that there are three main, interrelated advantages to using it: (1) the potential for changing the system early in its development, (2) the opportunity to stop development on a system that is not working, and (3) the possibility of developing a system that more closely addresses users' needs and expectations. Users have a distinct role to play in the prototyping process and systems analysts must work systematically to elicit and evaluate users' reactions to the prototype.

One particular use of prototyping is rapid application development (RAD). It is an object-oriented approach with three phases: requirements planning, the RAD design workshop, and implementation.

Agile modeling is a software development approach that defines an overall plan quickly, develops and releases software quickly, and then continuously revises software to add additional features. The values of the agile approach that are shared by the customer as well as the development team are communication, simplicity, feedback, and courage. Agile activities include coding, testing, listening, and designing. Resources available include time, cost, quality, and scope.

## HYPERCASE® EXPERIENCE 6

**T**hank goodness it's the time of year when everything is new. I love spring; it's the most exhilarating time here at MRE. The trees are so green, with leaves in so many different shades. So many new projects to do, too; so many new clients to meet. We have a new intern, too. Anna Mae Silver. Sometimes the newest employee is the most eager to help. Call on her if you need more answers."

"All the newness reminds me of prototyping. Or what I know about prototyping, anyway. It's something new and fresh, a quick way to find out what's happening.

"I believe that we have a few prototypes already started. Sometimes our new onsite customer, Tessa Silverstone, gets involved by helping create user stories on which to build the prototypes. But the best thing about prototypes is that they can change. I don't know anyone who's really been satisfied with a first pass at a

prototype. But it's fun to be involved with something that's happening fast, and something that will change."

### HYPERCASE Questions

1. Make a list of the user stories Tessa Silverstone shared as examples.
2. Locate the prototype currently proposed for use in one of MRE's departments. Suggest a few modifications that would make this prototype even more responsive to the unit's needs.
3. Using a word processor, construct a nonoperational prototype for a Training Unit Project Reporting System. Include features brought up by the user stories you found. *Hint:* See sample screens in Chapters 11 and 12 to help you in your design.

**FIGURE 6.HC1**

One of the many prototype screens found in HyperCase.

Agile core practices distinguish agile methods, including a type of agile method called extreme programming (XP), from other systems development processes. The four core practices of the agile approach are (1) short releases, (2) 40-hour workweek, (3) onsite customer, and (4) pair programming. The agile development process includes choosing a task that is directly related to a customer-desired feature based on user stories, choosing a programming partner, selecting and writing appropriate test cases, writing the code, running the test cases, debugging it until all test cases run, implementing it with the existing design, and integrating it into what currently exists.

Later in this chapter we compared how SDLC and agile approaches handle improving knowledge work efficiency differently. We then discussed several inherent dangers to organizations adopting innovative approaches, including an incompatible organizational culture, poor timing of the project, cost of training systems analysts, unfavorable client reactions to new behavioral expectations, difficulties in measuring the impact, and the possible compromise of the individual creative rights of programmers and analysts.

## KEYWORDS AND PHRASES

40-hour workweek	patched-up prototype
agile modeling	prototype
agile principles	RAD design workshop
agile values	rapid application development (RAD)
assume simplicity	rapid feedback
embracing change	requirements planning phase
extreme programming (XP)	scrum methodology
first-of-a-series prototype	selected-features prototype
implementation	short release
incremental change	stressing the user interface
modifying the prototype	user involvement with prototyping
nonoperational prototype	user stories
onsite customer	working in manageable modules
pair programming	

## REVIEW QUESTIONS

1. What four kinds of information is the analyst seeking through prototyping?
2. What is meant by the term *patched-up prototype*?
3. Define a prototype that is a nonworking scale model.
4. Give an example of a prototype that is a first full-scale model.
5. Define what is meant by a prototype that is a model with some, but not all, essential features.
6. List the advantages and disadvantages of using prototyping to *replace* the traditional SDLC.
7. Describe how prototyping can be used to augment the traditional SDLC.
8. What are the criteria for deciding whether a system should be prototyped?
9. List four guidelines the analyst should observe in developing a prototype.
10. What are the two main problems identified with prototyping?
11. List the three main advantages in using prototyping.
12. How can a prototype mounted on an interactive Web site facilitate the prototyping process? Answer in a paragraph.
13. What are three ways that a user can be of help in the prototyping process?
14. Define what is meant by RAD.
15. What are the three phases of RAD?
16. What are the four values that must be shared by the development team and business customers when taking an agile approach?
17. What are agile principles? Give five examples.
18. What are the four core practices of the agile approach?
19. Name the four resource control variables used in the agile approach.
20. Outline the typical steps in an agile development episode.
21. What is a user story? Is it primarily written or spoken? State your choice, then defend your answer with an example.
22. List software tools that can aid the developer in doing a variety of tests of code.
23. What is scrum?
24. Name the seven strategies for improving efficiency in knowledge work.
25. Identify six risks in adopting organizational innovation.

## PROBLEMS

1. As part of a larger systems project, Clone Bank of Clone, Colorado, wants your help in setting up a new monthly reporting form for its checking and savings account customers. The president and vice presidents are very attuned to what customers in the community are saying. They think that their customers want a checking account summary that looks like the one offered by the other three banks in town. They are unwilling, however, to commit to that form without a formal summary of customer feedback that supports their decision. Feedback will not be used to change the prototype form in any way. They want you to send a prototype of one form to one group and to send the old form to another group.
  - a. In a paragraph discuss why it probably is not worthwhile to prototype the new form under these circumstances.
  - b. In a second paragraph discuss a situation under which it would be advisable to prototype a new form.

2. C. N. Itall has been a systems analyst for Tun-L-Vision Corporation for many years. When you came on board as part of the systems analysis team and suggested prototyping as part of the SDLC for a current project, C. N. said, “Sure, but you can’t pay any attention to what users say. They have no idea what they want. I’ll prototype, but I’m not ‘observing’ any users.”
  - a. As tactfully as possible, so as not to upset C. N. Itall, make a list of the reasons that support the importance of observing user reactions, suggestions, and innovations in the prototyping process.
  - b. In a paragraph, describe what might happen if part of a system is prototyped and no user feedback about it is incorporated into the successive system.
3. “Every time I think I’ve captured user information requirements, they’ve already changed. It’s like trying to hit a moving target. Half the time, I don’t think they even know what they want themselves,” exclaims Flo Chart, a systems analyst for 2 Good 2 Be True, a company that surveys product use for the marketing divisions of several manufacturing companies.
  - a. In a paragraph, explain to Flo Chart how prototyping can help her to better define users’ information requirements.
  - b. In a paragraph, comment on Flo’s observation: “Half the time, I don’t think they even know what they want themselves.” Be sure to explain how prototyping can actually help users better understand and articulate their own information requirements.
  - c. Suggest how an interactive Web site featuring a prototype might address Flo’s concerns about capturing user information requirements. Use a paragraph.
4. Harold, a district manager for the multioutlet chain of Sprocket’s Gifts, thinks that building a prototype can mean only one thing: a nonworking scale model. He also believes that this way is too cumbersome to prototype information systems and thus is reluctant to do so.
  - a. Briefly (in two or three paragraphs) compare and contrast the other three kinds of prototyping that are possible so that Harold has an understanding of what prototyping can mean.
  - b. Harold has an option of implementing one system, trying it, and then having it installed in five other Sprocket locations if it is successful. Name a type of prototyping that would fit well with this approach, and in a paragraph defend your choice.
5. “I’ve got the idea of the century!” proclaims Bea Kwicke, a new systems analyst with your systems group. “Let’s skip all this SDLC garbage and just prototype everything. Our projects will go a lot more quickly, we’ll save time and money, and all the users will feel as if we’re paying attention to them instead of going away for months on end and not talking to them.”
  - a. List the reasons you (as a member of the same team as Bea) would give Bea to dissuade her from trying to scrap the SDLC and prototype every project.
  - b. Bea is pretty disappointed with what you have said. To encourage her, use a paragraph to explain the situations you think would lend themselves to prototyping.
6. The following remark was overheard at a meeting between managers and a systems analysis team at the Fence-Me-In fencing company: “You told us the prototype would be finished three weeks ago. We’re still waiting for it!”
  - a. In a paragraph, comment on the importance of rapid delivery of a portion of a prototyped information system.
  - b. List three elements of the prototyping process that must be controlled to ensure prompt delivery of the prototype.
  - c. What are some elements of the prototyping process that are difficult to manage? List them.
7. Prepare a list of activities for a systems development team for an online travel agent that is setting up a Web site for customers. Now suppose you are running out of time. Describe some of your options. Describe what you will trade off to get the Web site released in time.
8. Given the situation for Williwonk’s chocolates (Problem 1 in Chapter 3), which of the four agile modeling resource variables may be adjusted?
9. Examine the collection of user stories from the online merchant shown earlier in the chapter. The online media store would now like to have you add some features to its Web site. Following the format shown earlier in this chapter in Figure 6.9, write a user story for the features listed below:
  - a. Include pop-up ads.
  - b. Offer to share the details of the customer’s purchases with his or her friends.
  - c. Extend offer to purchase other items.
10. Go to the Palm gear Web site at [www.palmgear.com](http://www.palmgear.com). Explore the Web site and write up a dozen brief user stories for improving the Web site.
11. Go to the iTunes Web site and write up a dozen brief user stories for improving the Web site.
12. Using the stories you wrote for Problem 9, walk through the five stages of the agile development process and describe what happens at each one of the stages.

## GROUP PROJECTS

1. Divide your group into two smaller subgroups. Have group 1 follow the processes specified in this chapter for creating prototypes. Using a CASE tool or a word processor, group 1 should devise two nonworking prototype screens using the information collected in the interviews with Maverick Transport employees accomplished in the group exercise in Chapter 4. Make any assumptions necessary to create two screens for truck dispatchers. Group 2 (playing the roles of dispatchers) should react to the prototype screens and provide feedback about desired additions and deletions.
2. The members of group 1 should revise the prototype screens based on the user comments they received. Those in group 2 should respond with comments about how well their initial concerns were addressed with the refined prototypes.
3. As a united group, write a paragraph discussing your experiences with prototyping for ascertaining information requirements.
4. Within your group, assign some of the roles that people take on in agile development. Make sure that one person is an onsite customer and at least two people are programmers. Assign other roles, as you see fit. Simulate the systems development situation discussed in Problem 7, or have the person acting as the onsite customer choose an ecommerce business with which he or she is familiar. Assume that the customer wants to add some functionality to his or her Web site. Role-play a scenario showing what each person would do if this was being approached through agile methods. Write a paragraph that discusses the constraints that each person faces in enacting his or her role.

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## EPISODE 6

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Reaction Time

"We need to get a feel for some of the output needed by the users," Anna comments. "It will help to firm up some of our ideas on the information they require."

"Agreed," replies Chip. "It will also help us determine the necessary input. From that we can design corresponding data entry screens. Let's create prototype reports and screens and get some user feedback. Why don't we use Microsoft Access to quickly create screens and reports? I'm quite familiar with the software. Let's start by writing some agile stories to summarize what is needed and then develop some prototypes. We can also use the user requirements, and should create a prototype for each 'communicates' line connecting an actor and a use case."

Anna smiles and remarks, "I've already written the following agile stories for the preventive maintenance problem." They are:

1. There is no way to know when to perform preventive maintenance on desktop computers.
2. Normally we go from room to room.
3. When a room is completed, we write it on a list.

Anna starts by developing the PREVENTIVE MAINTENANCE REPORT prototype. Based on agile stories, she sets to work creating the prototype of the report she feels Mike Crowe will need.

"This report should be used to predict when machines should have preventive maintenance," Anna thinks. "It seems to me that Mike would need to know *which* machine needs work performed as well as *when* the work should be scheduled. Now let's see, what information would identify the machine clearly? The inventory number, brand name, and model would identify the machine. I imagine the room and campus should be included to quickly locate the machine. A calculated maintenance date would tell Mike when the work should be completed. What sequence should the report be in? Probably the most useful would be by location."

The PREVENTIVE MAINTENANCE REPORT prototype showing the completed report is shown in Figure E6.1. Notice that Xxxxxx's and generic dates are used to indicate where data should be printed. Realistic campus and room locations as well as inventory numbers are included. They are necessary for Microsoft Access to accomplish group printing.

The report prototype is soon finished. After printing the final copy, Anna takes the report to both Mike Crowe and Dot Matricks. Mike Crowe is enthusiastic about the project and wants to know when the report will be in production. Dot is similarly impressed.

Several changes come up. Mike wants an area to write in the completion date of the preventive maintenance so the report can be used to reenter the dates into the computer. She also suggests that the report title be changed to WEEKLY PREVENTIVE MAINTENANCE REPORT. The next steps are to modify the prototype report to reflect the recommended changes and then have both Mike and Dot review the result.

The report is easily modified and printed. Dot is pleased with the final result. "This is really a fine method for designing the system," she comments. "It's so nice to feel that we are a part of the development process and that our opinions count. I'm starting to feel quite confident that the final system will be just what we've always wanted."

Mike has similar praise, observing, "This will make our work so much smoother. It eliminates the guesswork about which machines need to be maintained. And sequencing them by room is a fine idea. We won't have to spend so much time returning to rooms to work on machines."

Chip makes a note about each of these modifications on a Prototype Evaluation Form (like Figure 6.3 in the chapter). This form gets Chip organized and documents the prototyping process.

Chip and Anna next turn their attention to creating screen prototypes. "Because I like the hardware aspect of the system, why don't I start working on the ADD NEW COMPUTER screen design?" asks Chip.

"Sounds good to me," Anna replies. "I'll focus on the software aspects."

Chip analyzes the results of detailed interviews with Dot and Mike. He compiles a list of elements that each user would need when adding a computer. Other elements, such as location and maintenance information, would update the COMPUTER MASTER later, after the machine was installed.

"Having the database tables defined sure helps to make quick prototypes," Chip comments. "It didn't take very long to complete the screen. Would you like to watch me test the prototype?"

"Sure," replies Anna. "This is my favorite part of prototyping."

**FIGURE E6.1**

Prototype for PREVENTIVE MAINTENANCE REPORT. This report needs to be revised.

Preventive Maintenance Report					
Week of 6/1/10					
Campus Location	Room Location	Inventory Brand Name Number	Model	Page 1 of 1	
Central Administration	11111	84004782 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Administration	11111	90875039 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Administration	11111	93955411 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Administration	11111	99381373 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Administration	22222	10220129 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Administration	99999	22838234 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Administration	99999	24720952 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Administration	99999	33453403 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Administration	99999	34044449 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Administration	99999	40030303 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Administration	99999	47403948 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Administration	99999	56620548 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Computer Science	22222	34589349 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Computer Science	22222	38376910 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Computer Science	22222	94842282 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Zoology	22222	339393 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Zoology	22222	11398423 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Zoology	99999	28387465 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	4/4/10	—
Central Zoology	99999	70722533 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—
Central Zoology	99999	99481102 XXXXXXXXXXXXXXXXX	Xxxxxxxxxxxxxxxxxxxxxx	3/24/10	—

Chip executes the screen design as Anna, Mike, and Dot watch. The drop-down lists and check boxes make it easy to enter accurate data.

"I really like this," Dot says. "May I try adding some data?"

"Be my guest," replies Chip. "Try to add both invalid and valid data. And notice the help messages that appear at the bottom of the screen to indicate what should be entered. Why don't you try out this prototype for a day or two and get back to me? Then I'll make the changes that you recommend and have you review the revised prototype."

Anna returns to her desk and creates the ADD SOFTWARE RECORD screen design.

When Anna completes the screen design, she asks Cher to test the prototype. Cher keys information in, checks the drop-down list values, and views help messages.

"I really like the design of this screen and how it looks," remarks Cher. "It lacks some of the fields that would normally be included when a software package is entered, though, like the computer type that the software runs on, the memory required, and the processor speed. I would also like buttons to save the record and exit."

"Those are all doable. I'll make the changes and get back to you," replies Anna, making some notes to herself.

A short time later, Cher again tests the ADD SOFTWARE RECORD screen. It includes all the features that she requires. The completed screen design may be viewed using Microsoft Access. Notice that there is a line separating the software information from the hardware entries.

A few days later Dot visits Anna with suggested changes for the ADD NEW COMPUTER prototype. "I reviewed this with Mike and we like what we have seen, but we have some suggestions," remarks Dot. "One of the things that is missing is the operating system. We have a number of technical people that have multiple operating systems. Many of the Mac users have Windows installed on their Macs, and some of the

Windows users have Linux-type operating systems installed. We need to include multiple operating systems on the ADD NEW COMPUTER screen.”

“This will take some time to update the tables and prototypes,” comments Chip after a lengthy pause. “But this is why we use short cycles to develop, test, and get feedback. I’ll modify the prototype and get back to you.”

After some thought and reworking of database tables, the prototype is modified and sent to Mike for approval. After a few days, Mike stops in with some feedback. “This looks great!” exclaims Mike. “However, I realized that there are some additional requirements that I forgot to tell you about. We have a refresh program that replaces computers after an interval of time. The time period varies by type of machine and when it was purchased. When we purchase the machine, we estimate the refresh interval. Can we have the refresh interval added to the database and the prototype? We could use it to calculate the refresh date, and periodically scan the Computer Master for all computers that need to be refreshed.”

Chip starts working on the modifications. “This agile development is interesting,” he says, grinning at Anna. “I can see why it’s used to discover the requirements.”

The final version of the ADD NEW COMPUTER prototype screen created with Access is shown in Figure E6.2. Placed on the top of the screen are the current date and time as well as a centered screen title. Field captions are placed on the screen, with the characters left aligned. Check boxes are included for the warranty field, as well as a drop-down list for the type of optical drive. An operating system subform is included to select multiple operating systems in the lower right portion of the screen. “Add Record” and “Print” buttons are included.

“Chip, I was speaking with Dot and she mentioned that there has been funding for putting some of the information on the Web, as part of the Web site for technology support at CPU,” comments Anna, looking up from her computer. “I have been busy creating a prototype for the Web page menus and the first screen, one to report technology problems. Because solving problems is Mike’s area, I have invited him and Dot to review the prototype. Care to join the session?”

“Sure,” replies Chip. “I am interested in working on the design of some of the Web pages.”

A short time later Mike, Dot, and Chip are gathered around Anna as she demonstrates the Web page, illustrated in Figure E6.3.

“I really like the menu style,” comments Dot. “The main menu features drop-down submenus on the top that are easy to use, and I like the way they drop down and the menu items change color when the mouse moves over them.”

“Yes, and having submenus drop down below the main one for the features of each choice makes it easy to find what you are looking for,” adds Mike. “I do have some suggestions for the Web page for reporting problems, though. It would be more useful if the Problem Category selection area were moved to the top of the page. Each problem type is assigned to a different technician, one who is more or less an expert in that area. We need an additional check box to identify if it is a Macintosh or a Windows machine or software we are working with. The Tag Number help is a great idea. Many people do not realize that each piece of equipment has a small metal identifying tag on it with a unique inventory number. Hmm. . . . That large blue area seems to stand out too much. After all, it is just help. I think that it would be better to replace it with a small graphic image.”

**FIGURE E6.2**

Prototype for the ADD NEW COMPUTER screen. Microsoft Access was used as the prototyping tool. Improvements can be made at this stage.

Operating System		Operating System Code
Mac OS X Leopard		
Windows XP		
*		

Record: [navigation buttons] 1 [next button] \* of 2

The warranty length of time in years

**FIGURE E6.3**

Prototype for the PROBLEM REPORTING SYSTEM Web page. This Web page needs some improvement.

"I think that these changes will be easy to do," remarks Anna.

"Great," replies Mike. "It would also be useful to include the tech support hotline phone number on the Web page. If it's a real emergency, it might speed up our resolution to the problem. We should add an entry field for their phone number as well. Of course, we could always look it up, but the person reporting the problem may be in a computer lab or another location away from his office."

"Good idea!" exclaims Dot. "This is going to be extremely helpful to the faculty and staff. I think that we should prototype all the Web pages for the site. I realize that Web pages are supposed to change from time to time, but let's get these as good as possible from the start! Why don't you look these over and give us feedback in a few days?"

Anna glances at Chip and grins. "I guess you'll be working on Web page design sooner than you think!"

A few days later Mike stops back with additional feedback on the Web design. "This Web page looks good," grins Mike, "But it got me thinking. We have an image of all the software on each lab computer. When there is a problem, such as a virus or bad hard drive, we fix it and re-image the machine. However each lab has different requirements for the software that should be on the machine. Additionally, we ask the faculty if the image needs updating. This usually happens at the end of the spring semester and we work on it over the summer. Can you whip up a couple of Web page prototypes for us to review? One should have a list of all the software, including browsers, virus detection, and other standard packages, that are included for each machine in a given room. Another Web page would be used for faculty to update the image list."

"Whew, that's a tall order," replies Anna with a thoughtful look. "We'll work on it."

Anna and Chip continued to work on prototypes by designing, obtaining user feedback, and modifying the design to accommodate user changes. Now that the work is complete, they have a solid sense of the requirements of the system.

"This is becoming a large project," comments Anna as she looks at the large amount of prototypes that have been assembled. "I don't think that we can develop all this software in the allotted amount of time."

"I agree with you—you seem to have a good sense about this," replies Chip thoughtfully. "We only have six months of development time to complete the project, including the Web pages. There's a lot of server code and JavaScript to write."

Anna puts down a stack of prototype evaluation forms and looks directly at Chip. "What are our options?"

Chip takes a moment to reflect and replies, "Well, compromising quality is not an option, and the due date is inflexible. That leaves cost and scope as trade-offs."

"Cost is somewhat fixed," replies Anna. "Dot and Paige have said in no uncertain terms that there are so many software development projects that we have to stay within our budget."

"Well, that means that we will have to reduce the scope of the project," says Chip after a moment. "We will work on the high priority items first."

"What about sacrificing a 40 hour workweek?" chides Anna.

"Not an option," grins Chip. "After all, it's a core value!"

## EXERCISES

Critique the report and screen prototypes for the exercises below (E-1 through E-10). Record the changes on a copy of the Prototype Evaluation Form. Use Microsoft Access to view the prototypes, then modify the report and screen prototypes with the suggested changes. Print the final prototypes.

Use the following guidelines to help in your analysis:

1. **Alignment of fields on reports.** Are the fields aligned correctly? Are report column headers aligned correctly over the columns? If the report has captions to the left of data fields, are they aligned correctly (usually on the left)? Are the data aligned correctly *within* each entry field?
2. **Report content.** Does the report contain all the necessary data? Are appropriate and useful totals and subtotals present? Are there extra totals or data that should not be on the report? Are codes or the meaning of the codes printed on the report (codes should be avoided because they may not clearly present the user with information)?
3. **Check the visual appearance of the report.** Does it look pleasing? Are repeating fields group printed (that is, the data should print only once, at the beginning of the group)? Are there enough blank lines between groups to easily identify them?
4. **Screen data and caption alignment.** Are the captions correctly aligned on the screens? Are the data fields correctly aligned? Are the data *within* a field correctly aligned?
5. **Screen visual appearance.** Does the screen have a pleasing appearance? Is there enough vertical spacing between fields? Is there enough horizontal spacing between columns? Are the fields logically grouped together? Are features, such as buttons and check boxes, grouped together?
6. **Does the screen contain all the necessary functional elements?** Look for missing buttons that would help the user work smoothly with the screen; also look for missing data, extra unnecessary data, or fields that should be replaced with a check box or drop-down list.

E-1. The HARDWARE INVENTORY LISTING shows all personal computers, sorted by campus and room.



E-2. The SOFTWARE INVESTMENT REPORT is used to calculate the total amount invested in software.



E-3. The INSTALLED COMPUTER REPORT shows the information for installed machines.



E-4. The prototype for the COMPUTER PROBLEM REPORT lists all machines sorted by the total cost of repairs and includes the number of repairs (some machines do not have a high cost, because they are still under warranty). This prototype is used to calculate the total cost of repairs for the entire university, as well as to identify the problem machines.



E-5. The NEW SOFTWARE INSTALLED REPORT shows the number of machines with each software package that are installed in each room of each campus.



E-6. The SOFTWARE CROSS-REFERENCE REPORT lists all locations for each version of each software package.



E-7. The DELETE COMPUTER RECORD screen is used to select computers to remove from the system. The entry area is the Hardware Inventory Number field. The other fields are for display only, to identify the machine. The users would like the ability to print each record before they delete it. They also want to scroll to the next and previous records. *Hint:* Examine the fields shown in the HARDWARE INVENTORY LISTING report.



E-8. An UPDATE MAINTENANCE INFORMATION screen enables Mike Crowe to change maintenance information about personal computers. Sometimes these are routine changes, such as the LAST PREVENTIVE MAINTENANCE DATE or the NUMBER OF REPAIRS, but other changes may occur only sporadically, such as the expiration of a warranty. The HARDWARE INVENTORY NUMBER is entered, and the matching COMPUTER RECORD is found. The BRAND and MODEL are displayed for feedback. The operator may then change the WARRANTY, MAINTENANCE INTERVAL, NUMBER OF REPAIRS, LAST PREVENTIVE MAINTENANCE DATE, and TOTAL COST OF REPAIRS fields. Mike would like to print the screen information, as well as undo any changes, easily.



E-9. The SOFTWARE LOCATION INQUIRY displays information about rooms and machines containing selected software. The TITLE, VERSION NUMBER, and OPERATING SYSTEM are entered. The output portion of the screen should show the CAMPUS LOCATION, ROOM LOCATION, HARDWARE INVENTORY NUMBER, BRAND NAME, and MODEL. Buttons allow the user to move to the next record, the previous record, and to close and exit the screen.

- E-10. The UPDATE LAB IMAGE Web page prototype is shown in Figure E6.4. Review this Web page and suggest changes.

The screenshot shows a Mozilla Firefox browser window displaying a web page titled "CENTRAL PACIFIC UNIVERSITY Classroom and Lab Software Image Update". The page includes a navigation bar with links for Home, Problem, Training, Software, Classroom, Resources, Other, and Search. A logo for Central Pacific University (CPU) is visible. The main content area contains instructions for updating software in a lab room, followed by a table of current software installations. At the bottom, there is a search field and three buttons: View Software, Send Image Request, and Clear Form.

Check to remove	Software Title	Version	New Software Version
<input type="checkbox"/>	Windows	Vista	<input type="text"/>
<input type="checkbox"/>	Microsoft Office	2007	<input type="text"/>
<input type="checkbox"/>	McAfee Virus Scan	8.5	<input type="text"/>
<input type="checkbox"/>	VM Ware	V6	<input type="text"/>
<input type="checkbox"/>	Ubuntu	9	<input type="text"/>

**FIGURE E6.4**

Prototype for the UPDATE LAB IMAGE Web page. This Web page needs some improvement.

The exercises preceded by a Web-icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Visible Analyst Project and a Microsoft Access database that can be used to complete the exercises.

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# Using Data Flow Diagrams

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Comprehend the importance of using logical and physical data flow diagrams (DFDs) to graphically depict data movement for humans and systems in an organization.
2. Create, use, and explode logical DFDs to capture and analyze the current system through parent and child levels.
3. Develop and explode logical DFDs that illustrate the proposed system.
4. Produce physical DFDs based on logical DFDs you have developed.
5. Understand and apply the concept of partitioning of physical DFDs.



The systems analyst needs to make use of the conceptual freedom afforded by data flow diagrams, which graphically characterize data processes and flows in a business system. In their original state, data flow diagrams depict the broadest possible overview of system inputs, processes, and outputs, which correspond to those of the general systems model discussed in

Chapter 2. A series of layered data flow diagrams may be used to represent and analyze detailed procedures in the larger system.

## THE DATA FLOW APPROACH TO HUMAN REQUIREMENTS DETERMINATION

When systems analysts attempt to understand the information requirements of users, they must be able to conceptualize how data move through the organization, the processes or transformation that the data undergo, and what the outputs are. Although interviews and the investigation of hard data provide a verbal narrative of the system, a visual depiction can crystallize this information for users and analysts in a useful way.

Through a structured analysis technique called data flow diagrams (DFDs), the systems analyst can put together a graphical representation of data processes throughout the organization. By using combinations of only four symbols, the systems analyst can create a pictorial depiction of processes that will eventually provide solid system documentation.

### Advantages of the Data Flow Approach

The data flow approach has four chief advantages over narrative explanations of the way data move through the system:

1. Freedom from committing to the technical implementation of the system too early.
2. Further understanding of the interrelatedness of systems and subsystems.
3. Communicating current system knowledge to users through data flow diagrams.
4. Analysis of a proposed system to determine if the necessary data and processes have been defined.

Perhaps the biggest advantage lies in the conceptual freedom found in the use of the four symbols (covered in the upcoming subsection on DFD conventions). (You will recognize three of the symbols from Chapter 2.) None of the symbols specifies the physical aspects of implementation. DFDs emphasize the processing of data or the transforming of data as they move through a variety of processes. In logical DFDs, there is no distinction between manual or automated processes. Neither are the processes graphically depicted in chronological order. Rather, processes are eventually grouped together if further analysis dictates that it makes sense to do so. Manual processes are put together, and automated processes can also be paired with each other. This concept, called *partitioning*, is taken up in a later section.

### Conventions Used in Data Flow Diagrams

Four basic symbols are used to chart data movement on data flow diagrams: a double square, an arrow, a rectangle with rounded corners, and an open-ended rectangle (closed on the left side and open ended on the right), as shown in Figure 7.1. An entire system and numerous subsystems can be depicted graphically with these four symbols in combination.

The double square is used to depict an external entity (another department, a business, a person, or a machine) that can send data to or receive data from the system. The external entity, or just entity, is also called a source or destination of data, and it is considered to be external to the system being described. Each entity is labeled with an appropriate name. Although it interacts with the system, it is considered as outside the boundaries of the system. Entities should be named with a noun. The same entity may be used more than once on a given data flow diagram to avoid crossing data flow lines.

The arrow shows movement of data from one point to another, with the head of the arrow pointing toward the data's destination. Data flows occurring simultaneously can be depicted doing just that through the use of parallel arrows. Because an arrow represents data about a person, place, or thing, it too should be described with a noun.

A rectangle with rounded corners is used to show the occurrence of a transforming process. Processes always denote a change in or transformation of data; hence, the data flow leaving a process is *always* labeled differently than the one entering it. Processes represent work being

**FIGURE 7.1**

The four basic symbols used in data flow diagrams, their meanings, and examples.

Symbol	Meaning	Example
	Entity	
	Data Flow	
	Process	
	Data Store	

performed in the system and should be named using one of the following formats. A clear name makes it easier to understand what the process is accomplishing.

1. When naming a high-level process, assign the process the name of the whole system. An example is INVENTORY CONTROL SYSTEM.
2. When naming a major subsystem, use a name such as INVENTORY REPORTING SUBSYSTEM or INTERNET CUSTOMER FULFILLMENT SYSTEM.
3. When naming detailed processes, use a verb-adjective-noun combination. The verb describes the type of activity, such as COMPUTE, VERIFY, PREPARE, PRINT, or ADD. The noun indicates what the major outcome of the process is, such as REPORT or RECORD. The adjective illustrates which specific output, such as BACKORDERED or INVENTORY, is produced. Examples of complete process names are COMPUTE SALES TAX, VERIFY CUSTOMER ACCOUNT STATUS, PREPARE SHIPPING INVOICE, PRINT BACK-ORDERED REPORT, SEND CUSTOMER EMAIL CONFIRMATION, VERIFY CREDIT CARD BALANCE, and ADD INVENTORY RECORD.

A process must also be given a unique identifying number indicating its level in the diagram. This organization is discussed later in this chapter. Several data flows may go into and out of each process. Examine processes with only a single flow in and out for missing data flows.

The last basic symbol used in data flow diagrams is an open-ended rectangle, which represents a data store. The rectangle is drawn with two parallel lines that are closed by a short line on the left side and are open ended on the right. These symbols are drawn only wide enough to allow identifying lettering between the parallel lines. In logical data flow diagrams, the type of physical storage is not specified. At this point the data store symbol is simply showing a depository for data that allows examination, addition, and retrieval of data.

The data store may represent a manual store, such as a filing cabinet, or a computerized file or database. Because data stores represent a person, place, or thing, they are named with a noun. Temporary data stores, such as scratch paper or a temporary computer file, are not included on the data flow diagram. Give each data store a unique reference number, such as D1, D2, D3, and so on.

## DEVELOPING DATA FLOW DIAGRAMS

Data flow diagrams can and should be drawn systematically. Figure 7.2 summarizes the steps involved in successfully completing data flow diagrams. First, the systems analyst needs to conceptualize data flows from a top-down perspective.

To begin a data flow diagram, collapse the organization's system narrative (or story) into a list with the four categories of external entity, data flow, process, and data store. This list in turn helps determine the boundaries of the system you will be describing. Once a basic list of data elements has been compiled, begin drawing a context diagram.

Here are a few basic rules to follow:

1. The data flow diagram must have at least one process, and must not have any freestanding objects or objects connected to themselves.
2. A process must receive at least one data flow coming into the process and create at least one data flow leaving from the process.
3. A data store should be connected to at least one process.
4. External entities should not be connected to each other. Although they communicate independently, that communication is not part of the system we design using DFDs.

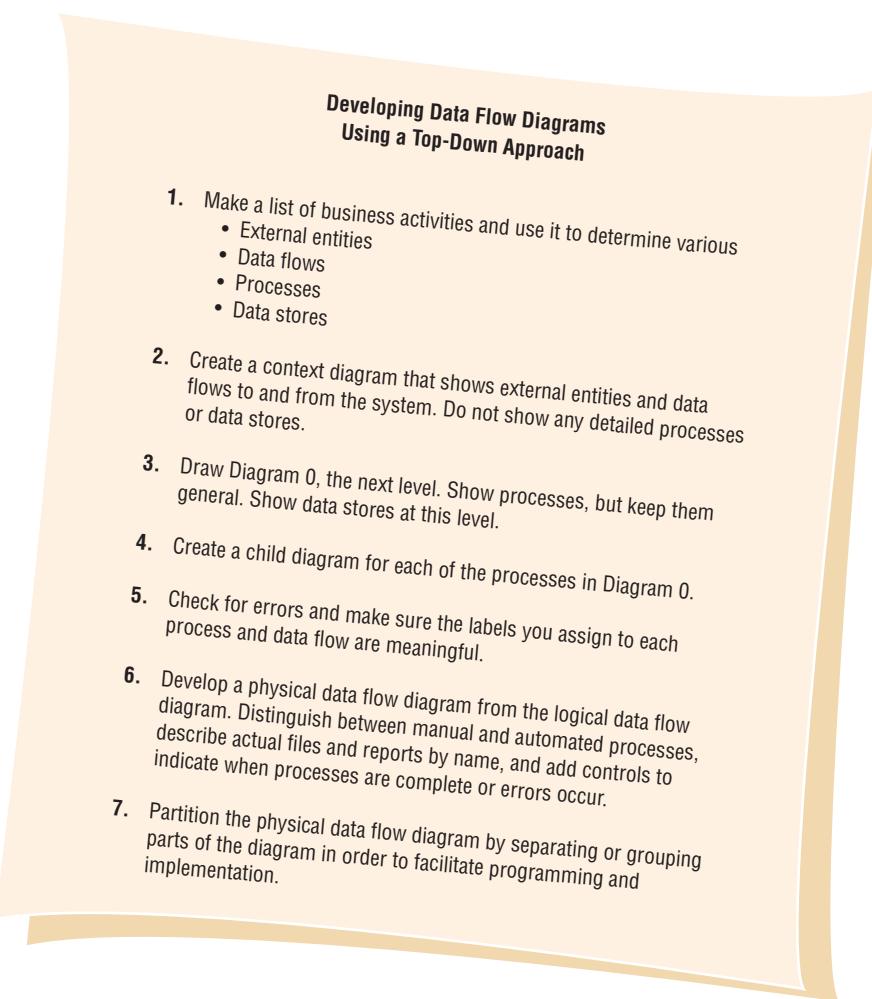
### Creating the Context Diagram

With a top-down approach to diagramming data movement, the diagrams move from general to specific. Although the first diagram helps the systems analyst grasp basic data movement, its general nature limits its usefulness. The initial context diagram should be an overview, one including basic inputs, the general system, and outputs. This diagram will be the most general one, really a bird's-eye view of data movement in the system and the broadest possible conceptualization of the system.

The context diagram is the highest level in a data flow diagram and contains only one process, representing the entire system. The process is given the number zero. All external entities are shown

**FIGURE 7.2**

Steps in developing data flow diagrams.



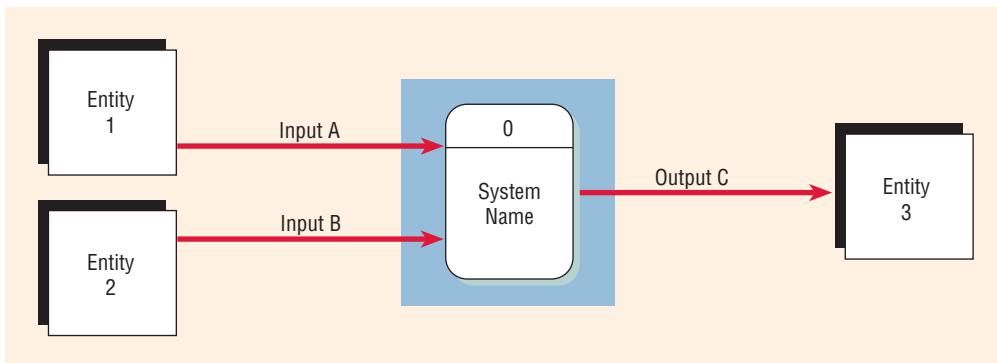
on the context diagram, as well as major data flow to and from them. The diagram does not contain any data stores and is fairly simple to create, once the external entities and the data flow to and from them are known to analysts.

### Drawing Diagram 0 (The Next Level)

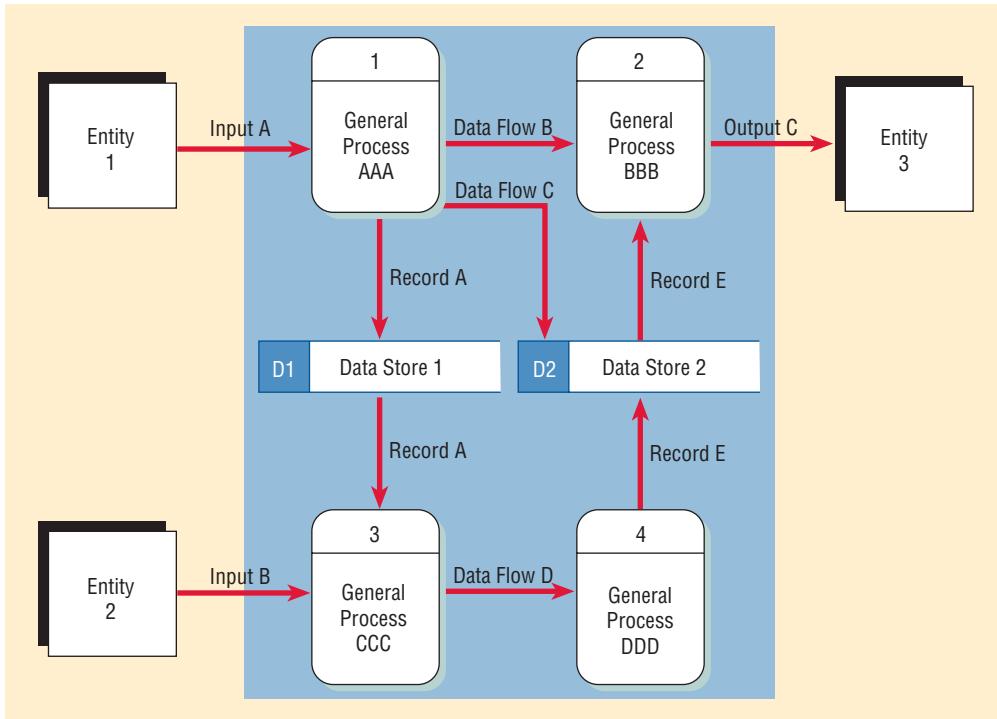
More detail than the context diagram permits is achievable by “exploding the diagrams.” Inputs and outputs specified in the first diagram remain constant in all subsequent diagrams. The rest of the original diagram, however, is exploded into close-ups involving three to nine processes and showing data stores and new lower-level data flows. The effect is that of taking a magnifying glass to view the original data flow diagram. Each exploded diagram should use only a single sheet of paper. By exploding DFDs into subprocesses, the systems analyst begins to fill in the details about data movement. The handling of exceptions is ignored for the first two or three levels of data flow diagramming.

Diagram 0 is the explosion of the context diagram and may include up to nine processes. Including more processes at this level will result in a cluttered diagram that is difficult to understand. Each process is numbered with an integer, generally starting from the upper left-hand corner of the diagram and working toward the lower right-hand corner. The major data stores of the system (representing master files) and all external entities are included on Diagram 0. Figure 7.3 schematically illustrates both the context diagram and Diagram 0.

Because a data flow diagram is two-dimensional (rather than linear), you may start at any point and work forward or backward through the diagram. If you are unsure of what you would include at any point, take a different external entity, process, or data store, and then start drawing the flow from it. You may:

**FIGURE 7.3**

Context diagrams (above) can be “exploded” into Diagram 0 (below). Note the greater detail in Diagram 0.



1. Start with the data flow from an entity on the input side. Ask questions such as: “What happens to the data entering the system?” “Is it stored?” “Is it input for several processes?”
2. Work backward from an output data flow. Examine the output fields on a document or screen. (This approach is easier if prototypes have been created.) For each field on the output, ask: “Where does it come from?” or “Is it calculated or stored on a file?” For example, when the output is a PAYCHECK, the EMPLOYEE NAME and ADDRESS would be located on an EMPLOYEE file, the HOURS WORKED would be on a TIME RECORD, and the GROSS PAY and DEDUCTIONS would be calculated. Each file and record would be connected to the process that produces the paycheck.
3. Examine the data flow to or from a data store. Ask: “What processes put data into the store?” or “What processes use the data?” Note that a data store used in the system you are working on may be produced by a different system. Thus, from your vantage point, there may not be any data flow into the data store.
4. Analyze a well-defined process. Look at what input data the process needs and what output it produces. Then connect the input and output to the appropriate data stores and entities.
5. Take note of any fuzzy areas where you are unsure of what should be included or what input or output is required. Awareness of problem areas will help you formulate a list of questions for follow-up interviews with key users.

### Creating Child Diagrams (More Detailed Levels)

Each process on Diagram 0 may in turn be exploded to create a more detailed child diagram. The process on Diagram 0 that is exploded is called the *parent process*, and the diagram that results is called the *child diagram*. The primary rule for creating child diagrams, vertical balancing, dictates that a child diagram cannot produce output or receive input that the parent process does not also produce or receive. All data flow into or out of the parent process must be shown flowing into or out of the child diagram.

The child diagram is given the same number as its parent process in Diagram 0. For example, process 3 would explode to Diagram 3. The processes on the child diagram are numbered using the parent process number, a decimal point, and a unique number for each child process. On Diagram 3, the processes would be numbered 3.1, 3.2, 3.3, and so on. This convention allows the analyst to trace a series of processes through many levels of explosion. If Diagram 0 depicts processes 1, 2, and 3, the child diagrams 1, 2, and 3 are all on the same level.

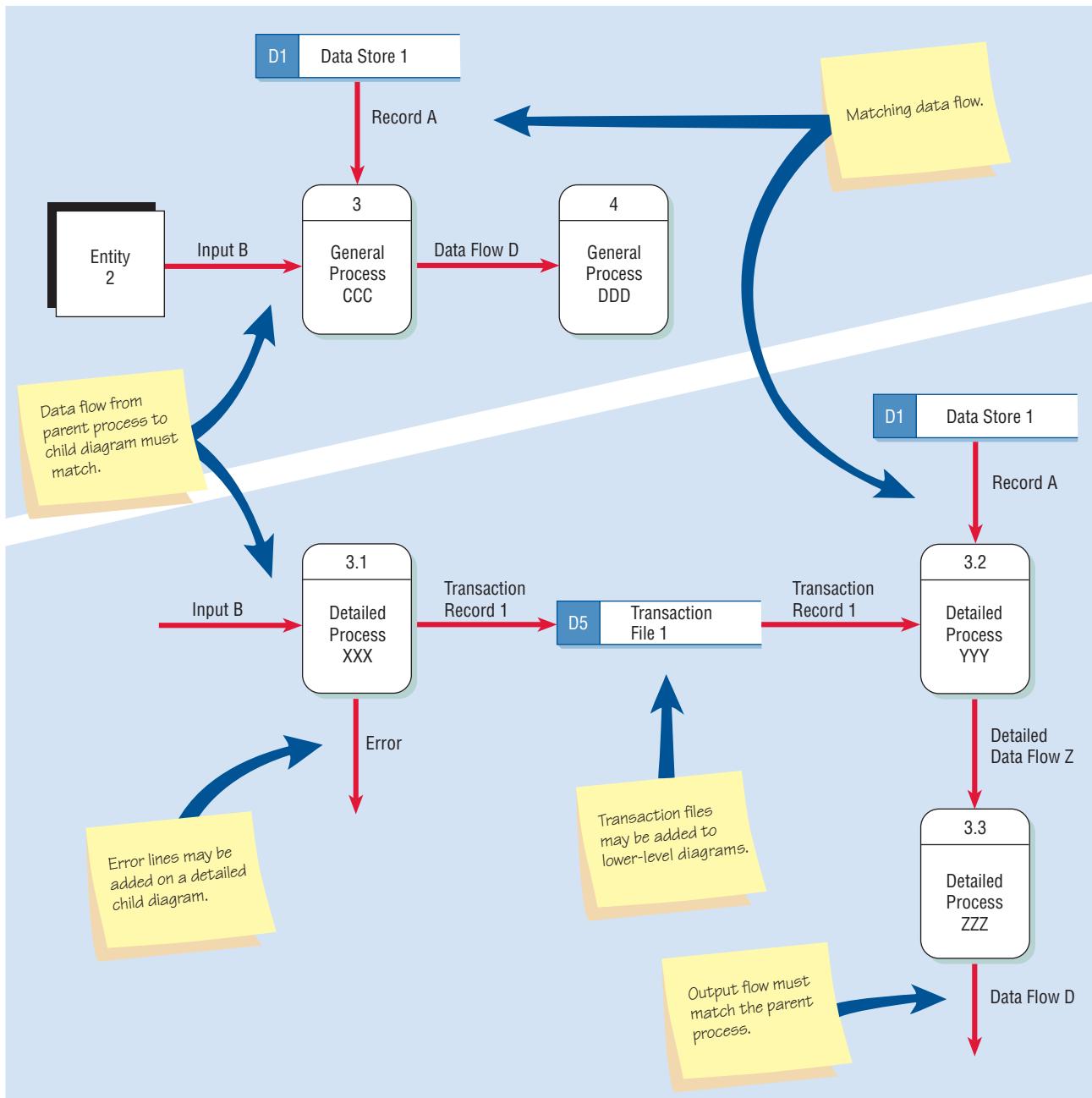
Entities are usually not shown on the child diagrams below Diagram 0. Data flow that matches the parent flow is called an *interface data flow* and is shown as an arrow from or into a blank area of the child diagram. If the parent process has data flow connecting to a data store, the child diagram may include the data store as well. In addition, this lower-level diagram may contain data stores not shown on the parent process. For example, a file containing a table of information, such as a tax table, or a file linking two processes on the child diagram may be included. Minor data flow, such as an error line, may be included on a child diagram but not on the parent.

Processes may or may not be exploded, depending on their level of complexity. When a process is not exploded, it is said to be functionally primitive and is called a *primitive process*. Logic is written to describe these processes and is discussed in detail in Chapter 9. Figure 7.4 illustrates detailed levels in a child data flow diagram.

### Checking the Diagrams for Errors

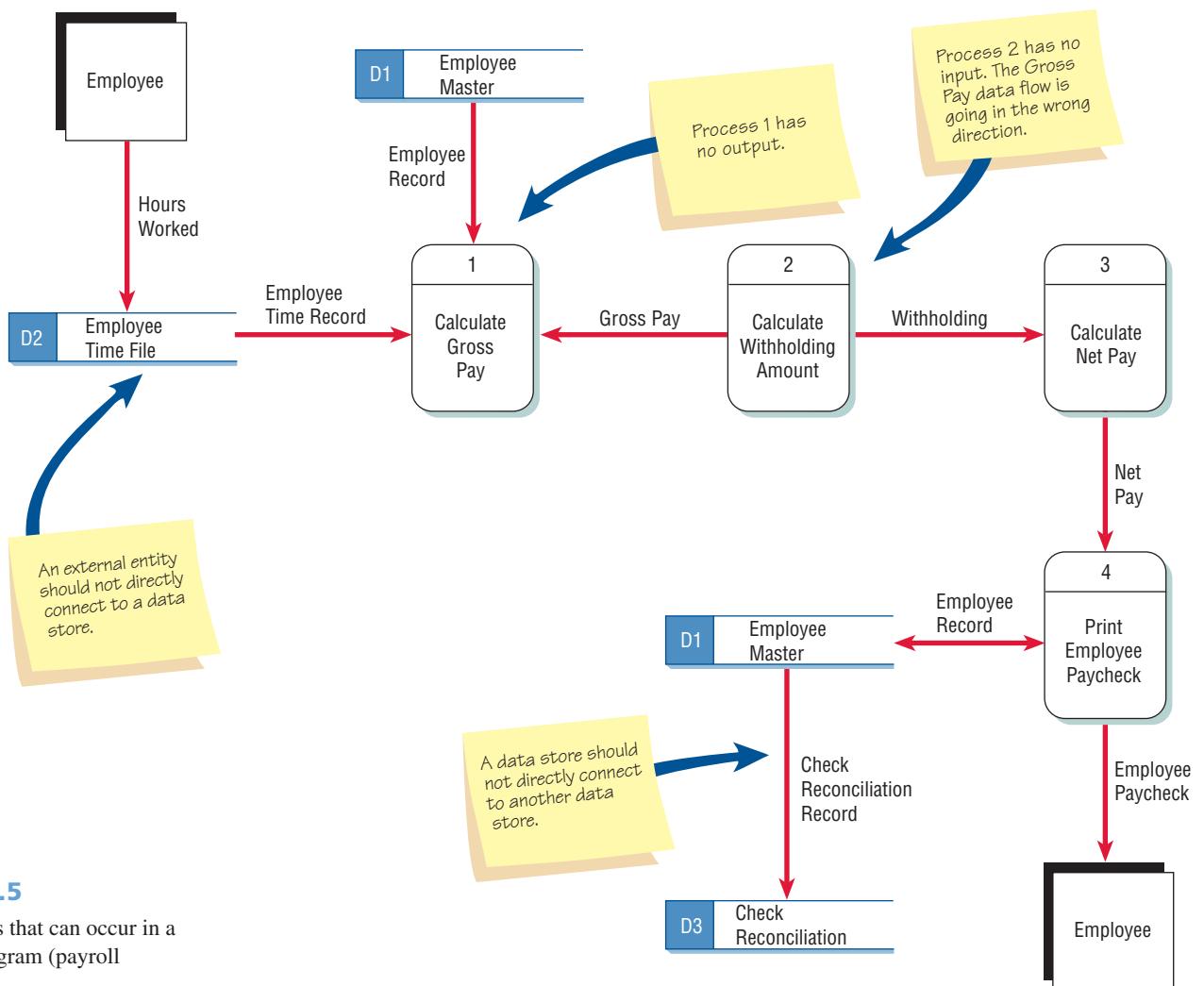
Several common errors made when drawing data flow diagrams are as follows:

1. Forgetting to include a data flow or pointing an arrow in the wrong direction. An example is a drawn process showing all its data flow as either input or output. Each process transforms data and must receive input and produce output. This type of error usually occurs when the analyst has forgotten to include a data flow or has placed an arrow pointing in the wrong direction. Process 1 in Figure 7.5 contains only input because the GROSS PAY arrow is pointing in the wrong direction. This error also affects process 2, CALCULATE WITHHOLDING AMOUNT, which is in addition missing a data flow representing input for the withholding rates and the number of dependents.
2. Connecting data stores and external entities directly to each other. Data stores and entities may not be connected to each other; data stores and external entities must connect only with a process. A file does not interface with another file without the help of a program or a person moving the data, so EMPLOYEE MASTER cannot directly produce the CHECK RECONCILIATION file. External entities do not directly work with files. For example, you would not want a customer rummaging around in the customer master file. Thus, the EMPLOYEE does not create the EMPLOYEE TIME FILE. Two external entities directly connected indicate that they wish to communicate with each other. This connection is not included on the data flow diagram unless the system is facilitating the communication. Producing a report is an instance of this sort of communication. A process must still be interposed between the entities to produce the report, however.
3. Incorrectly labeling processes or data flow. Inspect the data flow diagram to ensure that each object or data flow is properly labeled. A process should indicate the system name or use the verb-adjective-noun format. Each data flow should be described with a noun.
4. Including more than nine processes on a data flow diagram. Having too many processes creates a cluttered diagram that is confusing to read and hinders rather than enhances communication. If more than nine processes are involved in a system, group some of the processes that work together into a subsystem and place them in a child diagram.

**FIGURE 7.4**

Differences between the parent diagram (above) and the child diagram (below).

5. Omitting data flow. Examine your diagram for linear flow, that is, data flow in which each process has only one input and one output. Except in the case of very detailed child data flow diagrams, linear data flow is somewhat rare. Its presence usually indicates that the diagram has missing data flow. For instance, the process CALCULATE WITHHOLDING AMOUNT needs the number of dependents that an employee has and the WITHHOLDING RATES as input. In addition, NET PAY cannot be calculated solely from the WITHHOLDING, and the EMPLOYEE PAYCHECK cannot be created from the NET PAY alone; it also needs to include an EMPLOYEE NAME, as well as the current and year-to-date payroll and WITHHOLDING AMOUNT figures.
6. Creating unbalanced decomposition (or explosion) in child diagrams. Each child diagram should have the same input and output data flow as the parent process. An exception to this rule is minor output, such as error lines, which are included only on the child diagram. The



The data flow diagram in Figure 7.6 is correctly drawn. Note that although the data flow is not linear, you can clearly follow a path directly from the source entity to the destination entity.

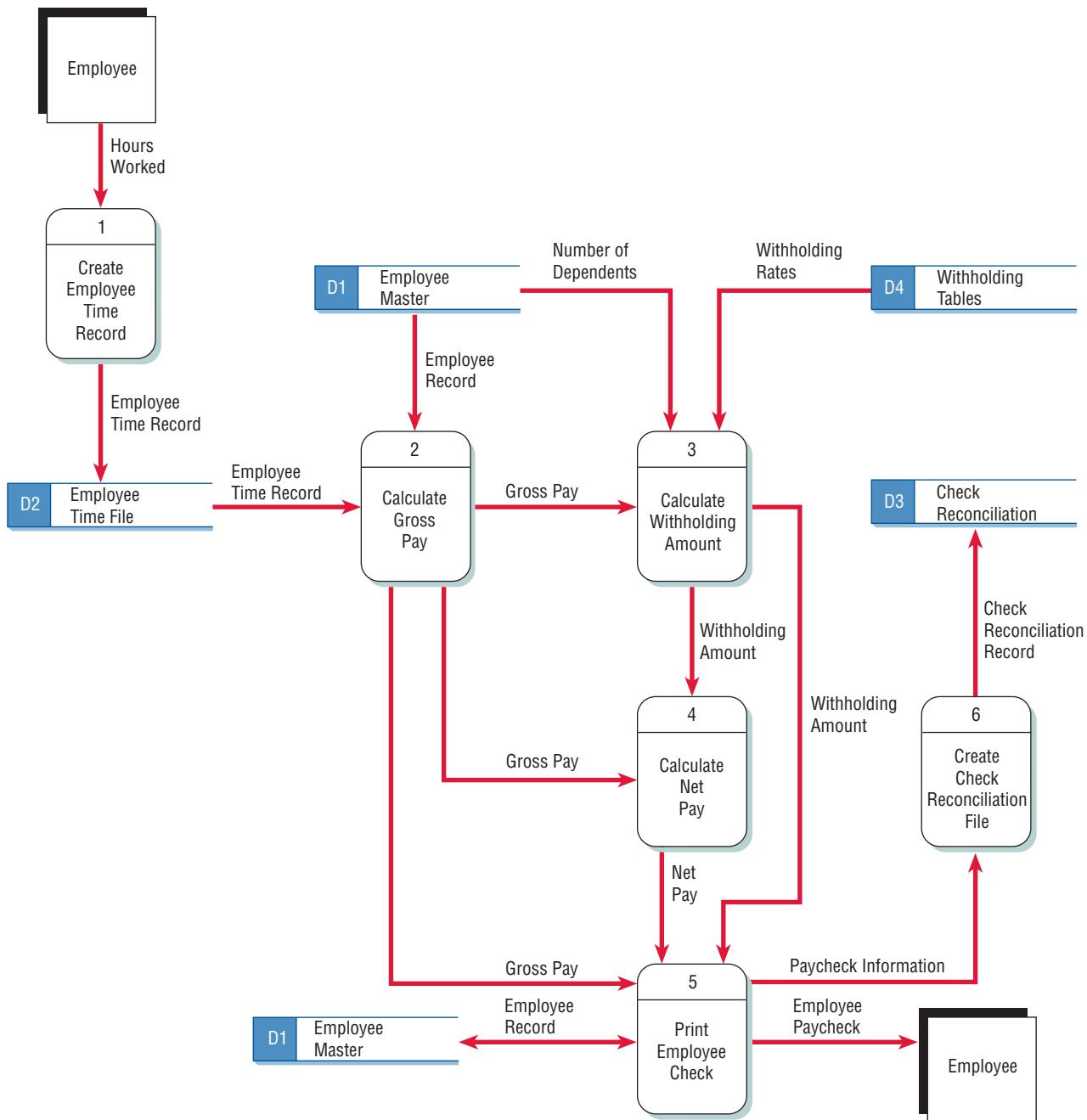
## LOGICAL AND PHYSICAL DATA FLOW DIAGRAMS

Data flow diagrams are categorized as either logical or physical. A logical data flow diagram focuses on the business and how the business operates. It is not concerned with how the system will be constructed. Instead, it describes the business events that take place and the data required and produced by each event. Conversely, a physical data flow diagram shows how the system will be implemented, including the hardware, software, files, and people involved in the system. The chart shown in Figure 7.7 contrasts the features of logical and physical models. Notice that the logical model reflects the business, whereas the physical model depicts the system.

Ideally, systems are developed by analyzing the current system (the current logical DFD) and then adding features that the new system should include (the proposed logical DFD). Finally, the best methods for implementing the new system should be developed (the physical DFD). This progression is shown in Figure 7.8.

Developing a logical data flow diagram for the current system affords a clear understanding of how the current system operates, and thus a good starting point for developing the logical model of the current system. This time-consuming step is often omitted so as to go straight to the proposed logical DFD.

One argument in favor of taking the time to construct the logical data flow diagram of the current system is that it can be used to create the logical data flow diagram of the new system.

**FIGURE 7.6**

The correct data flow diagram for the payroll example.

Processes that will be unnecessary in the new system may be dropped, and new features, activities, output, input, and stored data may be added. This approach provides a means of ensuring that the essential features of the old system are retained in the new system. In addition, using the logical model for the current system as a basis for the proposed system provides for a gradual transition to the design of the new system. After the logical model for the new system has been developed, it may be used to create a physical data flow diagram for the new system.

Figure 7.9 shows a logical data flow diagram and a physical data flow diagram for a grocery store cashier. The CUSTOMER brings the ITEMS to the register; PRICES for all ITEMS are LOOKED UP and then totaled; next, PAYMENT is given to the cashier; finally, the CUSTOMER is given a RECEIPT. The logical data flow diagram illustrates the processes involved without going into detail about the physical implementation of activities. The physical data flow diagram shows that a bar code—the universal product code (UPC) BAR CODE found on most grocery store items—is used. In addition, the physical data flow diagram mentions manual processes such

**FIGURE 7.7**

Features common to both logical and physical data flow diagrams.

Design Feature	Logical	Physical
What the model depicts	How the business operates.	How the system will be implemented (or how the current system operates).
What the processes represent	Business activities.	Programs, program modules, and manual procedures.
What the data stores represent	Collections of data regardless of how the data are stored.	Physical files and databases, manual files.
Type of data stores	Show data stores representing permanent data collections.	Master files, transition files. Any processes that operate at two different times must be connected by a data store.
System controls	Show business controls.	Show controls for validating input data, for obtaining a record (record found status), for ensuring successful completion of a process, and for system security (example: journal records).

as scanning, explains that a temporary file is used to keep a subtotal of items, and indicates that the PAYMENT could be made by CASH, CHECK, or DEBIT CARD. Finally, it refers to the receipt by its name, CASH REGISTER RECEIPT.

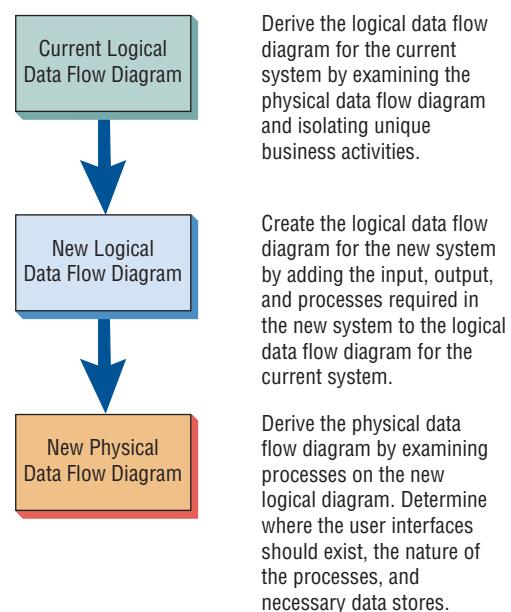
### Developing Logical Data Flow Diagrams

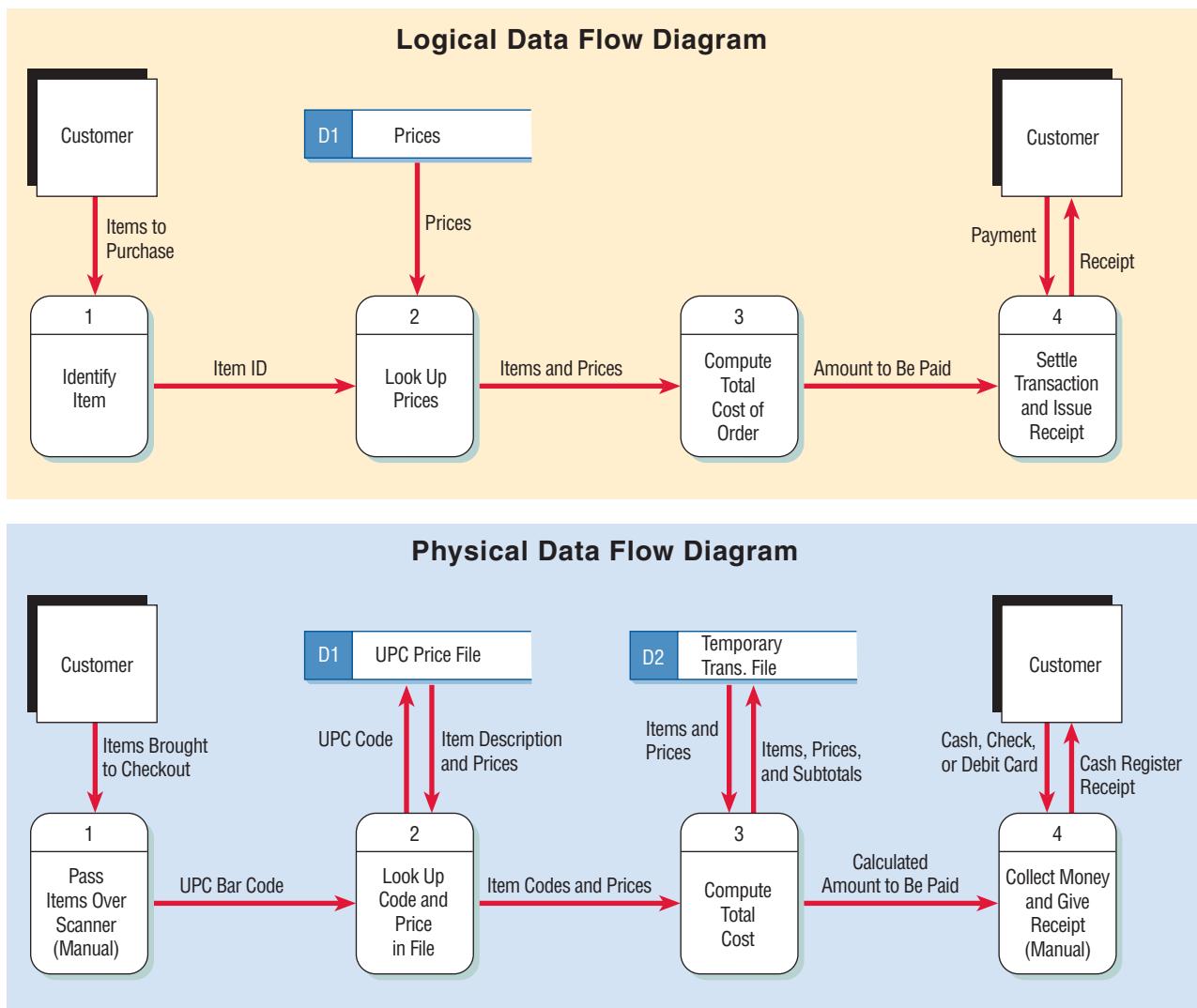
To develop such a diagram, first construct a logical data flow diagram for the current system. There are a number of advantages to using a logical model, including:

1. Better communication with users.
2. More stable systems.
3. Better understanding of the business by analysts.
4. Flexibility and maintenance.
5. Elimination of redundancies and easier creation of the physical model.

**FIGURE 7.8**

The progression of models from logical to physical.





A logical model is easier to use when communicating with users of the system because it is centered on business activities. Users will thus be familiar with the essential activities and many of the human information requirements of each activity.

Systems formed using a logical data flow diagram are often more stable because they are based on business events and not on a particular technology or method of implementation. Logical data flow diagrams represent features of a system that would exist no matter what the physical means of doing business are. For example, activities such as applying for a video store membership card, checking out a DVD, and returning the DVD, would all occur whether the store had an automated, manual, or hybrid system.

### Developing Physical Data Flow Diagrams

After you develop the logical model of the new system, you may use it to create a physical data flow diagram. The physical data flow diagram shows how the system will be constructed, and usually contains most, if not all, of the elements found in Figure 7.10. Just as logical data flow diagrams have certain advantages, physical data flow diagrams have others, including:

1. Clarifying which processes are performed by humans (manual) and which are automated.
2. Describing processes in more detail than logical DFDs.
3. Sequencing processes that have to be done in a particular order.
4. Identifying temporary data stores.
5. Specifying actual names of files, database tables, and printouts.
6. Adding controls to ensure the processes are done properly.

**FIGURE 7.9**

The physical data flow diagram (below) shows certain details not found on the logical data flow diagram (above).

**FIGURE 7.10**

Physical data flow diagrams contain many items not found in logical data flow diagrams.

**Contents of Physical Data Flow Diagrams**

- Manual processes
- Processes for adding, deleting, changing, and updating records
- Data entry and verifying processes
- Validation processes for ensuring accurate data input
- Sequencing processes to rearrange the order of records
- Processes to produce every unique system output
- Intermediate data stores
- Actual file names used to store data
- Controls to signify completion of tasks or error conditions

Physical data flow diagrams are often more complex than logical data flow diagrams simply because of the many data stores present in a system. The acronym CRUD is often used for Create, Read, Update, and Delete, the activities that must be present in a system for each master file. A CRUD matrix is a tool to represent where each of these processes occurs in a system. Figure 7.11 is a CRUD matrix for an Internet storefront. Notice that some of the processes include more than one activity. Data entry processes such as keying and verifying are also part of physical data flow diagrams.

Physical data flow diagrams also have intermediate data stores, often a transaction file or a temporary database table. Intermediate data stores often consist of transaction files used to store data between processes. Because most processes that require access to a given set of data are unlikely to execute at the same instant in time, transaction files must hold the data from one process to the next. An easily understood example of this concept is found in the everyday experiences of grocery shopping, meal preparation, and eating. The activities are:

1. Selecting items from shelves.
2. Checking out and paying the bill.
3. Transporting the groceries home.
4. Preparing a meal.
5. Eating the meal.

**FIGURE 7.11**

A CRUD matrix for an Internet storefront. This tool can be used to represent where each of four processes (Create, Read, Update, and Delete) occurs within a system.

Activity	Customer	Item	Order	Order Detail
Customer Logon	R			
Item Inquiry		R		
Item Selection		R	C	C
Order Checkout	U	U	U	R
Add Account	C			
Add Item		C		
Close Customer Account	D			
Remove Obsolete Item		D		
Change Customer Demographics	RU			
Change Customer Order	RU	RU	RU	CRUD
Order Inquiry	R	R	R	R

Each of these five activities would be represented by a separate process on a physical data flow diagram, and each one occurs at a different time. For example, you would not typically transport the groceries home and eat them at the same time. Therefore, a “transaction data store” is required to link each task. When you are selecting items, the transaction data store is the shopping cart. After the next process (checking out), the cart is unnecessary. The transaction data store linking checking out and transporting the groceries home is the shopping bag (cheaper than letting you take the cart home!). Bags are an inefficient way of storing the groceries once they are home, so cupboards and a refrigerator are used as a transaction data store between the activity of transporting the goods home and preparing the meal. Finally, a plate, bowl, and cup constitute the link between preparing and eating the meal.

Timing information may also be included. For example, a physical DFD may indicate that an edit program must be run before an update program. Updates must be performed before producing a summary report, or an order must be entered on a Web site before the amount charged to a credit card may be verified with the financial institution. Note that because of such considerations, a physical data flow diagram may appear more linear than a logical model.

Create the physical data flow diagram for a system by analyzing its output and input. When creating a physical data flow diagram, input data flow from an external entity is sometimes called a *trigger* because it starts the activities of a process, and output data flow to an external entity is sometimes called a *response* because it is sent as the result of some activity. Determine which data fields or elements need to be keyed. These fields are called *base elements* and must be stored in a file. Elements that are not keyed but are rather the result of a calculation or logical operation are called *derived elements*.

Sometimes it is not clear how many processes to place in one diagram and when to create a child diagram. One suggestion is to examine each process and count the number of data flows entering and leaving it. If the total is greater than four, the process is a good candidate for a child diagram. Physical data flow diagrams are illustrated later in this chapter.

**EVENT MODELING AND DATA FLOW DIAGRAMS.** A practical approach to creating physical data flow diagrams is to create a simple data flow diagram fragment for each unique system event. Events cause the system to do something and act as a trigger to the system. Triggers start activities and processes, which in turn use data or produce output. An example of an event is a customer reserving a flight on the Web. As each Web form is submitted, processes are activated, such as validating and storing the data and formatting and displaying the next Web page.

Events are usually summarized in an event response table. An example of an event response table for an Internet storefront business is illustrated in Figure 7.12. A data flow diagram fragment is represented by a row in the table. Each DFD fragment is a single process on a data flow diagram. All the fragments are then combined to form Diagram 0. The trigger and response columns become the input and output data flows, and the activity becomes the process. The analyst must determine the data stores required for the process by examining the input and output data flows. Figure 7.13 illustrates a portion of the data flow diagram for the first three rows of the event response table.

The advantage of building data flow diagrams based on events is that the users are familiar with the events that take place in their business area and know how the events drive other activities.

**USE CASES AND DATA FLOW DIAGRAMS.** In Chapter 2, we introduced the concept of a *use case*. We use this notion of a use case in creating data flow diagrams. A use case summarizes an event and has a similar format to process specifications (described in Chapter 9). Each use case defines one activity and its trigger, input, and output. Figure 7.14 illustrates a use case for Process 3, Add Customer Item.

This approach allows the analyst to work with users to understand the nature of the processes and activities and then create a single data flow diagram fragment. When creating use cases, first make an initial attempt to define the use cases without going into detail. This step provides an overview of the system and leads to the creation of Diagram 0. Decide what the names should be and provide a brief description of the activity. List the activities, inputs, and outputs for each one.

Make sure you document the steps used in each use case. These should be in the form of business rules that list or explain the human and system activities completed for each use case. If at all

Event	Source	Trigger	Activity	Response	Destination
Customer logs on	Customer	Customer number and password	Find customer record and verify password. Send Welcome Web page.	Welcome Web page	Customer
Customer browses items at Web storefront	Customer	Item information	Find item price and quantity available. Send Item Response Web page.	Item Response Web page	Customer
Customer places item into shopping basket at Web storefront	Customer	Item purchase (item number and quantity)	Store data on Order Detail Record. Calculate shipping cost using shipping tables. Update customer total. Update item quantity on hand.	Items Purchased Web page	Customer
Customer checks out	Customer	Clicks "Check Out" button on Web page	Display Customer Order Web page.	Verification Web page	
Obtain customer payment	Customer	Credit card information	Verify credit card amount with credit card company. Send.	Credit card data Customer feedback	Credit card company Customer
Send customer email		Temporal, hourly	Send customer an email confirming shipment.		Customer

**FIGURE 7.12**

An event response table for an Internet storefront.

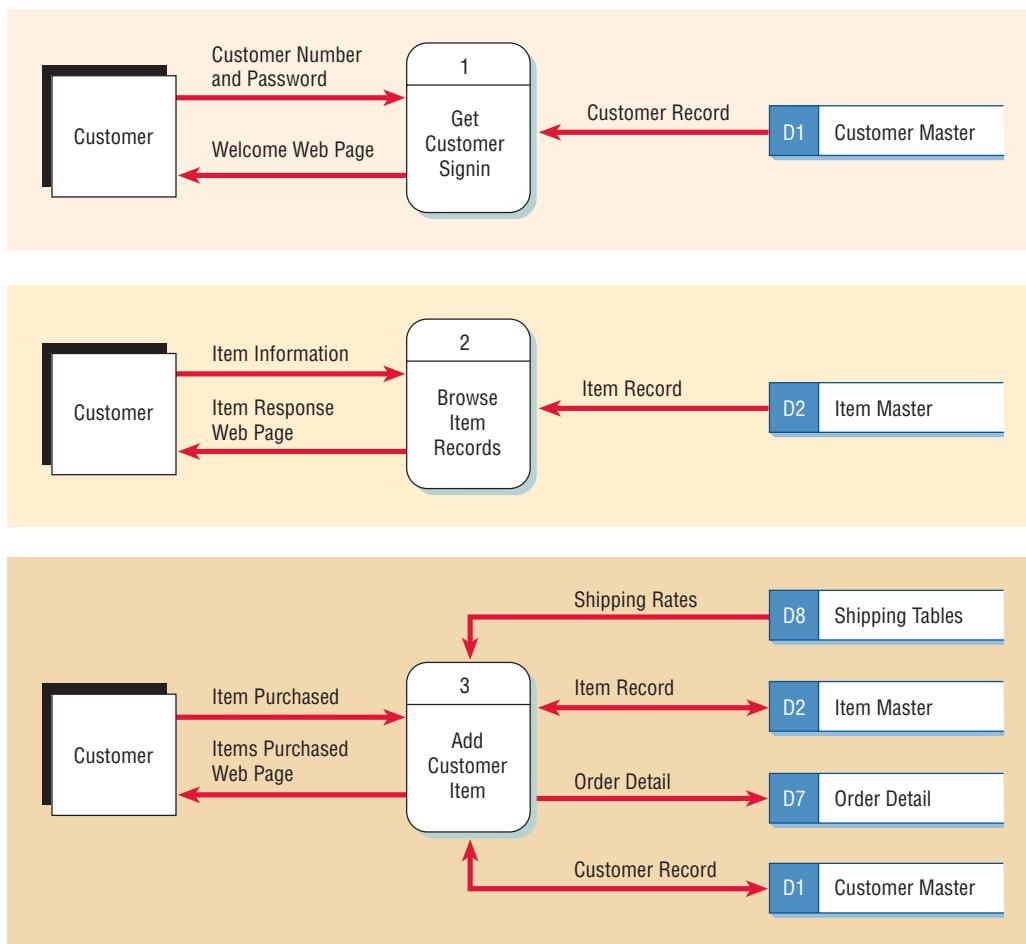
possible, list them in the sequence that they would normally be executed. Next, determine the data used by each step. This step is easier if a data dictionary has been completed. Finally, ask the users to review and suggest modifications of the use cases. It is important that the use cases are written clearly. (See Chapter 10 for a further discussion of UML, use cases, and use case diagrams.)

### Partitioning Data Flow Diagrams

Partitioning is the process of examining a data flow diagram and determining how it should be divided into collections of manual procedures and collections of computer programs. Analyze each process to determine whether it should be a manual or automated procedure. Group automated procedures into a series of computer programs. A dashed line is often drawn around a process or group of processes that should be placed into a single computer program.

There are six reasons for partitioning data flow diagrams:

- 1. Different user groups.** Are the processes performed by several different user groups, often at different physical locations in the company? If so, they should be partitioned into different computer programs. An example is the need to process customer returns and customer payments in a department store. Both processes involve obtaining financial information that is used to adjust customer accounts (subtracting from the amount the customer owes), but they are performed by different people at different locations. Each group needs a different screen for recording the particulars of the transaction, either a credit screen or a payment screen.
- 2. Timing.** Examine the timing of the processes. If two processes execute at different times, they cannot be grouped into one program. Timing issues may also involve how much data is presented at one time on a Web page. If an ecommerce site has rather lengthy Web pages for ordering items or making an airline reservation, the Web pages may be partitioned into separate programs that format and present the data.

**FIGURE 7.13**

Data flow diagrams for the first three rows of the Internet storefront event response table.

## A DATA FLOW DIAGRAM EXAMPLE

The following example is intended to illustrate the development of a data flow diagram by selectively looking at each of the components explored earlier in this chapter. This example, called “World’s Trend Catalog Division,” will also be used to illustrate concepts covered in Chapters 8 and 9.

### Developing the List of Business Activities

A list of business activities for World’s Trend can be found in Figure 7.15. You could develop this list using information obtained through interacting with people in interviews, through investigation, and through observation. The list can be used to identify external entities such as CUSTOMER, ACCOUNTING, and WAREHOUSE as well as data flows such as ACCOUNTS

Use case name: Add Customer Item			Process ID: 3
Description: Adds an item for a customer Internet order.			
Trigger: Customer places an order item in the shopping basket.			
Trigger type: External <input checked="" type="checkbox"/> Temporal <input type="checkbox"/>			
Input Name	Source	Output Name	Destination
Item Purchased (Item Number and Quantity)	Customer	Items Purchased Confirmation Web Page	Customer
Steps Performed		Information for Steps	
1. Find Item Record using the Item Number. If the item is not found, place a message on the Items Purchased Web page. 2. Store item data on Order Detail Record.  3. Use the Customer Number to find the Customer Record.  4. Calculate Shipping Cost using shipping tables. Using the Item Weight from the Item Record and the Zip Code from the Customer Record, look up the Shipping Cost in the Shipping Tables.  5. Modify the Customer Total using the Quantity Purchased and the Item Price. Add the Shipping Cost. Update the Customer Record.  6. Modify the Item Quantity on Hand and update the Item Record.		Item Number, Item Record  Order Detail Record  Customer Number, Customer Record  Zip Code, Item Weight, Shipping Table  Item Record, Quantity Purchased, Shipping Cost, Customer Record  Quantity Ordered, Item Record	

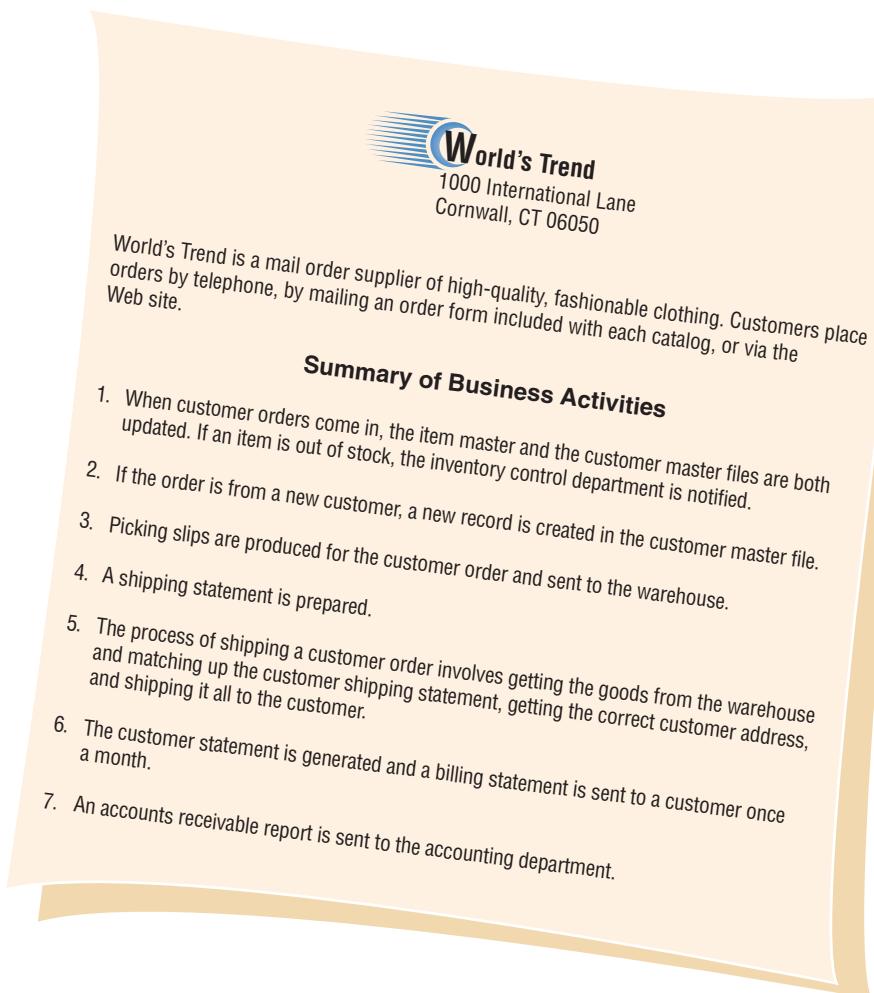
**FIGURE 7.14**

A use case form for the Internet storefront describes the Add Customer Item activity and its triggers, input, and output.

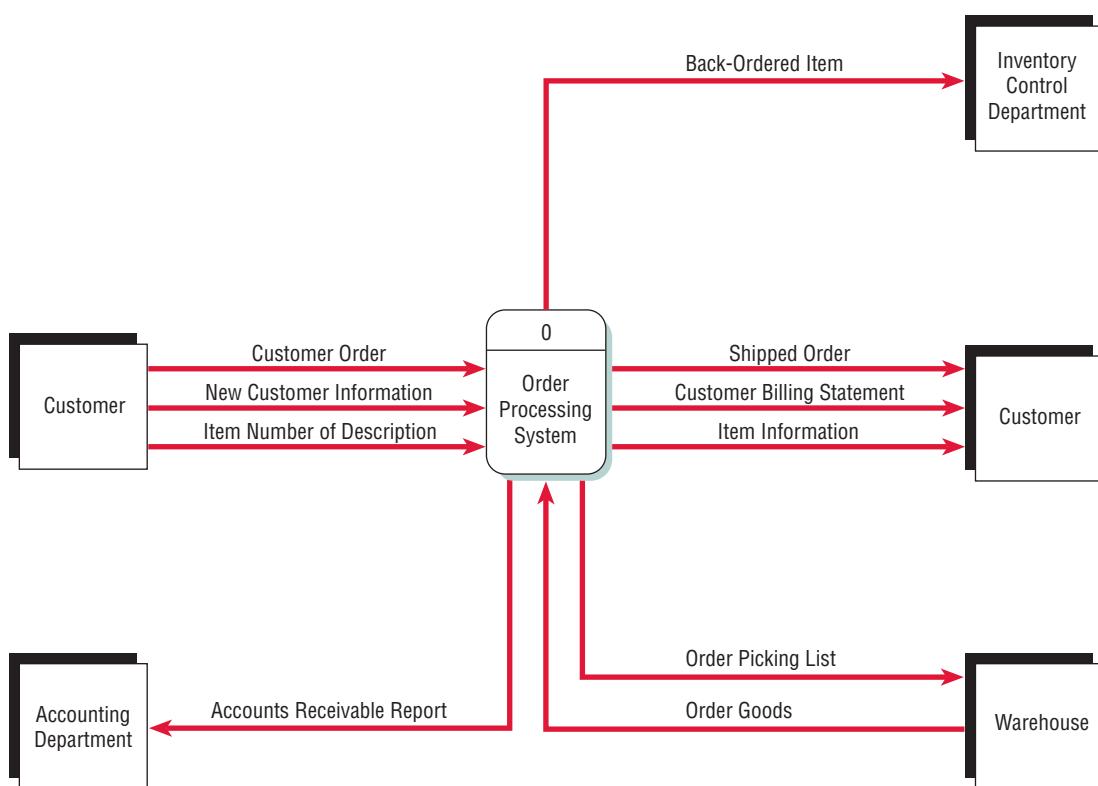
RECEIVABLE REPORT and CUSTOMER BILLING STATEMENT. Later (when developing level 0 and child diagrams), the list can be used to define processes, data flows, and data stores.

#### **Creating a Context-level Data Flow Diagram**

Once this list of activities is developed, create a context-level data flow diagram as shown in Figure 7.16. This diagram shows the ORDER PROCESSING SYSTEM in the middle (no processes are described in detail in the context-level diagram) and five external entities (the two

**FIGURE 7.15**

A summary of business activities for World's Trend Catalog Division.

**FIGURE 7.16**

A context-level data flow diagram for the order processing system at World's Trend.

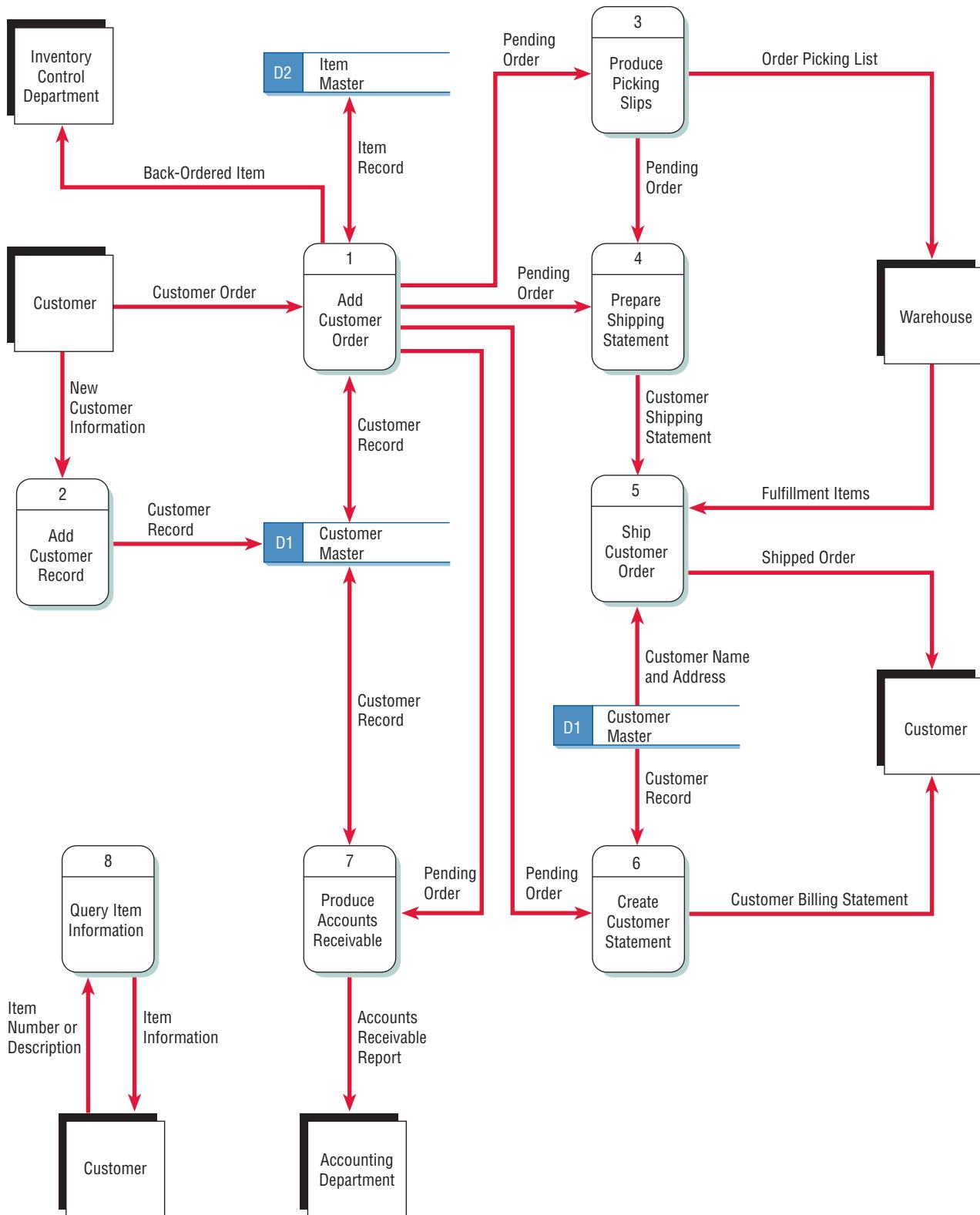
separate entities both called CUSTOMER are really one and the same). The data flows that come from and go to the external entities are shown as well (for example, CUSTOMER ORDER and ORDER PICKING LIST).

**FIGURE 7.17**

Diagram 0, of the order processing system for World's Trend Catalog Division.

### Drawing Diagram 0

Next, go back to the activity list and make a new list of as many processes and data stores as you can find. You can add more later, but start making the list now. If you think you have enough information, draw a level 0 diagram such as the one found in Figure 7.17. Call this Diagram 0 and keep



the processes general so as not to overcomplicate the diagram. Later, you can add detail. When you are finished drawing the seven processes, draw data flows between them and to the external entities (the same external entities shown in the context-level diagram). If you think there need to be data stores such as ITEM MASTER or CUSTOMER MASTER, draw those in and connect them to processes using data flows. Now take the time to number the processes and data stores. Pay particular attention to making the labels meaningful. Check for errors and correct them before moving on.

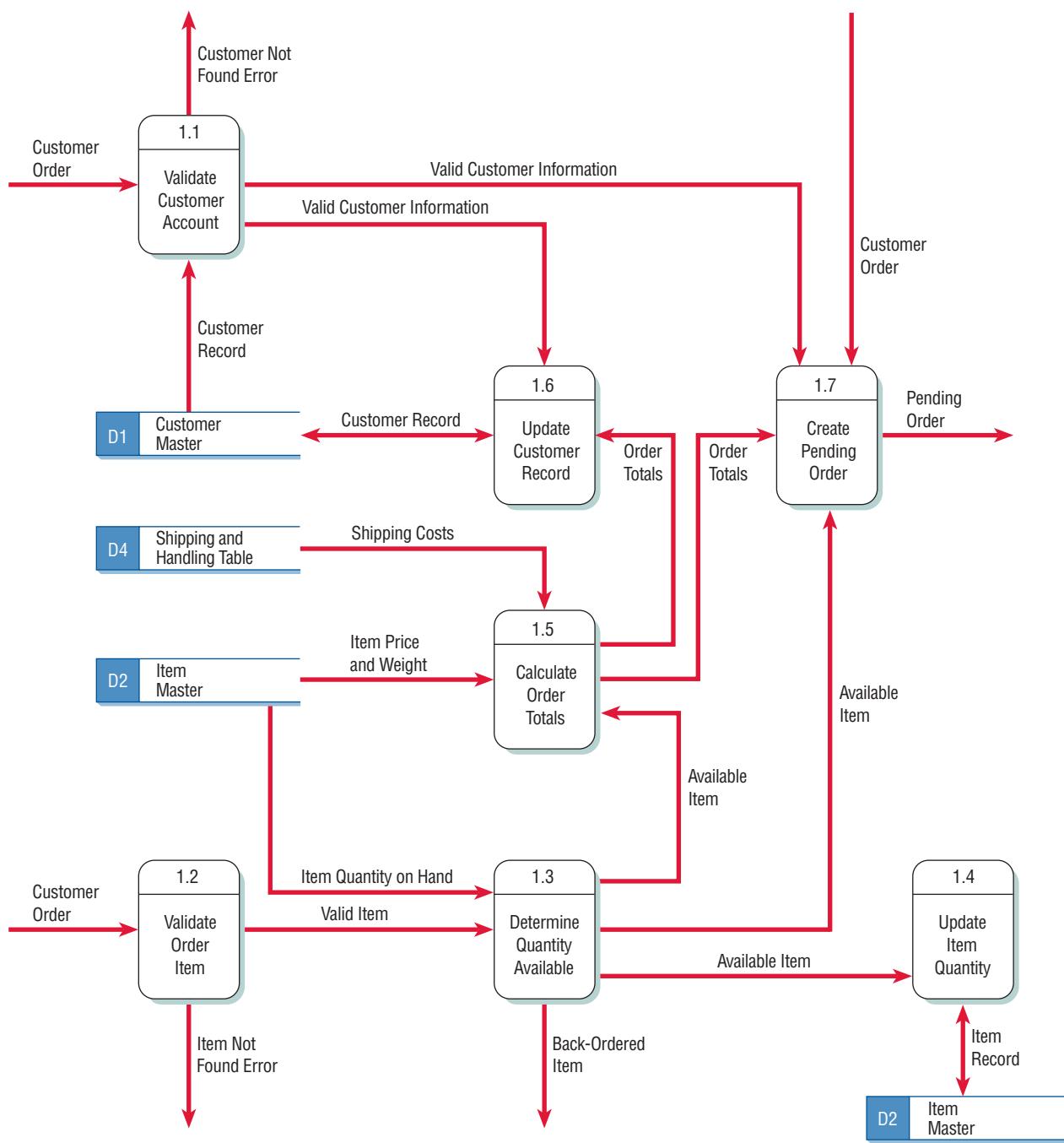
### Creating a Child Diagram

At this point try to draw a child diagram (sometimes also called a level 1 diagram) such as the one in Figure 7.18. Child diagram processes are more detailed, illustrating the logic required to produce the output. Number your child diagrams Diagram 1, Diagram 2, and so on, in accordance with the number you assigned to each process in the level 0 diagram.

When you draw a child diagram, make a list of subprocesses first. A process such as ADD CUSTOMER ORDER can have subprocesses (in this case, there are seven). Connect these subprocesses

**FIGURE 7.18**

Diagram 1, of the order processing system for World's Trend Catalog Division.

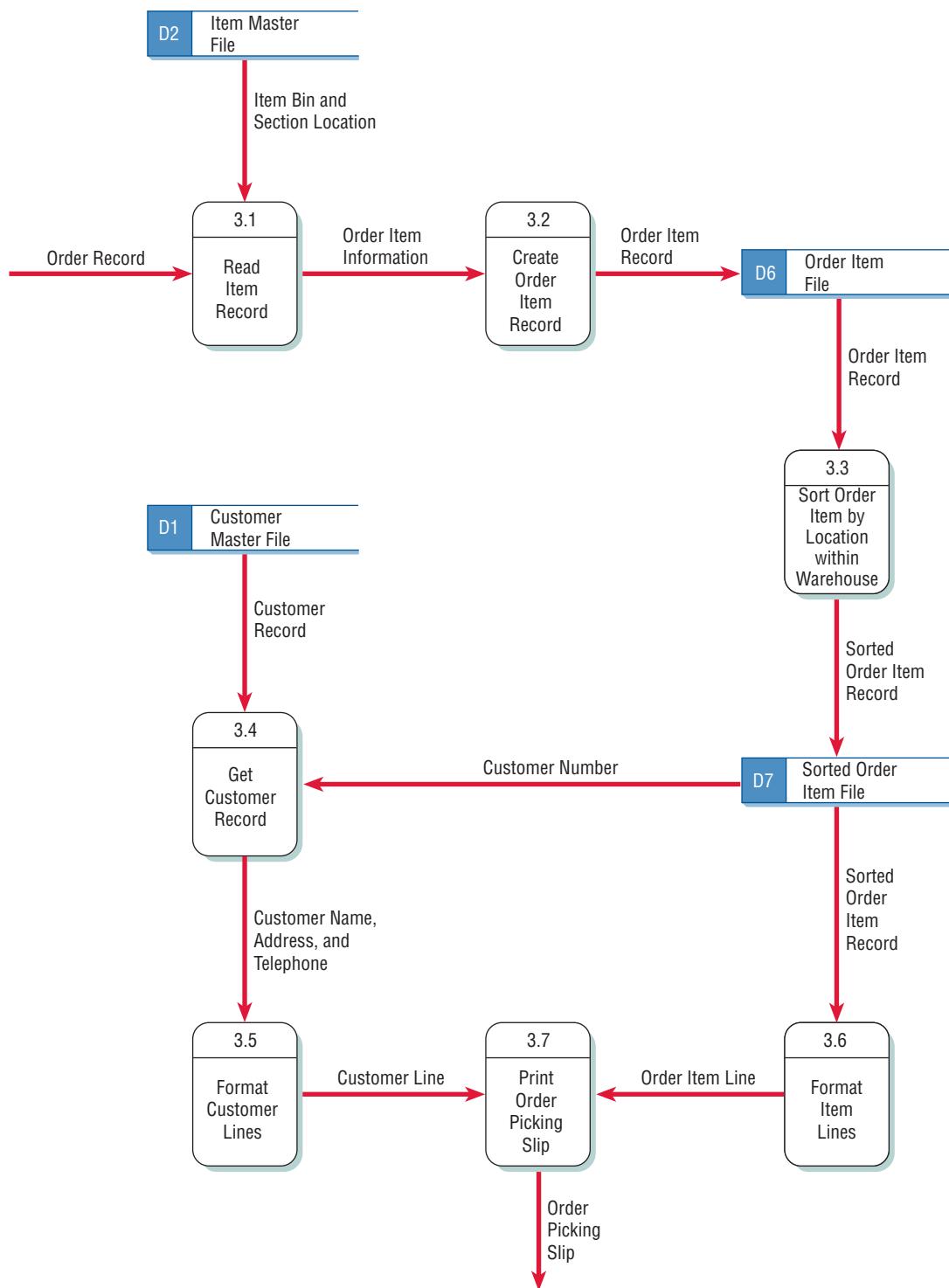


to one another and also to data stores when appropriate. Subprocesses do not have to be connected to external entities, because we can always refer to the parent (or level 0) data flow diagram to identify these entities. Label the subprocesses 1.1, 1.2, 1.3, and so on. Take the time to check for errors and make sure the labels make sense.

### Creating a Physical Data Flow Diagram from the Logical DFD

**FIGURE 7.19**

A physical data flow child diagram for World's Trend Catalog Division.



playing screens, locating records, and creating and updating files. The sequence of activities is important in physical DFDs, because the emphasis is on how the system will work and in what order events happen.

When you label a physical model, take care to describe the process in great detail. For example, subprocess 3.3 in a logical model could simply be SORT ORDER ITEM, but in the physical model, a better label is SORT ORDER ITEM BY LOCATION WITHIN CUSTOMER. When you write a label for a data store, refer to the actual file or database, such as CUSTOMER MASTER FILE or SORTED ORDER ITEM FILE. When you describe data flows, describe the actual form, report, or screen. For example, when you print a slip for order picking, call the data flow ORDER PICKING SLIP.

### Partitioning the Physical DFD

Finally, take the physical data flow diagram and suggest partitioning through combining or separating the processes. As stated earlier, there are many reasons for partitioning: identifying distinct processes for different user groups, separating processes that need to be performed at different times, grouping similar tasks, grouping processes for efficiency, combining processes for consistency, or separating them for security. Figure 7.20 shows that partitioning is useful in the case of World's Trend Catalog Division. You would first group processes 1 and 2 because it would make sense to add new customers at the same time their first order was placed. You would then put processes 3 and 4 in two separate partitions because these must be done at different times from each other and thus cannot be grouped into a single program.

The process of developing a data flow diagram is now completed from the top down, first drawing a companion physical data flow diagram to accompany the logical data flow diagram, then partitioning the data flow diagram by grouping or separating the processes. The World's Trend example is used again in Chapters 8 and 9.

## PARTITIONING WEB SITES

Partitioning is a very useful principle when designing a Web site. Web site designers who use forms to collect data may find it more appropriate to divide a Web site into a series of Web pages, which will improve the way humans use the site, the speed of processing, and the ease of maintaining the site. Each time data must be obtained from a data store or an external partner, a Web site designer might consider creating a unique Web form and DFD process to validate and process the data.

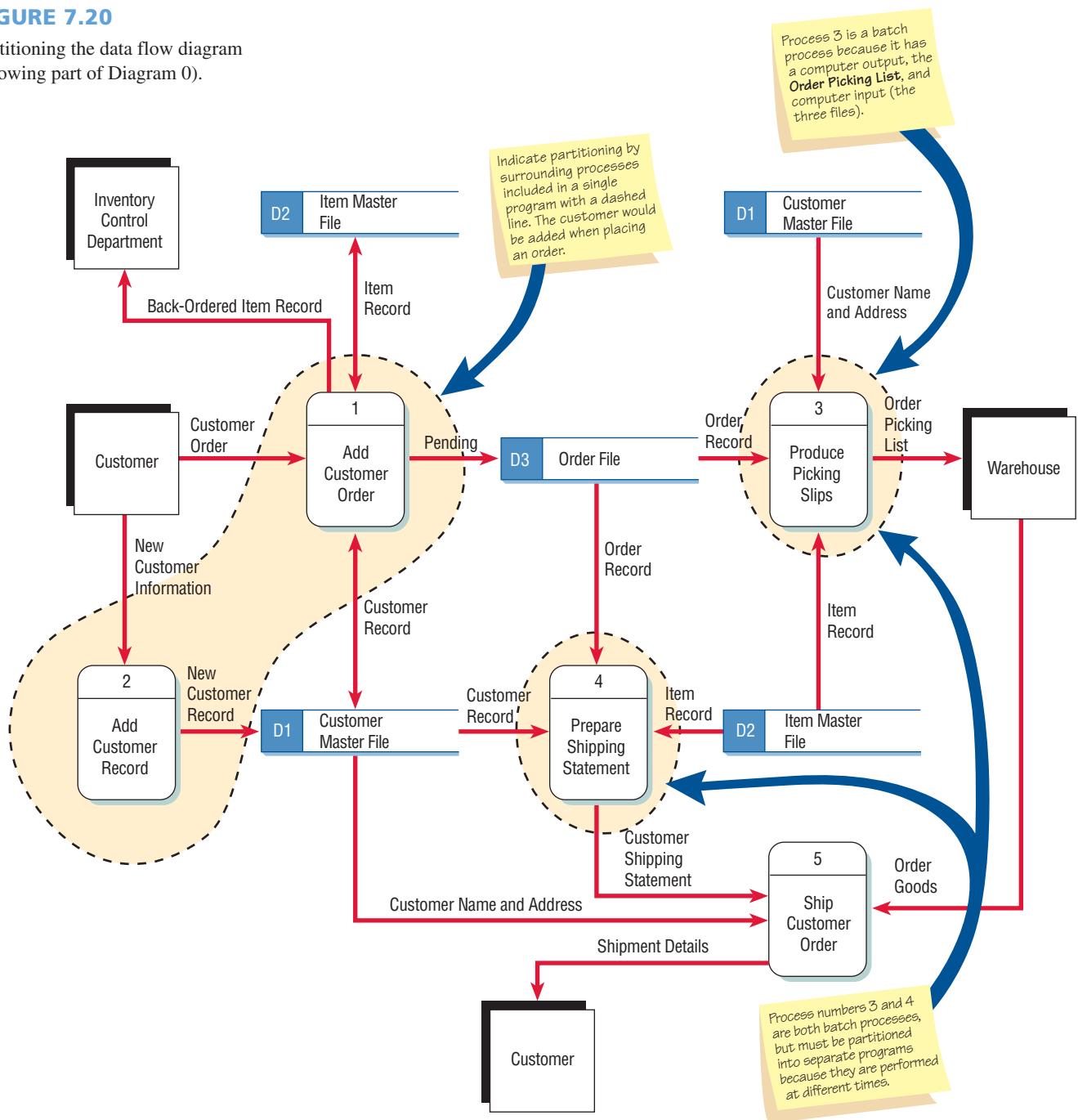
The Web developer may also use Ajax, sending a request to the server and obtaining a small amount of data or an XML document returned to the same page. Ajax may be used to avoid creating too many small pages containing only a few extra or changed Web form elements. However, the analyst should create several pages when needed. One consideration is when a large amount of data needs to be obtained from the server, such as a list of all the flights that match starting and destination airports for specific travel days. When accessing different database tables on the same database, the data may be obtained containing fields from different database tables and passed to one process. However, if different databases are involved, the analyst may decide to use separate Web pages. When user input is required, the analyst may either use separate Web pages or use Ajax to facilitate a change in a drop-down list or to change a small amount of data.

A good example of partitioning can be seen in the development of a Web-based travel booking site. To simplify, we will only look at the airline booking portion of the Web site, shown in the data flow diagram in Figure 7.21. Notice that the Web designer has chosen to create several processes and unique partitions in making a flight reservation. Process 1 receives and validates the dates and airports entered by the customer (or travel agent acting for a customer). The selection data is used to obtain flight details and create a transaction data store of flight details that match the flight request.

It is advisable to partition the process of finding the flight information as a separate process, because a data store must be searched and the flight details are used to display a series of successive Web pages with matching flights. Then, once a customer chooses a flight, the information must be sent to a selected airline. It is important to have the FLIGHT DETAILS transaction file available to display each Web page of new flights, because redoing the search may take a lengthy amount of time that is unacceptable to a human user trying to complete a transaction.

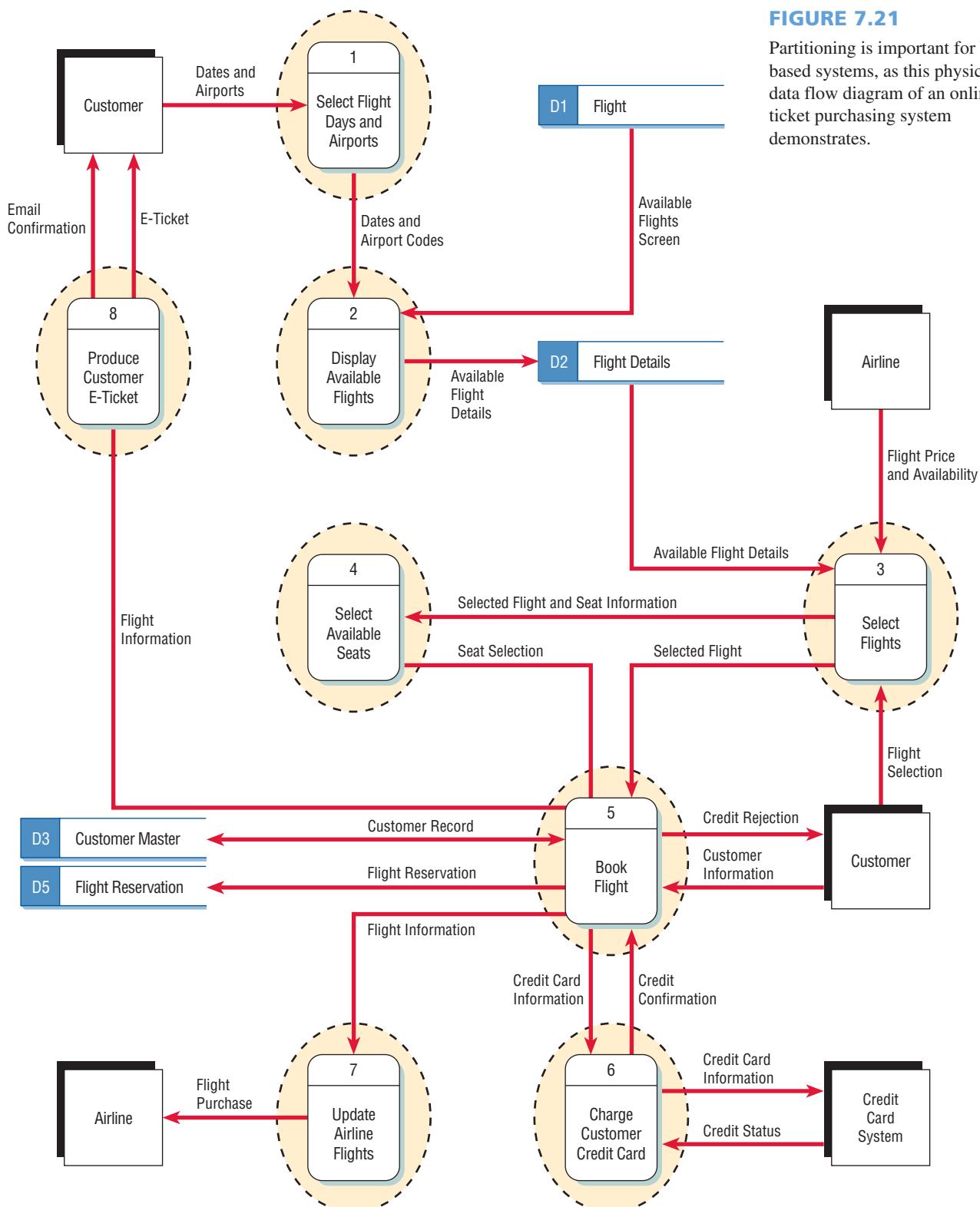
**FIGURE 7.20**

Partitioning the data flow diagram  
(showing part of Diagram 0).



The selection of available flights (process 2) uses an internal database, but this database does not have information about availability of seats, because the airlines are receiving reservations from many travel service organizations. This means that there must be a separate process and small program partitioned for determining if seats are available and for reserving specific seats.

Because there is a lot of user input, forms are designed to handle all the user requests. Having separate forms means that the forms are less complex, and therefore users will find them more attractive and easier to fill out. This design meets both the usability and usefulness criteria important when designing Web sites for human-computer interaction. It also means that processing will take place more quickly, because once the flight is chosen, the next step involving the choice of seats should not require the customer to input or even see the flight details again at this time. Most airline Web sites now use pop-up windows in which customers point to their seat selection.

**FIGURE 7.21**

Partitioning is important for Web-based systems, as this physical data flow diagram of an online ticket purchasing system demonstrates.

Another reason for partitioning is to keep the transaction secure. Once the seat has been selected, the customer must confirm the reservation and supply credit card information. This is done using a secure connection, and the credit card company is involved in validating the amount of purchase. The secure connection means a separate process must be used. Once the credit card has been confirmed, two additional processes must be included, one to format and send an email confirmation and an e-ticket to the customer, and another to send notification of the flight purchase to the airline.



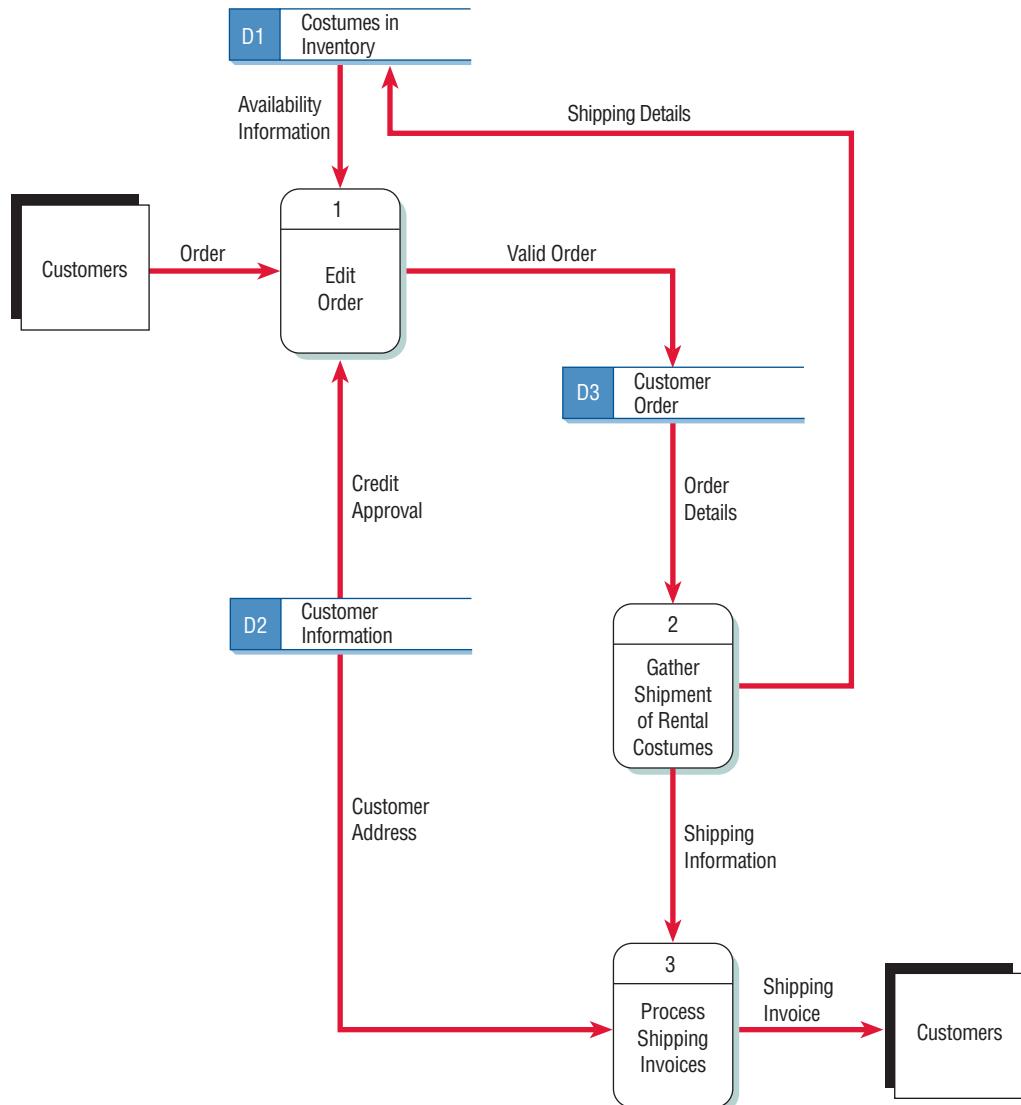
## CONSULTING OPPORTUNITY 7.1

### There's No Business Like Flow Business

The phone at Merman's Costume Rentals rings, and Annie Oaklea, head of costume inventory, picks it up and answers a query by saying, “Let me take a look at my inventory cards. Sorry, it looks as if there are only two male bear suits in inventory, with extra growly expressions at that. We've had a great run on bear. When do you need them? Perhaps one will be returned. No, can't do it, sorry. Would you like these two sent, regardless? The name of your establishment? Manhattan Theatre Company? London branch? Right. Delightful company! I see by our account card that you've rented from us before. And how long will you be needing the costumes?”

Figure 7.C1 is a data flow diagram that sets the stage for processing of costume rentals from Merman's. It shows rentals such as the one Annie is doing for Manhattan Theatre Company.

After conversing for another few moments about shop policy on alterations, Annie concludes her conversation by saying, “You are very lucky to get the bears on such short notice. I've got another company reserving them for the first week in July. I'll put you down for the bear suits, and they'll be taken to you directly by our courier. As always, prompt return will save enormous trouble for us all.”



**FIGURE 7.C1**

A data flow diagram for Merman's Costume Rentals.

Merman's costume rental enterprise is located in London's world-famous West End theatre district. When a theatre or television production company lacks the resources (either time or expertise) to construct a costume in its own shop, the cry goes up to "Ring up Merman's!" and it proceeds to rent what it needs with a minimum of fuss.

The shop (more aptly visualized as a warehouse) goes on for three floors full of costume racks, holding thousands of costumes hung together by historical period, then grouped as to whether they

are for men or women, and then by costume size.<sup>1</sup> Most theatre companies are able to locate precisely what they need through Annie's capable assistance.

Now tailor-make the *rental return* portion of the data flow diagram given earlier. Remember that timely returns are critical for keeping the spotlight on costumes rented from Merman's.

<sup>1</sup>Western Costume Company in Hollywood, California, is said to have more than 1 million costumes worth about \$40 million.

The entire procedure must be partitioned into a series of interacting processes, each with a corresponding Web page or interaction with an external system. Each time a new data store is used to obtain additional data, a process must be included to format or obtain the data. Each time an external company or system is involved, a process needs to be partitioned into a separate program. When processes or forms need to be revised, it is not a major task. The small size of the programs makes them easy to change. In this way, the Web site is secure, efficient, and more easily maintained.

## COMMUNICATING USING DATA FLOW DIAGRAMS

Data flow diagrams are useful throughout the analysis and design process. Use original, unexploded data flow diagrams early when ascertaining information requirements. At this stage they can help provide an overview of data movement through the system, lending a visual perspective unavailable in narrative data.

A systems analyst might be quite competent at sketching through the logic of the data stream for data flow diagrams, but to make the diagrams truly communicative to users and other members of the project team, meaningful labels for all data components are also required. Labels should not be generic, because then they do not tell enough about the situation at hand. All general systems models bear the configuration of input, process, and output, so labels for a data flow diagram need to be more specific than that.

Finally, remember that data flow diagrams are used to document the system. Assume that data flow diagrams will be around longer than the people who drew them, which is, of course, always true if an external consultant is drawing them. Data flow diagrams can be used for documenting high or low levels of analysis and helping to substantiate the logic underlying the data flows of the organizations.

## SUMMARY

To better understand the logical movement of data throughout a business, the systems analyst draws data flow diagrams (DFDs). Data flow diagrams are structured analysis and design tools that allow the analyst to comprehend the system and subsystems visually as a set of interrelated data flows.

Graphical representations of data movement storage and transformation are drawn with the use of four symbols: a rounded rectangle to depict data processing or transformations, a double square to show an outside data entity (source or receiver of data), an arrow to depict data flow, and an open-ended rectangle to show a data store.

The systems analyst extracts data processes, sources, stores, and flows from early organizational narratives or stories told by users or revealed by data and uses a top-down approach to first draw a context-level data flow diagram of the system within the larger picture. Then a level 0 logical data flow diagram is drawn. Processes are shown and data stores are added. Next, the analyst creates a child diagram for each of the processes in Diagram 0. Inputs and outputs remain constant, but the data stores and sources change. Exploding the original data flow diagram allows the systems analyst to focus on ever more detailed depictions of data movement in the system. The analyst then develops a physical data flow diagram from the logical data flow diagram, partitioning it to facilitate programming. Each process is analyzed to determine whether it should be a manual or automated procedure.

Six considerations for partitioning data flow diagrams include whether processes are performed by different user groups, processes execute at the same times, processes perform similar tasks, batch processes can be combined for efficient processing, processes may be combined into one program for consistency of data, or processes may be partitioned into different programs for security reasons.

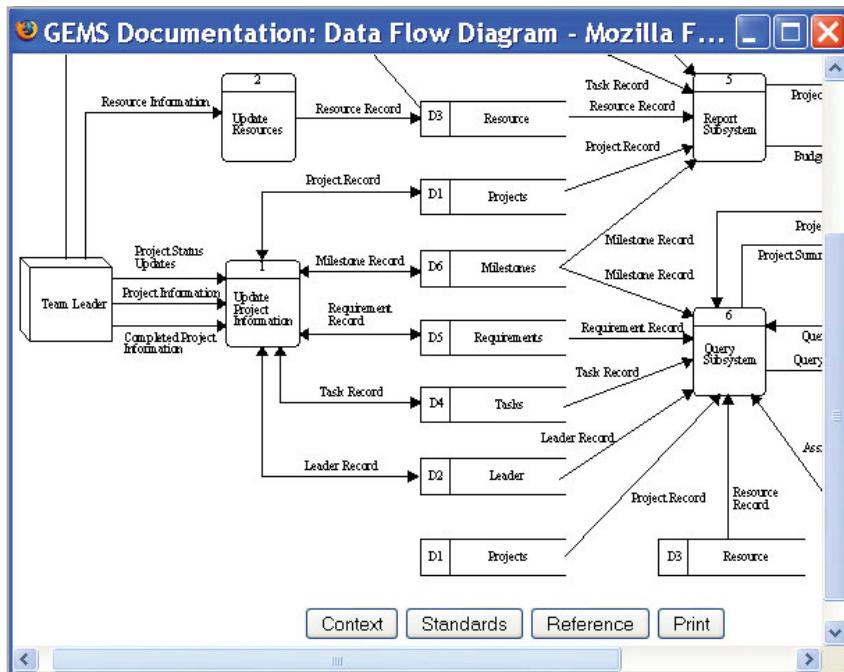


## HYPERCASE® EXPERIENCE 7

“You take a very interesting approach to the problems we have here at MRE. I’ve seen you sketching diagrams of our operation almost since the day you walked in the door. I’m actually getting used to seeing you doodling away now. What did you call those? Oh, yes. Context-level diagrams. And flow networks? Oh, no. Data flow diagrams. That’s it, isn’t it?”

### HYPERCASE Questions

- Find the data flow diagrams already drawn in MRE. Make a list of those you found and add a column to show where in the organization you found them.
- Draw a context-level diagram modeling the Training Unit Project Development process, one that is based on interviews with relevant Training Unit staff. Then draw a level 0 diagram detailing the process.



**FIGURE 7.HC1**

In HyperCase you can click on elements in a data flow diagram.

## KEYWORDS AND PHRASES

Ajax  
base element  
child diagram  
context-level data flow diagram  
data flow diagram  
data flow diagram fragment  
data-oriented system  
data store  
derived elements  
event modeling  
event response table  
event trigger

exploding  
external entity (source or destination)  
functionally primitive  
interface data flow  
level 0 diagram  
logical model  
online process  
parent process  
partitioning  
physical data store  
physical model  
primitive process

top-down approach	unified modeling language (UML)
transaction data store	use case
transforming process	vertical balancing

## REVIEW QUESTIONS

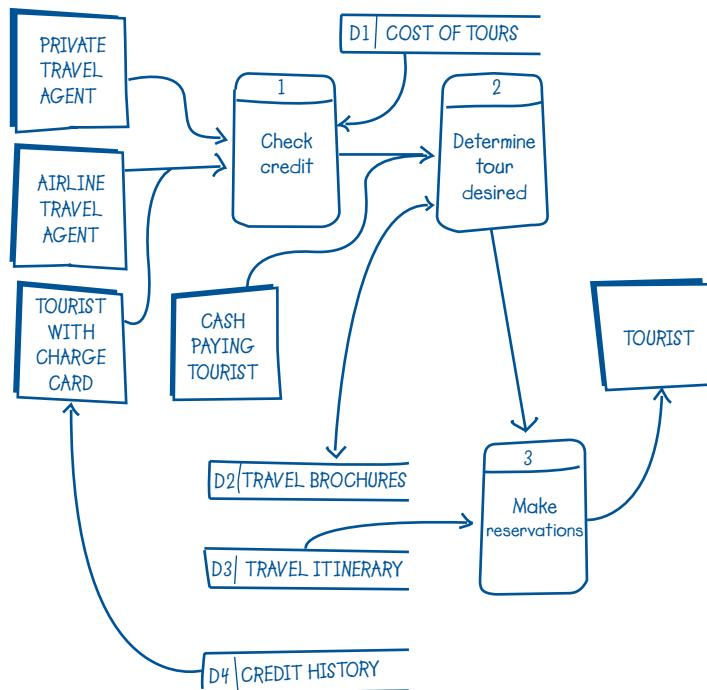
1. What is one of the main methods available for the analyst to use when analyzing data-oriented systems?
2. What are the four advantages of using a data flow approach over narrative explanations of data movement?
3. What are the four data items that can be symbolized on a data flow diagram?
4. What is a context-level data flow diagram? Contrast it to a level 0 DFD.
5. Define the top-down approach as it relates to drawing data flow diagrams.
6. Describe what “exploding” data flow diagrams means.
7. What are the trade-offs involved in deciding how far data streams should be exploded?
8. Why is labeling data flow diagrams so important? What can effective labels on data flow diagrams accomplish for those unfamiliar with the system?
9. What is the difference between a logical and physical data flow diagram?
10. List three reasons for creating a logical data flow diagram.
11. List five characteristics found on a physical data flow diagram that are not on a logical data flow diagram.
12. When are transaction files required in the system design?
13. How can an event table be used to create a data flow diagram?
14. List the major sections of a use case.
15. How can a use case be used to create a data flow diagram?
16. What is partitioning, and how is it used?
17. How can an analyst determine when a user interface is required?
18. List three ways of determining partitioning in a data flow diagram.
19. List three ways to use completed data flow diagrams.

## PROBLEMS

1. Up to this point you seem to have had excellent rapport with Kevin Cahoon, the owner of a musical instrument manufacturing company. When you showed him a set of data flow diagrams you drew, he wasn't able to see how the system you were proposing was described in the diagrams.
  - a. In a paragraph, write down in general terms how to explain a data flow diagram to a user. Be sure to include a list of symbols and what they mean.
  - b. It takes some effort to educate users about data flow diagrams. Is it worthwhile to share them with users? Why or why not? Defend your response in a paragraph.
  - c. Compare data flow diagrams to use cases and use case scenarios. What do data flow diagrams show that use case diagrams have a difficult time trying to explain?
2. Your latest project is to combine two systems used by Producers Financial. Angie Schworer's loan application system is fairly new, but has no documentation. Scott Wittman's loan management system is older, needs much revision, and the records are coded and kept independently of the other system. The loan application system accepts applications, processes them, and recommends loans for approval. The loan management system takes loans that have been approved and follows them through their final disposition (paid, sold, or defaulted). Draw a context diagram and a level 1 data flow diagram that shows what an idealized combined system would look like.
3. One common experience that students in every college and university share is enrolling in a college course.
  - a. Draw a level 1 data flow diagram of data movement for enrollment in a college course. Use a single sheet and label each data item clearly.
  - b. Explode one of the processes in your original data flow diagram into subprocesses, adding data flows and data stores.
  - c. List the parts of the enrollment process that are “hidden” to the outside observer and about which you have had to make assumptions to complete a second-level diagram.
4. Figure 7.EX1 is a level 1 data flow diagram of data movement in a Niagara Falls tour agency called Marilyn's Tours. Read it over, checking for any inaccuracies.
  - a. List and number the errors that you have found in the diagram.
  - b. Redraw and label the data flow diagram of Marilyn's so that it is correct. Be sure that your new diagram employs symbols properly so as to cut down on repetitions and duplications where possible.

**FIGURE 7.EX1**

A hand-sketched data flow diagram for Marilyn's Tours.



5. Perfect Pizza wants to install a system to record orders for pizza and chicken wings. When regular customers call Perfect Pizza on the phone, they are asked their phone number. When the number is typed into a computer, the name, address, and last order date is automatically brought up on the screen. Once the order is taken, the total, including tax and delivery, is calculated. Then the order is given to the cook. A receipt is printed. Occasionally, special offers (coupons) are printed so the customer can get a discount. Drivers who make deliveries give customers a copy of the receipt and a coupon (if any). Weekly totals are kept for comparison with last year's performance. Write a summary of business activities for taking an order at Perfect Pizza.
6. Draw a context-level data flow diagram for Perfect Pizza (Problem 5).
7. Explode the context-level diagram in Problem 6 showing all the major processes. Call this Diagram 0. It should be a logical data flow diagram.
8. Draw a logical child diagram for Diagram 0 in Problem 7 for the process that adds a new customer if he or she is not currently in the database (has never ordered from Perfect Pizza before).
9. Draw a physical data flow diagram for Problem 7.
10. Draw a physical data flow diagram for Problem 8.
11. Partition the physical data flow diagram in Problem 7, grouping and separating processes as you deem appropriate. Explain why you partitioned the data flow diagram in this manner. (Remember that you do not have to partition the entire diagram, only the parts that make sense to partition.)
12. a. Draw a logical child diagram for process 6 in Figure 7.17.  
b. Draw a physical child diagram for process 6 in Figure 7.17.
13. Draw a physical data flow diagram for process 1.1 in Figure 7.18.
14. Create a context diagram for a real estate agent trying to create a system that matches buyers with potential houses.
15. Draw a logical data flow diagram showing general processes for Problem 14. Call it Diagram 0.
16. Create a context-level diagram for billing in a dental office. External entities include the patients and insurance companies.
17. Draw a logical data flow diagram showing general processes for Problem 16. Call it Diagram 0.
18. Create an event response table for the activities listed for World's Trend order processing system.
19. Create a use case for the list of seven processes for the World's Trend order processing system.
20. Create a CRUD matrix for the files of World's Trend.
21. Use the principles of partitioning to determine which of the processes in Problem 18 should be included in separate programs.

22. Create a physical data flow child diagram for the following situation: The local PC Users Group holds meetings once a month with informative speakers, door prizes, and sessions for special interest groups. A laptop computer is taken to the meetings, and is used to add the names of new members to the group. The diagram represents an online process and is the child of process 1, ADD NEW MEMBERS. The following tasks are included:
- Key the new member information.
  - Validate the information. Errors are displayed on the screen.
  - When all the information is valid, a confirmation screen is displayed. The operator visually confirms that the data are correct and either accepts the transaction or cancels it.
  - Accepted transactions add new members to the MEMBERSHIP MASTER file, which is stored on the laptop hard drive.
  - Accepted transactions are written to a MEMBERSHIP JOURNAL file, which is stored on a second hard drive.

## GROUP PROJECTS

- Meet with your group to develop a context-level data flow diagram for Maverick Transport (first introduced in Chapter 4). Use any data you have subsequently generated with your group about Maverick Transport. (*Hint:* Concentrate on one of the company's functional areas rather than try to model the entire organization.)
- Using the context-level diagram developed in Problem 1, develop with your group a level 0 logical data flow diagram for Maverick Transport. Make any assumptions necessary to draw it. List them.
- With your group, choose one key process and explode it into a logical child diagram. Make any assumptions necessary to draw it. List follow-up questions and suggest other methods to get more information about processes that are still unclear to you.
- Use the work your group has done to date to create a physical data flow diagram of a portion of the new system you are proposing for Maverick Transport.

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## EPISODE 7

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

## Just Flowing Along

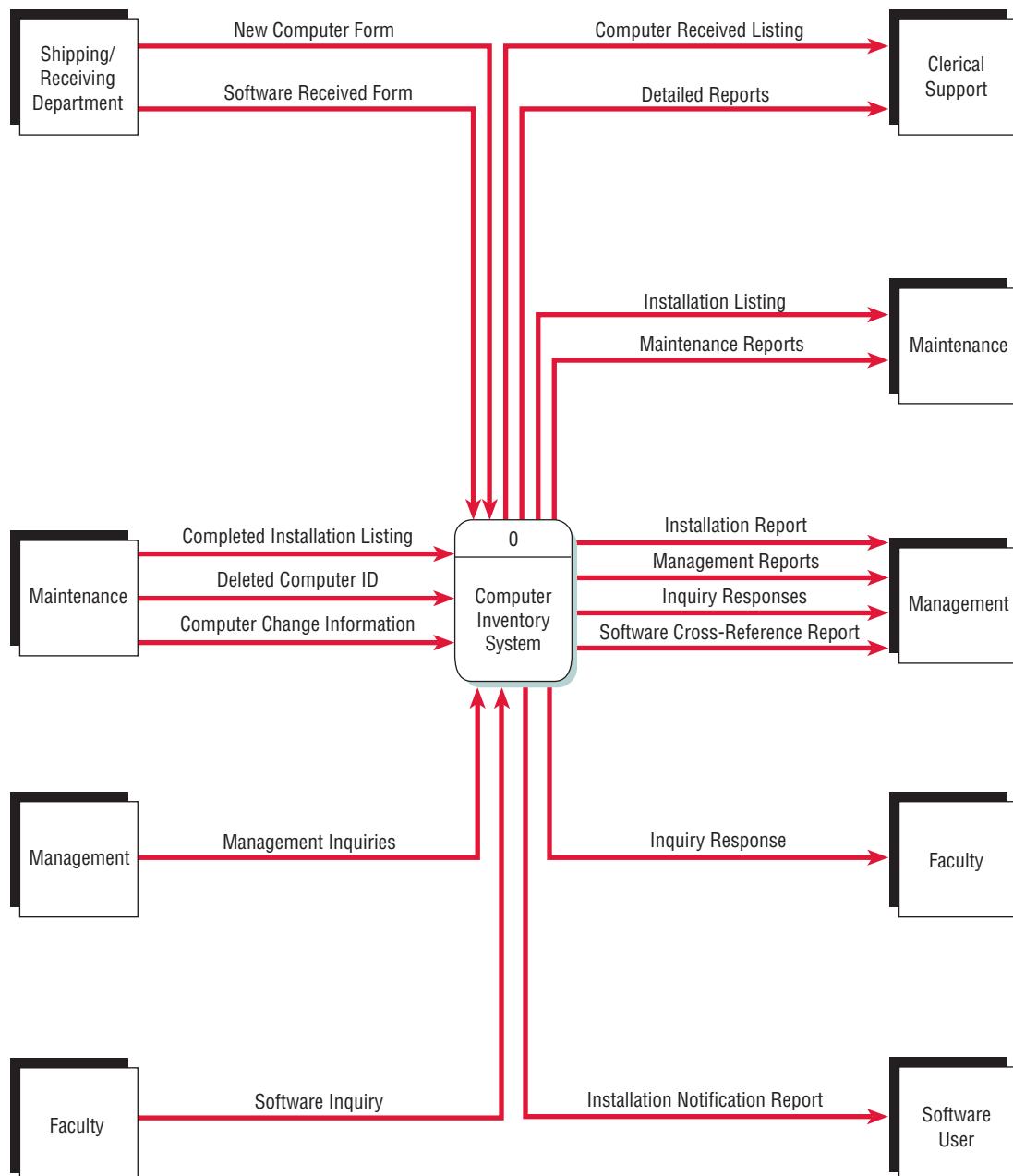
After the results of interviews, questionnaires, and prototyping are gathered and analyzed, Anna and Chip move to the next step, modeling the system. Their strategy is to create a layered set of data flow diagrams and then describe the components.

Anna says, “Let’s take the current logical data flow diagrams and add all the requirements and desired features of the new system. We can also eliminate any of the unnecessary features that wouldn’t be implemented in the new system.”

Anna then takes the context-level diagram (shown in the CPU Case in Chapter 2) and adds many of the reports, inquiries, and other information that will be included in the new system. The finished context-level diagram is shown in Figure E7.1. Notice the many new data flows. In the proposed system, the computer MAIN-

**FIGURE E7.1**

Context-level data flow diagram,  
Proposed CPU Computer  
Inventory 15 System.



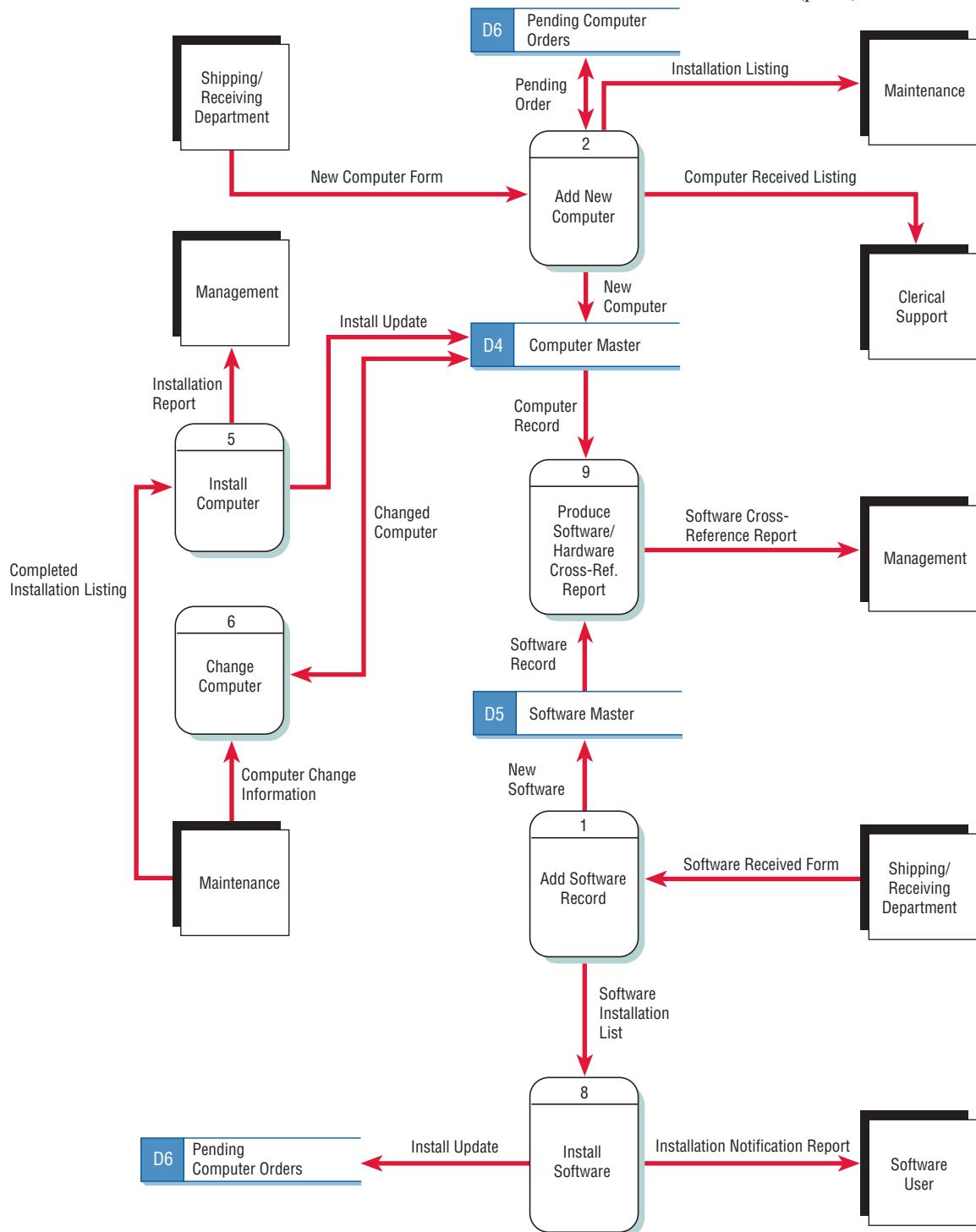
TENANCE staff will receive reports that currently are not available. One report, for example, helps to automate the installation of new computers, the INSTALLATION LISTING, and another report intended for management shows which software is located on which machines, the SOFTWARE CROSS-REFERENCE REPORT.

Anna continues, “Let’s expand this to Diagram 0 for the new system. This will be a logical data flow diagram because we want to focus on the business needs. Perhaps it would be best if we work in a team for this diagram.”

After working for several hours that afternoon and a good portion of the next morning, they complete the diagram. It is reviewed and modified with some minor changes. The finished Diagram 0 is shown in Figure E7.2 and Figure E7.3. Because it is a logical diagram, it shows no physical data entry method or validation

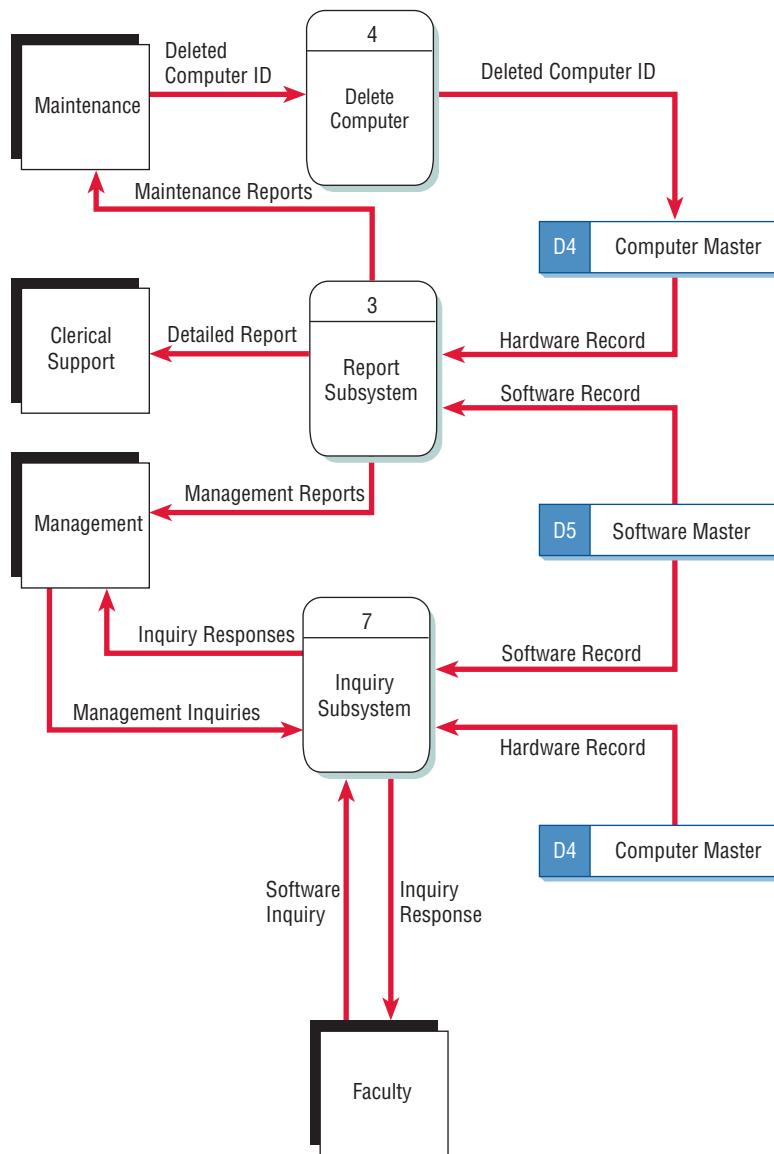
**FIGURE E7.2**

Diagram 0: Proposed CPU Computer Inventory System (part 1).



**FIGURE E7.3**

Diagram 0: Proposed CPU Computer Inventory System (part 2).



operations, nor does it show any temporary data stores or transaction files. Timing is not a consideration (an example is the ADD NEW COMPUTER process, in which it appears that orders are updated and reports produced simultaneously).

"This finally looks right," muses Chip. "All the major processes, data flows, and data stores are accounted for. And the overall diagram doesn't look too complicated."

"Putting all of the inquiries into one subsystem and all the reports into another helped. Remember how complex the original diagram was?" asks Anna.

"I sure do," Chip replies. "I started to think we were tackling too much at once with this system. At least it's more manageable now. Now that this is finished, what's the next step?"

"We need to describe Diagram 0 in more detail," remarks Anna. "We'll do this by drawing a level 1 diagram for each of the processes in Diagram 0. Just as a parent may have many children, there may be many level 1 diagrams for a specific level 0 diagram. For this reason many analysts refer to them as parent and child diagrams."

"I've been working on Diagram 1, an explosion of process 1, called ADD SOFTWARE RECORD. Perhaps you would like to review the finished result," remarks Anna. This Diagram 1 can be seen in Figure E7.4.

Chip and Anna both use Visible Analyst to verify that the data flow diagram syntax is correct. Visible Analyst will also check that the levels balance among data flow diagram processes and the child diagrams.

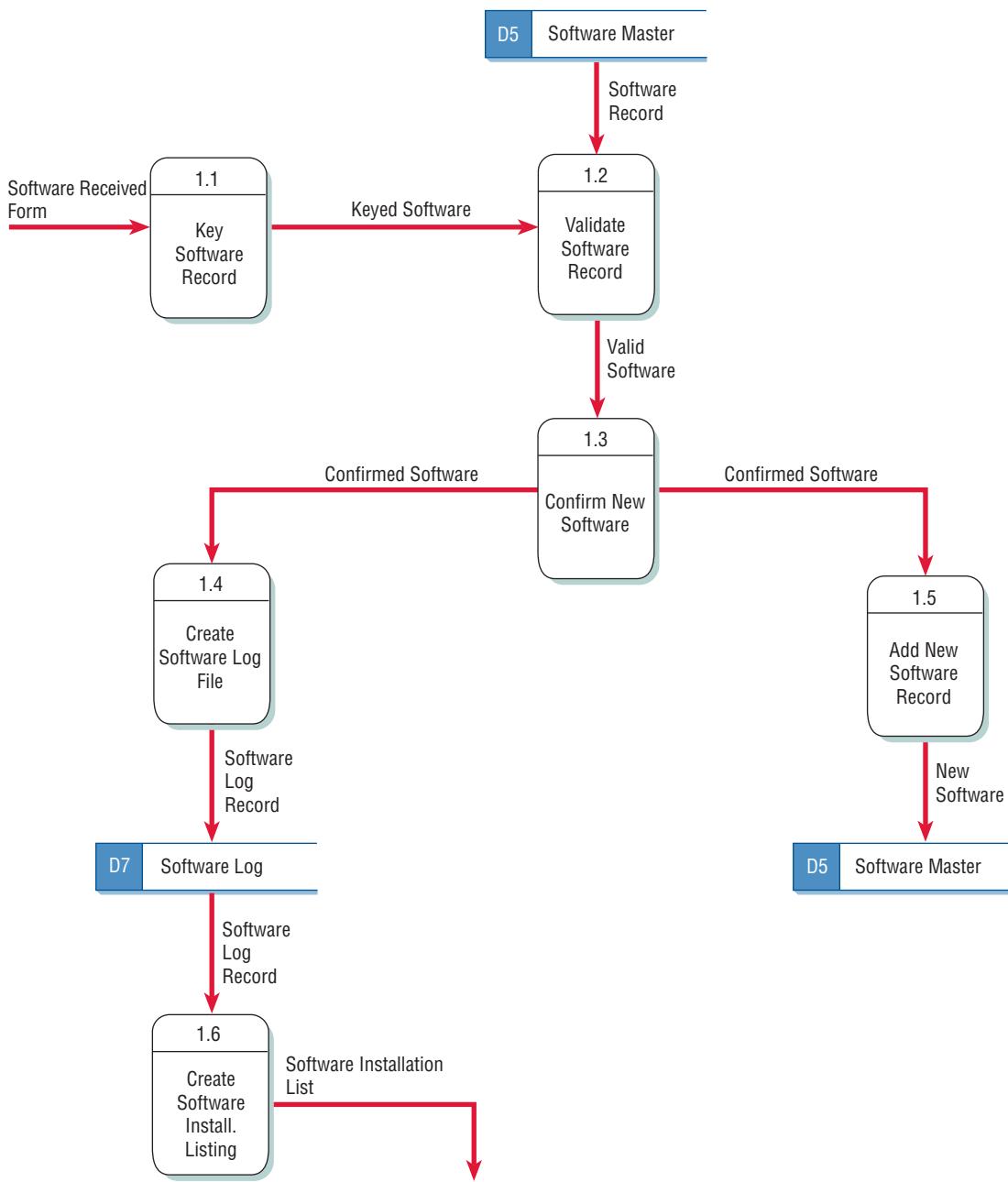
**FIGURE E7.4**

Diagram 1: ADD SOFTWARE RECORD from the proposed CPU Computer System.

## EXERCISES

- E-1.** Use Microsoft Visio or Visible Analyst to view the context-level diagram for the proposed computer system. If you are using Visible Analyst, experiment with the **Zoom** controls on the lower toolbar to change from a global to a detailed view of the diagram. Double click on the central process to examine the repository entry for it. Click **Exit** to return to the diagram. Right click on the central process to display the object menu for the central process. Use the **Explode** option to display Diagram 0, representing the details of the central process. Maximize the window and double click on some of the data stores and data flows to examine their repository entries. Click **Exit** to return to the diagram. Zoom to 100 percent and scroll around the screen to view different regions of the diagram; then print the diagram using a landscape orientation. Click **FILE**, **NEST**, and **PARENT** to return to the context-level diagram. Maximize the window.
- E-2.** Modify Diagram 0 of the proposed computer system. Add process 10, UPDATE SOFTWARE RECORD. You will have to move the MANAGEMENT external entity lower in the diagram; place it to the left of process 7, INQUIRY SUBSYSTEM. Create a repository entry for the process and then click **Exit** to return to the diagram. Print the diagram using a landscape orientation.



Input: 1. SOFTWARE CHANGE DATA, from CLERICAL SUPPORT  
 2. SOFTWARE DELETE ID, from MANAGEMENT  
 Output: 1. SOFTWARE RECORD, an update from the SOFTWARE MASTER data store



- E-3.** Modify Diagram 10, UPDATE SOFTWARE RECORD. Connect to the SOFTWARE MASTER using a double-headed arrow. (If you are using Visible Analyst, right click on the data flow, select **Change Item**, then select **Change Type**, and **Terminator Type, Double Filled**.) Print the final diagram.



- E-4.** Modify Diagram 8, INSTALL SOFTWARE. Add the following processes. Zoom in and scroll around the screen, checking your diagram for a professional appearance. Print the final result.

Process: 8.2 INSTALL COMPUTER SOFTWARE

Input: 1. COMPUTER LOCATION, from process 8.1  
 2. SOFTWARE TITLE AND VERSION, from process 8.1

Output: 1. INSTALLED SOFTWARE FORM

Process: 8.3 CREATE INSTALLED SOFTWARE TRANSACTION

Input: 1. INSTALLED SOFTWARE FORM

Output: 1. INSTALLED SOFTWARE TRANSACTION, to INSTALLED SOFTWARE data store

Process: 8.4 UPDATE SOFTWARE MASTER

Input: 1. INSTALLED SOFTWARE TRANSACTION

Output: 1. SOFTWARE MASTER, update

Process: 8.5 PRODUCE INSTALLATION NOTIFICATION

Input: 1. INSTALLED SOFTWARE TRANSACTION

2. SOFTWARE MASTER, from the SOFTWARE MASTER data store

3. HARDWARE MASTER, from the COMPUTER MASTER data store

Output: 1. INSTALLATION NOTIFICATION LISTING, an interface flow



- E-5.** Modify Diagram 6, CHANGE COMPUTER RECORD. This is an online program to change computer information. Add the following three processes. Create repository entries for each of the processes, as well as the data flow. When completed, zoom to 100 percent and change any data flow arrows that are not straight, and move data flow labels for a professional-looking graph. Print the diagram using landscape orientation.

- Process 6.6, VALIDATE CHANGES. This process edits each change field for validity. The input is the KEYED CHANGES. The output fields are CHANGE ERRORS (interface flow) and VALID CHANGES (to process 6.7).
- Process 6.7, CONFIRM CHANGES. This process is a visual confirmation of the changes. The operator has a chance to reject the changes or accept them. Input is the VALID CHANGES. The output fields are REJECTED CHANGES (interface flow) and CONFIRMED CHANGES (to process 6.8).
- Process 6.8, REWRITE COMPUTER MASTER. This process rewrites the COMPUTER MASTER record with the changes on the record. Input is the CONFIRMED CHANGES. Output flow is the COMPUTER MASTER record, to the COMPUTER MASTER data store.



- E-6.** Create the child data flow diagram for process 4, DELETE COMPUTER. The following table summarizes input, process, and output. Describe each process and data flow in the repository. When completed, zoom to 100 percent, move any data flow lines that are not aligned correctly, move the data flow labels for a professional-looking graph, and print the diagram.

Process: 4.1 KEY DELETE ID

Description: The computer ID is keyed interactively

Input: 1. DELETED COMPUTER ID

Output: 1. KEYED DELETE

Process: 4.2 OBTAIN COMPUTER RECORD

Description: COMPUTER MASTER record is read to ensure that it exists

Input: 1. KEYED DELETE (interface)

2. COMPUTER RECORD, from the COMPUTER MASTER data store

Output: 1. NOT FOUND ERROR (interface)

2. VALID COMPUTER RECORD

Process: 4.3 CONFIRM COMPUTER DELETION

Description: The computer information is displayed on the screen for operator confirmation or rejection

Input: 1. VALID COMPUTER RECORD

Output: 1. REJECTED DELETION (interface)  
2. CONFIRMED DELETION

Process: 4.4 DELETE COMPUTER RECORD

Description: The computer record is *logically* (not physically) deleted from the COMPUTER MASTER data store by rewriting the record with an I for inactive in the Record Code field

Input: 1. CONFIRMED DELETION

Output: 1. DELETED COMPUTER, a double-headed arrow to the COMPUTER MASTER data store

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

# CHAPTER 8

## Analyzing Systems Using Data Dictionaries

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand how analysts use data dictionaries for analyzing data-oriented systems.
2. Create data dictionary entries for data processes, stores, flows, structures, and logical and physical elements of the systems being studied, based on DFDs.
3. Understand the concept of a repository for analysts' project information and the role of CASE tools in creating them.
4. Recognize the functions of data dictionaries in helping users update and maintain information systems.



After successive levels of data flow diagrams are complete, systems analysts use them to help catalog the data processes, flows, stores, structures, and elements in a data dictionary. Of particular importance are the names used to characterize data items. When given an opportunity to name components of data-oriented systems, the systems analyst needs to work at making the name meaningful but exclusive of other existing data component names. This chapter covers the data dictionary, which is another method to aid in the analysis of data-oriented systems.

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### THE DATA DICTIONARY

The data dictionary is a specialized application of the kinds of dictionaries used as references in everyday life. The data dictionary is a reference work of data about data (that is, *metadata*), one that is compiled by systems analysts to guide them through analysis and design. As a document, the data dictionary collects and coordinates specific data terms, and it confirms what each term means to different people in the organization. The data flow diagrams covered in Chapter 7 are an excellent starting point for collecting data dictionary entries.

One important reason for maintaining a data dictionary is to keep clean data. This means that data must be consistent. If you store data about a man's sex as "M" in one record, "Male" in a second record, and as the number "1" in a third record, the data are not clean. Keeping a data dictionary will help in this regard.

Automated data dictionaries (part of the CASE tools mentioned earlier) are valuable for their capacity to cross-reference data items, thereby allowing necessary program changes to all programs sharing a common element. This feature supplants changing programs on a haphazard basis, or it prevents waiting until the program won't run because a change has not been implemented across all programs sharing the updated item. Clearly, automated data dictionaries become important for large systems that produce several thousand data elements requiring cataloging and cross-referencing.

## Need for Understanding the Data Dictionary

Many database management systems now come equipped with an automated data dictionary. These dictionaries can be either elaborate or simple. Some computerized data dictionaries automatically catalog data items when programming is done; others simply provide a template to prompt the person filling in the dictionary to do so in a uniform manner for every entry.

Despite the existence of automated data dictionaries, understanding what data compose a data dictionary, the conventions used in data dictionaries, and how a data dictionary is developed are issues that remain pertinent for the systems analyst during the systems effort. Understanding the process of compiling a data dictionary can aid the systems analyst in conceptualizing the system and how it works. The upcoming sections allow the systems analyst to see the rationale behind what exists in automated data dictionaries.

In addition to providing documentation and eliminating redundancy, the data dictionary may be used to:

1. Validate the data flow diagram for completeness and accuracy.
2. Provide a starting point for developing screens and reports.
3. Determine the contents of data stored in files.
4. Develop the logic for data flow diagram processes.
5. Create XML (extensible markup language).

## THE DATA REPOSITORY

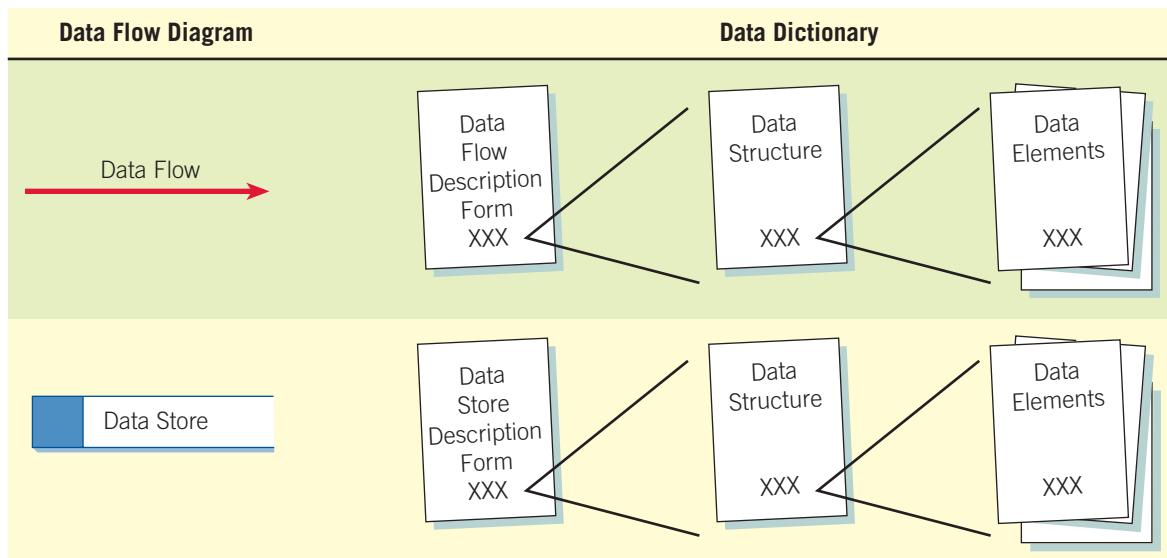
Although the data dictionary contains information about data and procedures, a larger collection of project information is called a repository. The repository concept is one of the many impacts of CASE tools and may contain the following:

1. Information about the data maintained by the system, including data flows, data stores, record structures, elements, entities, and messages.
2. Procedural logic and use cases.
3. Screen and report design.
4. Data relationships, such as how one data structure is linked to another.
5. Project requirements and final system deliverables.
6. Project management information, such as delivery schedules, achievements, issues that need resolving, and project users.

The data dictionary is created by examining and describing the contents of the data flows, data stores, and processes, as illustrated by Figure 8.1. Each data store and data flow should be defined and then expanded to include the details of the elements it contains. The logic of each process should be described using the data flowing into or out of the process. Omissions and other design errors should be noted and resolved.

**FIGURE 8.1**

How data dictionaries relate to data flow diagrams.



The four data dictionary categories—data flows, data structures, data elements, and data stores—should be developed to promote understanding of the data of the system. Procedural logic is presented in Chapter 9, entities are discussed in Chapter 13, and messages and use cases are presented in Chapters 2 and 10.

To illustrate how data dictionary entries are created, we use an example for World's Trend Catalog Division. This company sells clothing and other items by mail order using a toll-free phone order system (or faxing the mail order form), and via the Internet using customized Web forms. Regardless of the origin of the order, the underlying data captured by the system are the same for all three methods.

The World's Trend order form shown in Figure 8.2 gives some clues about what to enter into a data dictionary. First, you need to capture and store the name, address, and telephone number of the person placing the order. Then you need to address the details of the order: the item description, size, color, price, quantity, and so on. The customer's method of payment must also be determined. Once you have done this, these data may be stored for future use. This example is used throughout this chapter to illustrate each part of the data dictionary.

### Defining the Data Flows

Data flows are usually the first components to be defined. System inputs and outputs are determined from interviewing, observing users, and analyzing documents and other existing systems. The information captured for each data flow may be summarized using a form containing the following information:

1. ID, an optional identification number. Sometimes the ID is coded using a scheme to identify the system and the application in the system.
2. A unique descriptive name for this data flow. This name is the text that should appear on the diagram and be referenced in all descriptions using the data flow.
3. A general description of the data flow.
4. The source of the data flow. The source could be an external entity, a process, or a data flow coming from a data store.
5. The destination of the data flow (same items listed under the source).
6. An indication of whether the data flow is a record entering or leaving a file or a record containing a report, form, or screen. If the data flow contains data that are used between processes, it is designated as *internal*.
7. The name of the data structure describing the elements found in this data flow. For a simple data flow, it could be one or several elements.
8. The volume per unit of time. The data could be records per day or any other unit of time.
9. An area for further comments and notations about the data flow.

**FIGURE 8.2**

An online order form from World's Trend Catalog Division.

The screenshot shows a web browser window for "World's Trend Order Confirmation - Mozilla Firefox". The URL is <https://www.worldstrendonline.com/checkout/confirm.php?oid=290495>. The page title is "Customer Order Confirmation". It displays the following information:

**Customer Order Confirmation**

Please review the information below and click the Confirm Order button to place your order. Click the Change Order button to modify the order. The Save Order button will save the order and close the shopping cart.

Name	Gilbert Sullivan	Customer Number	09288
Street	116 Buttercup Lane	Apartment	
City	Penzance	State or Province	PA
Zip or Mailing Code	17057	Country	United States
Telephone Number	(215) 747-2837	Email Address	gsullivan@sympatico.net
Order Date	09-18-2010	Discount catalog code	9401A

**Method of Payment**

<input checked="" type="checkbox"/> Charge	<input type="checkbox"/> Bank Account	<input type="checkbox"/> PayPal	<input type="checkbox"/> Discover
<input checked="" type="checkbox"/> World's Trend	<input type="checkbox"/> MasterCard	<input type="checkbox"/> Visa	<input type="checkbox"/> AmExpress
Credit Card Number: xxxxxxxx1234		Expiration Date (mm/yyyy): 06/2015	

**Merchandise Total** **77.00**

Tax (CT Only)

Shipping and Handling **9.80**

**Order Total** **86.80**

I have read and agree to the [terms and conditions](#).

Once again we can use our World's Trend Catalog Division example from Chapter 7 to illustrate a completed form. Figure 8.3 is an example of the data flow description representing the screen used to add a new CUSTOMER ORDER and to update the customer and item files. Notice that the external entity CUSTOMER is the source and that PROCESS 1 is the destination, providing linkage back to the data flow diagram. The checked box for "Screen" indicates that the flow represents an input screen. It could be any screen, such as a Web page, graphical user interface (GUI), mobile phone, or perhaps a mainframe screen. The detailed description of the data flow could appear on this form, or it could be represented as a data structure.

Data flows for all inputs and outputs should be described first, because they usually represent the human interface, followed by the intermediate data flows and the data flows to and from data stores. The detail of each data flow is described using elements, sometimes called fields; a data structure; or a group of elements.

A simple data flow may be described using a single element, such as a customer number used by an inquiry program to find the matching customer record.

# Describing Data Structures

Data structures are usually described using algebraic notation. This method allows the analyst to produce a view of the elements that make up the data structure along with information about those elements. For instance, the analyst will denote whether there are many of the same element in the data structure (a repeating group), or whether two elements may exist mutually exclusive of each other. The algebraic notation uses the following symbols:

1. An equal sign (=) means “is composed of.”
  2. A plus sign (+) means “and.”
  3. Braces { } indicate repetitive elements, also called repeating groups or tables. There may be one repeating element or several in the group. The repeating group may have conditions, such as a fixed number of repetitions, or upper and lower limits for the number of repetitions.

## FIGURE 8.3

An example of a data flow description from World's Trend Catalog Division.

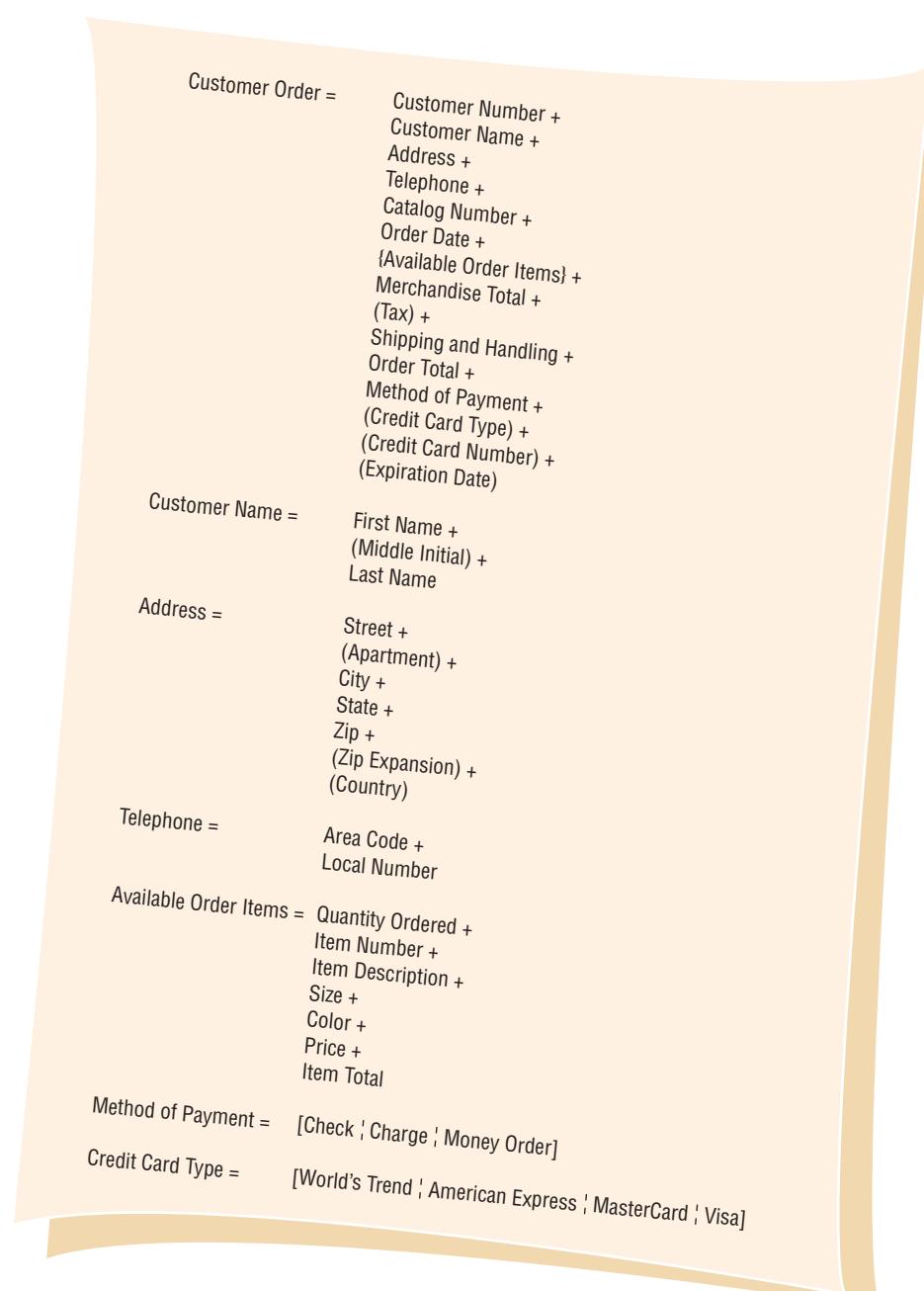
Data Flow Description			
ID Name Description	<u>Customer Order</u> <u>Contains customer order information and is used to update the customer master and item files and to produce an order record.</u>		
Source <i>Customer</i>	Destination <i>Process 1</i>		
Type of Data Flow <input type="checkbox"/> File <input checked="" type="checkbox"/> Screen <input type="checkbox"/> Report <input type="checkbox"/> Form <input type="checkbox"/> Internal			
Data Structure Traveling with the Flow <i>Order Information</i>	Volume/Time 10/hour		
Comments <i>Order record information for one customer order. The order may be received by Web entry, email, FAX, or by the customer telephoning the order-processing department directly.</i>			
<hr/> <hr/> <hr/>			

4. Brackets [ ] represent an either/or situation. Either one element may be present or another, but not both. The elements listed between the brackets are mutually exclusive.
5. Parentheses ( ) represent an optional element. Optional elements may be left blank on entry screens and may contain spaces or zeros for numeric fields in file structures.

Figure 8.4 is an example of the data structure for adding a customer order at World's Trend Catalog Division. Each NEW CUSTOMER screen consists of the entries found on the right side of the equal signs. Some of the entries are elements, but others, such as CUSTOMER NAME, ADDRESS, and TELEPHONE, are groups of elements or structural records. For example, CUSTOMER NAME is made up of FIRST NAME, MIDDLE INITIAL, and LAST NAME. Each structural record must be further defined until the entire set is broken down into its component elements. Notice that following the definition for the CUSTOMER ORDER screen are definitions for each structural record. Even a field as simple as the TELEPHONE NUMBER is defined as a structure so that the area code may be processed individually.

#### FIGURE 8.4

Data structure example for adding a customer order at World's Trend Catalog Division.



Structural records and elements that are used in many different systems are given a nonsystem-specific name, such as street, city, and zip, that does not reflect the functional area in which they are used. This method allows the analyst to define these records once and use them in many different applications. For example, a city may be a customer city, supplier city, or employee city. Notice the use of parentheses to indicate that (MIDDLE INITIAL), (APARTMENT), and (ZIP EXPANSION) are optional ORDER information (but not more than one). Indicate the OR condition by enclosing the options in square brackets and separating them with the symbol '|.

### Logical and Physical Data Structures

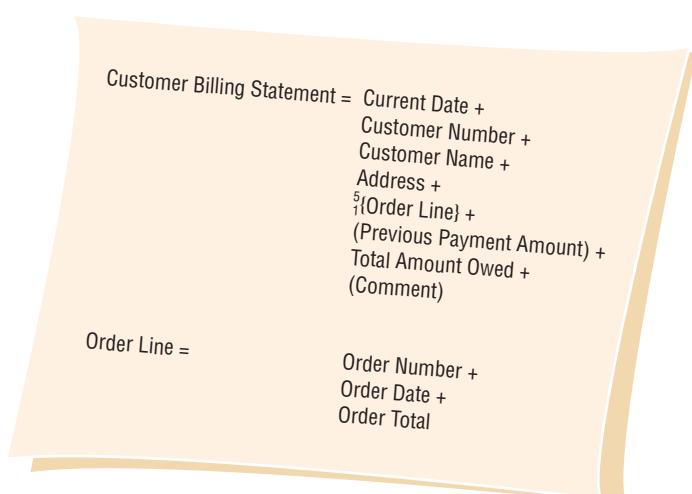
When data structures are first defined, only the data elements that the user would see, such as a name, address, and balance due, are included. This stage is the logical design, showing what data the business needs for its day-to-day operations. As we learned from HCI, it is important that the logical design accurately reflect the mental model of how the user views the system. Using the logical design as a basis, the analyst then designs the physical data structures, which include additional elements necessary for implementing the system. Examples of physical design elements are the following:

1. Key fields used to locate records in a database table. An example is an item number, which is not required for a business to function but is necessary for identifying and locating computer records.
2. Codes to identify the status of master records, such as whether an employee is active (currently employed) or inactive. Such codes can be maintained on files that produce tax information.
3. Transaction codes are used to identify types of records when a file contains different record types. An example is a credit file containing records for returned items as well as records of payments.
4. Repeating group entries containing a count of how many items are in the group.
5. Limits on the number of items in a repeated group.
6. A password used by a customer accessing a secure Web site.

Figure 8.5 is an example of the data structure for a CUSTOMER BILLING STATEMENT, one showing that the ORDER LINE is both a repeating item and a structural record. The ORDER LINE limits are from 1 to 5, indicating that the customer may order from one to five items on this screen. Additional items would appear on subsequent orders.

The repeating group notation may have several other formats. If the group repeats a fixed number of times, that number is placed next to the opening brace, as in 12 {Monthly Sales}, where there are always 12 months in the year. If no number is indicated, the group repeats indefinitely. An example is a table containing an indefinite number of records, such as Customer Master Table = {Customer Records}.

The number of entries in repeating groups may also depend on a condition, such as an entry on the Customer Master Record for each item ordered. This condition could be stored in the data dictionary as {Items Purchased} 5, where 5 is the number of items.



**FIGURE 8.5**

Physical elements added to a data structure.

## Data Elements

Each data element should be defined once in the data dictionary and may also be entered previously on an element description form, such as the one illustrated in Figure 8.6. Characteristics commonly included on the element description form are the following:

1. Element ID. This optional entry allows the analyst to build automated data dictionary entries.
2. The name of the element. The name should be descriptive, unique, and based on what the element is commonly called in most programs or by the major user of the element.
3. Aliases, which are synonyms or other names for the element. Aliases are names used by different users in different systems. For example, a CUSTOMER NUMBER may also be called a RECEIVABLE ACCOUNT NUMBER or a CLIENT NUMBER.
4. A short description of the element.
5. Whether the element is base or derived. A base element is one that is initially keyed into the system, such as a customer name, address, or city. Base elements must be stored in files. Derived elements are created by processes as the result of a calculation or a series of decision-making statements.
6. The length of an element. Some elements have standard lengths. In the United States, for example, lengths for state name abbreviations, zip codes, and telephone numbers are all

**FIGURE 8.6**

An element description form example from World's Trend Catalog Division.

Element Description Form																							
ID																							
Name	Customer Number																						
Alias	Client Number																						
Alias	Receivable Account Number																						
Description	Uniquely identifies a customer who has made any business transaction within the last five years.																						
<table border="0" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: left; padding-bottom: 5px;">Element Characteristics</th> </tr> </thead> <tbody> <tr> <td>Length</td> <td style="text-align: center;">6</td> <td>Dec. Pt. _____</td> </tr> <tr> <td>Input Format</td> <td style="text-align: center;">9 (6)</td> <td></td> </tr> <tr> <td>Output Format</td> <td style="text-align: center;">9 (6)</td> <td></td> </tr> <tr> <td>Default Value</td> <td colspan="2"></td> </tr> <tr> <td><input checked="" type="checkbox"/> Continuous or <input type="checkbox"/> Discrete</td> <td colspan="2"></td> </tr> </tbody> </table> <div style="margin-top: 10px;"> <input type="checkbox"/> Alphabetic  <input type="checkbox"/> Alphanumeric  <input type="checkbox"/> Date  <input checked="" type="checkbox"/> Numeric  <input type="checkbox"/> Base or <input checked="" type="checkbox"/> Derived         </div>						Element Characteristics			Length	6	Dec. Pt. _____	Input Format	9 (6)		Output Format	9 (6)		Default Value			<input checked="" type="checkbox"/> Continuous or <input type="checkbox"/> Discrete		
Element Characteristics																							
Length	6	Dec. Pt. _____																					
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<table border="0" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="3" style="text-align: left; padding-bottom: 5px;">Validation Criteria</th> </tr> </thead> <tbody> <tr> <td style="vertical-align: top; width: 30%;">Continuous</td> <td style="width: 30%; vertical-align: top;">           Upper Limit  <u>&lt;999999</u> </td> <td style="width: 40%; vertical-align: top;">           Discrete Value  <u>                  </u>            Meaning  <u>                  </u> </td> </tr> <tr> <td>Upper Limit</td> <td><u>&lt;999999</u></td> <td></td> </tr> <tr> <td>Lower Limit</td> <td><u>&gt;0</u></td> <td></td> </tr> </tbody> </table>						Validation Criteria			Continuous	Upper Limit <u>&lt;999999</u>	Discrete Value <u>                  </u> Meaning <u>                  </u>	Upper Limit	<u>&lt;999999</u>		Lower Limit	<u>&gt;0</u>							
Validation Criteria																							
Continuous	Upper Limit <u>&lt;999999</u>	Discrete Value <u>                  </u> Meaning <u>                  </u>																					
Upper Limit	<u>&lt;999999</u>																						
Lower Limit	<u>&gt;0</u>																						
Comments <u>The customer number must pass a modulus-11 check digit test.</u> <u>It is derived because it is computer generated and a check digit is added.</u>																							

standard. For other elements, the lengths may vary, and the analyst and user community must jointly decide the final length based on the following considerations:

- Numeric amount lengths should be determined by figuring the largest number the amount will probably contain and then allowing reasonable room for expansion. Lengths designated for totals should be large enough to accommodate the sum of the numbers accumulated in them.
- Name and address fields may be given lengths based on the following table. For example, a last name field of 11 characters will accommodate 98 percent of the last names in the United States.
- For other fields, it is often useful to examine or sample historical data found in the organization to determine a suitable field length.

<i>Field</i>	<i>Length</i>	<i>Percentage of Data That Will Fit (U.S.)</i>
Last Name	11	98
First Name	18	95
Company Name	20	95
Street	18	90
City	17	99

If the element is too small, the data that need to be entered will be truncated. The analyst must decide how that will affect the system outputs. For example, if a customer's last name is truncated, mail would usually still be delivered; if an email address is truncated, however, it will be returned as not found.

- The type of data—numeric, date, alphabetic, varchar, or character, which is sometimes called alphanumeric or text data. Varchar data may contain any number of characters, up to a limit set by the database software. When using varchar, specifying the length is optional. Several of these formats are shown in Figure 8.7. Character fields may contain a mixture of letters, numbers, and special characters. If the element is a date, its format—for example, MMDDYYYY—must be determined. If the element is numeric, its storage type should be determined.

Personal computer formats, such as currency, number, or scientific, depend on how the data will be used. Number formats are further defined as integer, long integer, single precision, double precision, and so on. There are many other types of formats used with PC

<b>Data Type</b>	<b>Meaning</b>
Bit	A value of 1 or 0, a true/false value
Char, varchar, text	Any alphanumeric character
Datetime, smalldatetime	Alphanumeric data, several formats
Decimal, numeric	Numeric data that are accurate to the least significant digit; can contain a whole and decimal portion
Float, real	Floating-point values that contain an approximate decimal value
Int, smallint, tinyint	Only integer (whole digit) data
Currency, money, smallmoney	Monetary numbers accurate to four decimal places
Binary, varbinary, image	Binary strings (sound, pictures, video)
Cursor, timestamp, uniqueidentifier	A value that is always unique within a database
Autonumber	A number that is always incremented by one when a record is added to a database table

**FIGURE 8.7**

Some examples of data formats used in PC systems.

systems. Unicode is a standardized coding system for defining graphic symbols, such as Chinese or Japanese characters. Unicode is described in greater detail in a later chapter. There are three standard formats for mainframe computers: zoned decimal, packed decimal, and binary. The zoned decimal format is used for printing and displaying data. The packed decimal format is commonly used to save space on file layouts and for elements that require a high level of arithmetic to be performed on them. The binary format is suitable for the same purposes as the packed decimal format but is less commonly used.

8. Input and output formats should be included, using special coding symbols to indicate how the data should be presented. These symbols and their uses are illustrated in Figure 8.8. Each symbol represents one character or digit. If the same character repeats several times, the character followed by a number in parentheses indicating how many times the character repeats is substituted for the group. For example, XXXXXXXX would be represented as X(8).
9. Validation criteria for ensuring that accurate data are captured by the system. Elements are either discrete, meaning they have certain fixed values, or continuous, with a smooth range of values. Here are common editing criteria:
  - a. A range of values is suitable for elements that contain continuous data. For example, in the United States a student grade point average may be from 0.00 through 4.00. If there is only an upper or lower bound to the data, a limit is used instead of a range.
  - b. A list of values is indicated if the data are discrete. Examples are codes representing the colors of items for sale in World's Trend's catalog.
  - c. A table of codes is suitable if the list of values is extensive (for example, state abbreviations, telephone country codes, or U.S. telephone area codes.)
  - d. For key or index elements, a check digit is often included.
10. Any default value the element may have. The default value is displayed on entry screens and is used to reduce the amount of keying that the operator may have to do. Usually, several fields in each system have default values. When using GUI lists or drop-down lists, the default value is the one currently selected and highlighted. When using radio buttons, the option for the default value is selected, and when using check boxes, the default value (either “yes” or “no”) determines whether or not the check box will have an initial check in it.
11. An additional comment or remarks area. This might be used to indicate the format of the date, special validation that is required, the check digit method used (explained in Chapter 15), and so on.

Data element descriptions such as CUSTOMER NUMBER may be called CLIENT NUMBER elsewhere in the system (perhaps old code written with this alias needs to be updated).

Another kind of data element is an alphabetic element. At World's Trend Catalog Division, codes are used to describe colors: for example, BL for blue, WH for white, and GR for green. When this element is implemented, a table will be needed for users to look up the meanings of these codes. (Coding is discussed further in Chapter 15.)

### Data Stores

All base elements must be stored in the system. Derived elements, such as the employee year-to-date gross pay, may also be stored in the system. Data stores are created for each different data

**FIGURE 8.8**

Format character codes.

Formatting Character	Meaning
X	May enter or display/print any character
9	Enter or display only numbers
Z	Display leading zeros as spaces
,	Insert commas into a numeric display
.	Insert a period into a numeric display
/	Insert slashes into a numeric display
-	Insert a hyphen into a numeric display
V	Indicate a decimal position (when the decimal point is not included)

entity being stored. That is, when data flow base elements are grouped together to form a structural record, a data store is created for each unique structural record.

Because a given data flow may only show part of the collective data that a structural record contains, you may have to examine many different data flow structures to arrive at a complete data store description.

Figure 8.9 is a typical form used to describe a data store. The information included on the form is as follows:

1. The data store ID. The ID is often a mandatory entry to prevent the analyst from storing redundant information. An example would be D1 for the CUSTOMER MASTER.
2. The data store name, which is descriptive and unique.
3. An alias for the table, such as CLIENT MASTER for the CUSTOMER MASTER.
4. A short description of the data store.
5. The file type, either computer or manual.
6. The format designates whether the file is a database table or if it has the format of a simple flat file. (File formats are detailed in Chapter 13.)
7. The maximum and average number of records on the file as well as the growth per year.

This information helps the analyst to predict the amount of disk space required for the application and is necessary for hardware acquisition planning.

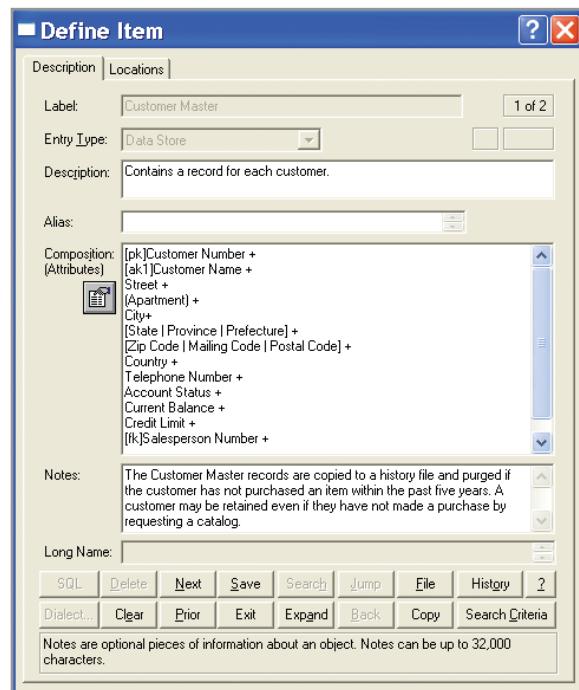
Data Store Description Form																									
ID	D1																								
Name	Customer Master																								
Alias	Client Master																								
Description	Contains a record for each customer.																								
<table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="4" style="text-align: center; font-weight: bold;">Data Store Characteristics</th> </tr> <tr> <td style="width: 25%;">File Type</td> <td style="width: 25%;"><input checked="" type="checkbox"/> Computer</td> <td style="width: 25%;"><input type="checkbox"/> Manual</td> <td style="width: 25%;"><input type="checkbox"/> Indexed</td> </tr> <tr> <td>File Format</td> <td><input checked="" type="checkbox"/> Database</td> <td></td> <td></td> </tr> </thead> <tbody> <tr> <td>Record Size (Characters):</td> <td>200</td> <td>Sequential</td> <td>Direct</td> </tr> <tr> <td>Number of Records: Maximum</td> <td>45,000</td> <td>Block Size: 4000</td> <td>Average: 42,000</td> </tr> <tr> <td>Percent Growth per Year:</td> <td>6 %</td> <td></td> <td></td> </tr> </tbody> </table>		Data Store Characteristics				File Type	<input checked="" type="checkbox"/> Computer	<input type="checkbox"/> Manual	<input type="checkbox"/> Indexed	File Format	<input checked="" type="checkbox"/> Database			Record Size (Characters):	200	Sequential	Direct	Number of Records: Maximum	45,000	Block Size: 4000	Average: 42,000	Percent Growth per Year:	6 %		
Data Store Characteristics																									
File Type	<input checked="" type="checkbox"/> Computer	<input type="checkbox"/> Manual	<input type="checkbox"/> Indexed																						
File Format	<input checked="" type="checkbox"/> Database																								
Record Size (Characters):	200	Sequential	Direct																						
Number of Records: Maximum	45,000	Block Size: 4000	Average: 42,000																						
Percent Growth per Year:	6 %																								
Data Set Name	Customer.MST																								
Copy Member	Custmast																								
Data Structure	Customer Record																								
Primary Key	Customer Number																								
Secondary Keys	Customer Name Zip Year-to-Date Amount Purchased																								
Comments	The Customer Master records are copied to a history file and purged if the customer has not purchased an item within the past five years. A customer may be retained even if he or she has not made a purchase by requesting a catalog.																								

**FIGURE 8.9**

An example of a data store form description for World's Trend Catalog Division.

**FIGURE 8.10**

Visible Analyst screen showing a data store description.



8. The file or data set name specifies the file name, if known. In the initial design stages, this item may be left blank. An electronic form produced using Visible Analyst is shown in Figure 8.10. This example shows that the CUSTOMER MASTER is stored on a computer in the form of a database with a maximum number of 45,000 records. (Records and the keys used to sort the database are explained in Chapter 13.)
9. The data structure should use a name found in the data dictionary, providing a link to the elements for this data store. Alternatively, the data elements could be described on the data store description form or on the CASE tool screen for the data store. Primary and secondary keys must be elements (or a combination of elements) found in the data structure. In the example, the CUSTOMER NUMBER is the primary key and should be unique. The CUSTOMER NAME, ZIP, and YEAR-TO-DATE AMOUNT PURCHASED are secondary keys used to control record sequencing on reports and to locate records directly. (Keys are discussed in Chapter 13.) Comments are used for information that does not fit into any of the above categories. They may include update or backup timing, security, or other considerations.

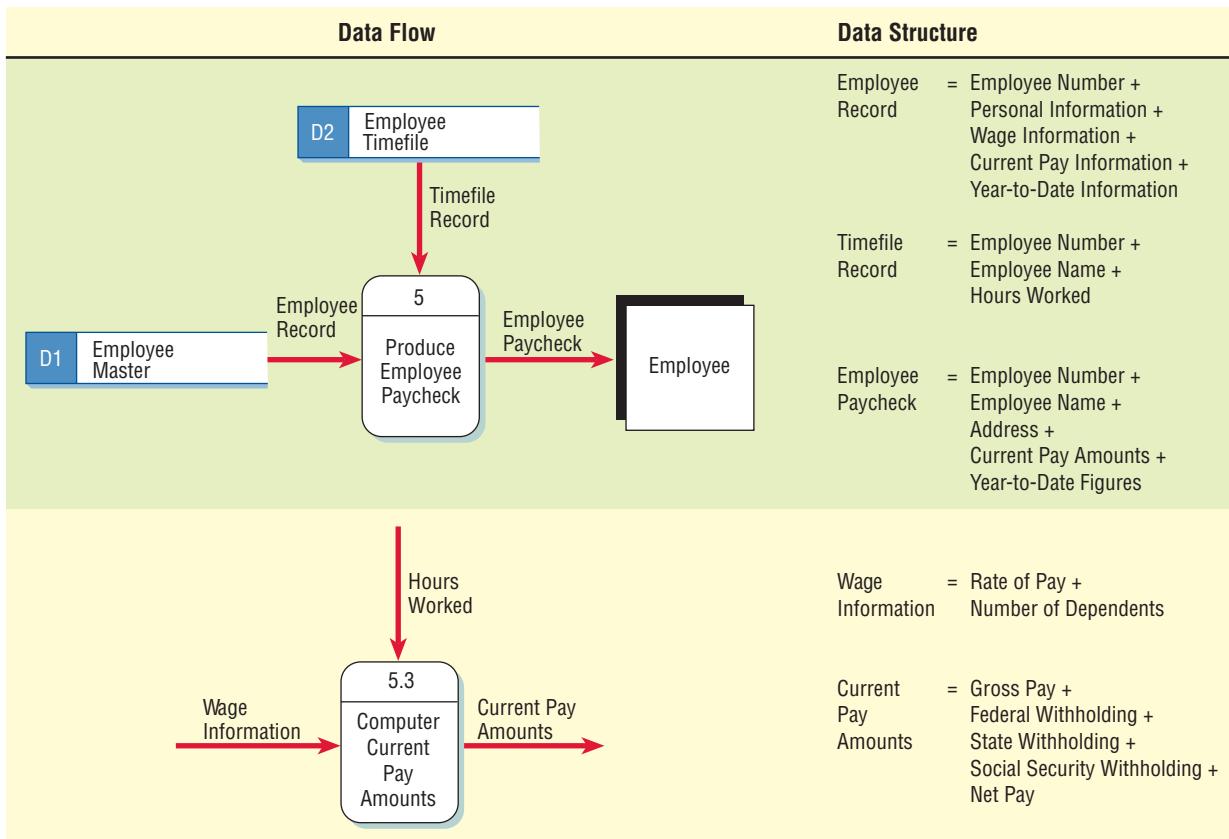
## CREATING THE DATA DICTIONARY

Data dictionary entries may be created after the data flow diagram has been completed, or they may be constructed as the data flow diagram is being developed. The use of algebraic notation and structural records allows the analyst to develop the data dictionary and the data flow diagrams using a top-down approach. For instance, the analyst may create a Diagram 0 data flow after the first few interviews and, at the same time, make the preliminary data dictionary entries. Typically, these entries consist of the data flow names found on the data flow diagram and their corresponding data structures.

After conducting several additional interviews with users to learn the details of the system and the ways they interact with it, the analyst will expand the data flow diagram and create the child diagrams. The data dictionary is then modified to include the new structural records and elements gleaned from further interviews, observation, and document analysis.

Each level of a data flow diagram should use data appropriate for the level. Diagram 0 should include only forms, screens, reports, and records. As child diagrams are created, the data flow into and out of the processes becomes more and more detailed, including structural records and elements.

Figure 8.11 illustrates a portion of two data flow diagram levels and corresponding data dictionary entries for producing an employee paycheck. Process 5, found on Diagram 0, is an



overview of the production of an EMPLOYEE PAYCHECK. The corresponding data dictionary entry for EMPLOYEE RECORD shows the EMPLOYEE NUMBER and four structural records, the view of the data obtained early in the analysis. Similarly, TIMEFILE RECORD and the EMPLOYEE PAYCHECK are also defined as a series of structures.

It is important that the data flow names on the child data flow diagram are contained as elements or structural records in the data flow on the parent process. Returning to the example, WAGE INFORMATION (input into process 5.3, COMPUTE CURRENT PAY AMOUNTS) is a structural record contained in the EMPLOYEE RECORD (input to process 5). Similarly, GROSS PAY (output from process 5.3.4, a lower-level process not shown in the figure) is contained in the structural record CURRENT PAY AMOUNTS (output from the parent process 5.3, COMPUTE CURRENT PAY AMOUNTS).

### Analyzing Input and Output

An important step in creating the data dictionary is to identify and categorize system input and output data flow. Input and output analysis forms contain the following commonly included fields:

1. A descriptive name for the input or output. If the data flow is on a logical diagram, the name should identify what the data are (for example, CUSTOMER INFORMATION). If the analyst is working on the physical design or if the user has explicitly stated the nature of the input or output, however, the name should include that information regarding the format. Examples are CUSTOMER BILLING STATEMENT and CUSTOMER DETAILS INQUIRY.
2. The user contact responsible for further details clarification, design feedback, and final approval.
3. Whether the data is input or output.
4. The format of the data flow. In the logical design stage, the format may be undetermined.
5. Elements indicating the sequence of the data on a report or screen (perhaps in columns).
6. A list of elements, including their names, lengths, and whether they are base or derived, and their editing criteria.

Once the form has been completed, each element should be analyzed to determine whether the element repeats, whether it is optional, or whether it is mutually exclusive of another element. El-

**FIGURE 8.11**

Two data flow diagrams and corresponding data dictionary entries for producing an employee paycheck.



## CONSULTING OPPORTUNITY 8.1

### Want to Make It Big in the Theatre? Improve Your Diction(ary)!

As you enter the door of Merman's, Annie Oaklea greets you warmly, saying, "I'm delighted with the work you have done on the data flow diagrams. I would like you to keep playing the role of systems analyst for Merman's and see if you can eventually get a new information system for our costume inventory sewn up. Unfortunately, some of the terms you're using don't come off very well in the language of Shakespeare. Bit of a translation problem, I suspect."

Clinging to Annie's initial praise, you are undaunted by her exit line. You determine that a data dictionary based on the rental and return data flow diagrams would make a big hit.

Begin by writing entries for a manual system in as much detail as possible. Prepare two data process entries, two data flow entries, two data store entries, one data structure entry, and four data element entries using the formats in this chapter. Portraying interrelated data items with precision will result in rave reviews. (Refer to Consulting Opportunity 7.1.)

ements that fall into a group or that regularly combine with several other elements in many structures should be placed together in a structural record.

These considerations can be seen in the completed Input and Output Analysis Form for World's Trend Catalog Division (see Figure 8.12). In this example of a CUSTOMER BILLING

**FIGURE 8.12**

An example of an input/output analysis form for World's Trend Catalog Division.

Input and Output Analysis Form				
Input/Output Name User Contact	Customer Billing Statement Susan Han			
File Type File Format	<input checked="" type="checkbox"/> Output <input checked="" type="checkbox"/> Report	<input type="checkbox"/> Input <input type="checkbox"/> Screen	<input type="checkbox"/> Undetermined	
Sequencing Element(s)	Zip Code (Page Sequence) Order Number			
Element Name	Length	B/D	Edit Criteria	
Current Date	6	B	(System Supplied)	
Customer Number	6	D	(Includes Check Digit)	
Customer First Name	20	B	Not Spaces	
Customer Last Name	15	B	Not Spaces	
Customer Middle Initial	1	B	A through Z or Space	
Street	20	B	Not Spaces	
Apartment	20	B	Not Spaces	
City	20	B	Not Spaces	
State	20	B	Not Spaces	
Zip	2	B	Not Spaces	
Order Number	9	B	Valid State Abbr.	
Order Date	6	D	Numeric, Last 4 Opt.	
Order Total	8	B	> 0	
Previous Payment Amount	9	D	MM/DD/YYYY	
Total Amount Owed	5	D	Format: 9 (7) V99	
Comment	9	D	Format: 9 (7) V99	
Comments	Print one page for each customer. If there are more items than will fit on a page, continue on a second page.			

STATEMENT, the CUSTOMER FIRST NAME, CUSTOMER LAST NAME, and CUSTOMER MIDDLE INITIAL should be grouped together in a structural record.

## Developing Data Stores

Another activity in creating the data dictionary is developing data stores. Up to now, we have determined what data needs to flow from one process to another. This information is described in data structures. The information, however, may be stored in numerous places, and in each place the data store may be different. Whereas data flows represent data in motion, data stores represent data at rest.

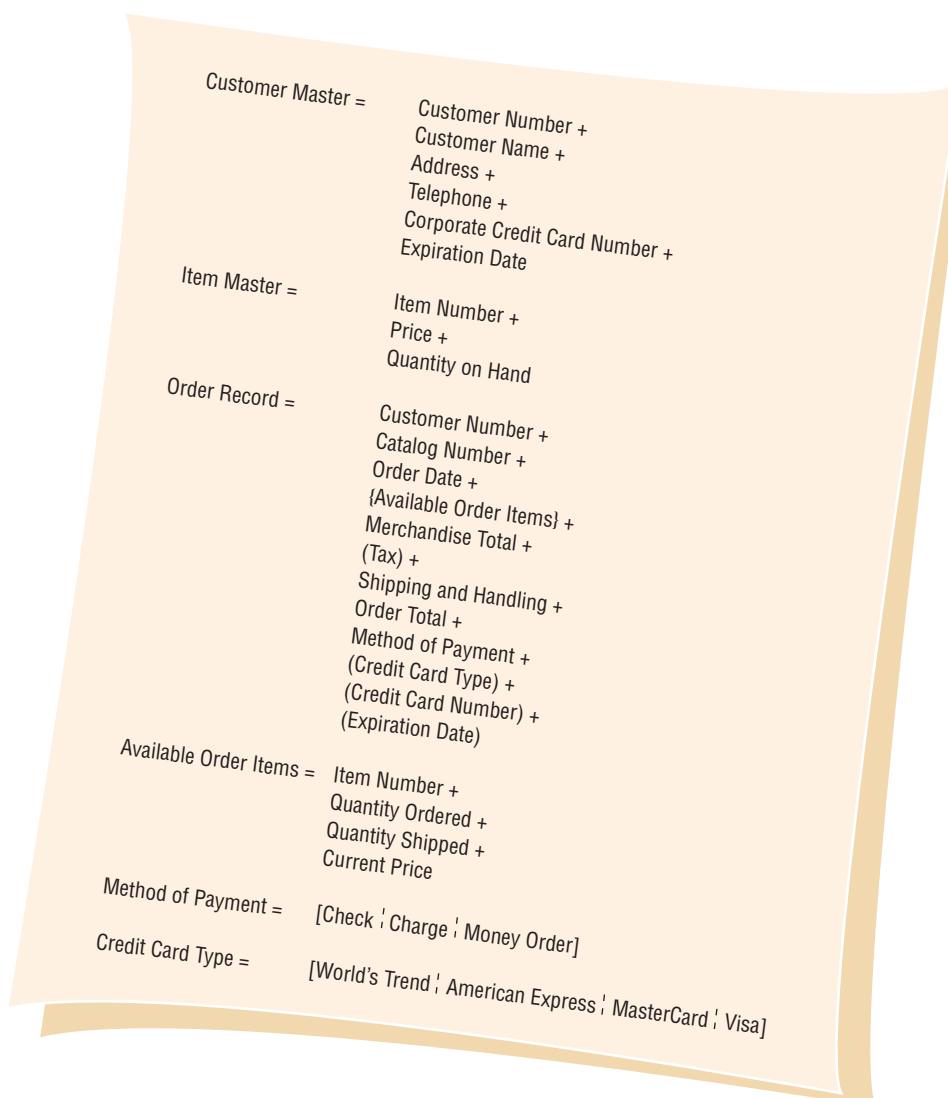
For example, when an order arrives at World's Trend (see Figure 8.13), it contains mostly temporary information, that is, the information needed to fill that particular order, but some information might be stored permanently. Examples of the latter include information about customers (so catalogs can be sent to them) and information about items (because these items will appear on many other customers' orders).

Data stores contain information of a permanent or semipermanent (temporary) nature. An ITEM NUMBER, DESCRIPTION, and ITEM COST are examples of information that is relatively permanent. So is the TAX RATE. When the ITEM COST is multiplied by the TAX RATE, however, the TAX CHARGED is calculated (or derived). Derived values do not have to be stored in a data store.

When data stores are created for only one report or screen, we refer to them as "user views," because they represent the way that the user wants to see the information.

**FIGURE 8.13**

Data stores derived from a pending order at World's Trend Catalog Division.



## USING THE DATA DICTIONARY

The ideal data dictionary is automated, interactive, online, and evolutionary. As the systems analyst learns about the organization's systems, data items are added to the data dictionary. On the other hand, the data dictionary is not an end in itself and must never become so. To avoid becoming sidetracked with the building of a complete data dictionary, the systems analyst should view it as an activity that parallels systems analysis and design.

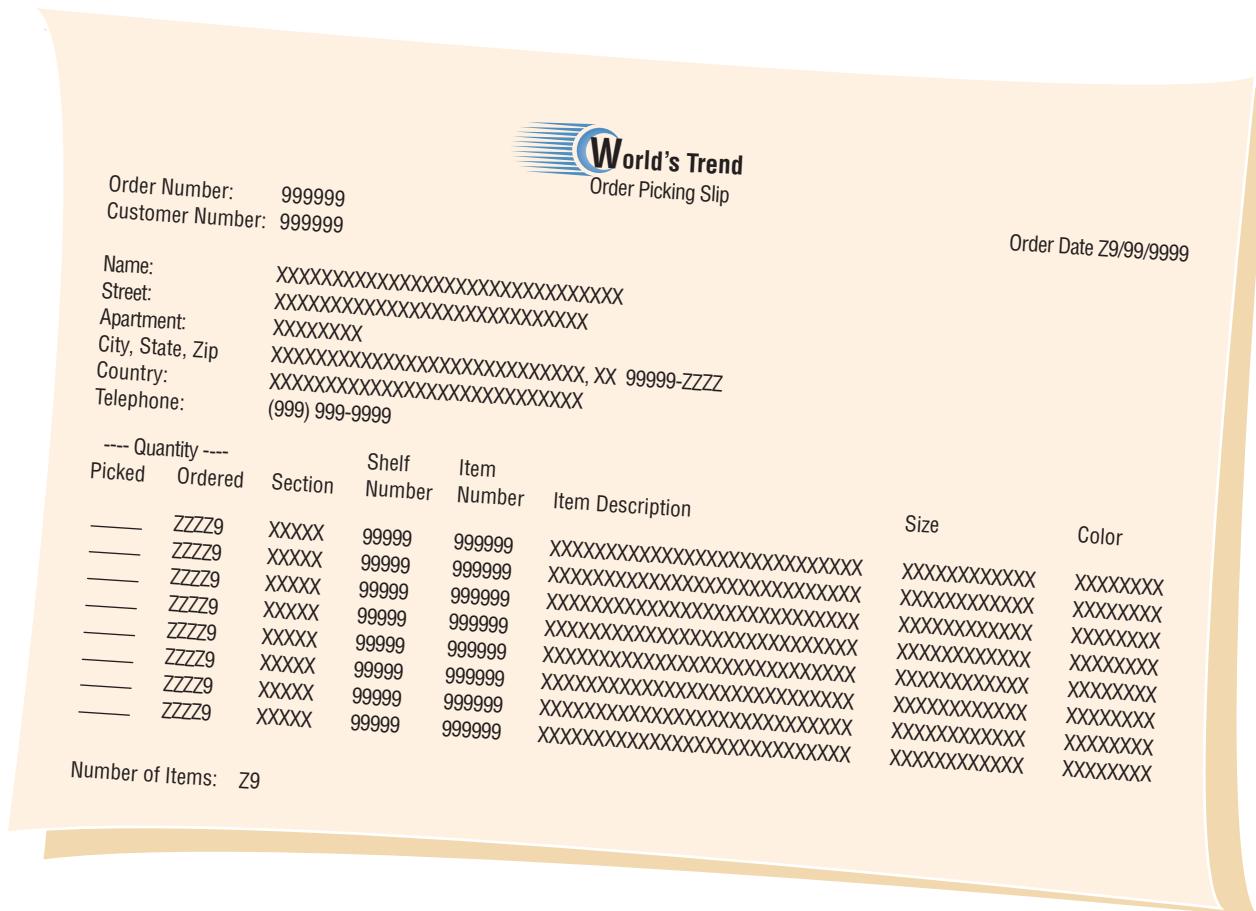
To have maximum power, the data dictionary should be tied into a number of systems programs so that when an item is updated or deleted from the data dictionary, it is automatically updated or deleted from the database. The data dictionary becomes simply a historical curiosity if it is not kept current.

The data dictionary may be used to create screens, reports, and forms. For example, examine the data structure for the World's Trend ORDER PICKING SLIP in Figure 8.14. Because the necessary elements and their lengths have been defined, the process of creating physical documents consists of arranging the elements in a pleasing and functional way using design guidelines and common sense. Repeating groups become columns, and structural records are grouped together on the screen, report, or form. The report layout for the World's Trend ORDER PICKING SLIP is shown in Figure 8.15. Notice that FIRST NAME and LAST NAME are grouped together

**FIGURE 8.14**

Data structure for an order picking slip at World's Trend Catalog Division.



**FIGURE 8.15**

Order picking slip created from the data dictionary.

in NAME, and that QUANTITY (PICKED and ORDERED), SECTION, SHELF NUMBER, ITEM NUMBER, ITEM DESCRIPTION, SIZE, and COLOR form a series of columns, because they are the repeating elements.

The data structure and elements for a data store are commonly used to generate corresponding computer language source code, which is then incorporated into computer programs. The data dictionary may be used in conjunction with a data flow diagram to analyze the system design, detecting flaws and areas that need clarification. Some considerations are:

1. All base elements on an output data flow must be present on an input data flow to the process producing the output. Base elements are keyed and should never be created by a process.
2. A derived element must be created by a process and should be output from at least one process into which it is not input.
3. The elements that are present in a data flow coming into or going out of a data store must be contained in the data store.

If begun early, a data dictionary can save many hours of time in the analysis and design phases. The data dictionary is the one common source in the organization for answering questions and settling disputes about any aspect of data definition. An up-to-date data dictionary can serve as an excellent reference for maintenance efforts on unfamiliar systems. Automated data dictionaries can serve as references for both people and programs.

### Using Data Dictionaries to Create XML

Extensible markup language (XML) is a language that can be used to exchange data between businesses or between systems within a business. It is similar to HTML, the markup language used to create Web pages, but is more powerful. HTML is concerned primarily with formatting a document; XML addresses the problem of sharing data when users have different computer systems and software or different database management systems (for example, one company using

Oracle and another using IBM's DB2). If everyone used the same software or database management system, there would be little need for XML.

Once an XML document has been created, the data may be transformed into a number of different output formats and displayed in many different ways, including printed output, Web pages, output for a handheld device, and portable document format (PDF) files. Thus, the document's data content is separated from the output format. The XML content is defined once as data and then transformed as many times as necessary.

The advantage of using an XML document is that the analyst may select only the data that an internal department or external partner needs to have in order to function. This helps to ensure the confidentiality of data. For example, a shipping company may receive only the customer name, the address, the item number, and the quantity to ship, but *not* credit card information or other financial data. This efficient approach also cuts down on information overload.

XML therefore is a way to define, sort, filter, and translate data into a universal data language that can be used by anyone. XML may be created from databases, a form, or software programs, or it may be keyed directly into a document, text editor, or XML entry program.

The data dictionary is an ideal starting point for developing XML content. The key to using XML is creating a standard definition of the data. This is accomplished by using a set of tags or data names that are included before and after each data element or structure. The tags become the metadata, or data about the data. Data may be further subdivided into smaller elements and structures until all elements are defined. XML elements may also include attributes, an additional piece of data included within the tag that describes something about the XML element.

Figure 8.16 illustrates a data dictionary containing customer, order, and payment information. The overall collection of customers is included in what is called the root element, customers. An XML document may contain only one root element, so it is often the plural of the data contained in the XML document. Each customer may place many orders. The structure is defined in the two left columns, and the XML code appears on the right. CUSTOMER, as you can see, consists of a NAME, ADDRESS, CURRENT BALANCE, multiple ORDER INFORMATION entries, and a PAYMENT. Some of these structures are further subdivided.

The XML document tends to mirror the data dictionary structure. The first entry (other than an XML line identifying the document) is <customer>, which defines the entire collection of customer information. The less than (<) and greater than (>) symbols are used to identify tag names (similar to HTML). The last line of the XML document is a closing tag, </customer>, signifying the end of the customer information.

Customer is defined first and contains an attribute, the customer number. There is often a discussion about whether data should be stored as an element or an attribute. In this case, they are stored as an attribute.

The name tag, <name>, is defined next because it is the first entry in the data dictionary. NAME is a structure consisting of LAST NAME, FIRST NAME, and an optional MIDDLE INITIAL. In the XML document, this structure starts with <name> and is followed by <lastname>, <firstname>, and <middle\_initial>. Because spaces are not allowed in XML tag names, an underscore is typically used to separate words. The closing </name> tag signifies the end of the group of elements. Using a structure such as name saves time and coding if the transformation displays the full name. Each of the child elements will be on one line separated by a space. Name also contains an attribute, either I for individual or C for corporation.

Indentation is used to show which structures contain elements. Note that <address> is similar to <customer>, but when we get to <order\_information> there is a big difference.

There are multiple entries for <order\_information>, each containing an <order\_number>, <order\_date>, <shipping\_date>, and <total>. Because the payment is made either by check or credit card, only one of these may be present. In our example, payment is by check. The dates have an attribute called format that indicates whether the date appears as month, day, year; year, month, day; or day, month, year. If a credit card is used to make a payment, a TYPE attribute contains either an M, V, A, D, or an O indicating the type of credit card (MasterCard, Visa, and so on).

### XML Document Type Definitions

Often the element structure of XML content is defined using a document type definition (DTD). A DTD is used to determine whether the XML document content is valid, that is, whether it conforms

Data Dictionary		XML
Customer =	Name + Address + Current Balance + (Order Information) + Payment	<pre>&lt;?xml version="1.0"&gt; &lt;customers&gt; &lt;customer number="C15008"&gt; &lt;name type="l"&gt; &lt;lastname&gt;Stadler&lt;/lastname&gt; &lt;firstname&gt;Karen&lt;/firstname&gt; &lt;middle_initial&gt;L&lt;/middle_initial&gt; &lt;/name&gt; &lt;address&gt; &lt;street&gt;123 Oak Street&lt;/street&gt; &lt;apartment&gt;Suite 16&lt;/apartment&gt; &lt;city&gt;Madison&lt;/city&gt; &lt;state&gt;WI&lt;/state&gt; &lt;zip&gt;43704&lt;/zip&gt; &lt;country&gt;United States&lt;/country&gt; &lt;/address&gt; &lt;current_balance&gt;123.45&lt;/current_balance&gt;</pre>
Name =	Last Name + First Name + (Middle Initial)	<pre>&lt;order customer_number="C15008"&gt; &lt;order_number&gt;00123&lt;/order_number&gt; &lt;order_date format="yyyymmdd"&gt;2008-06-23&lt;/order_date&gt; &lt;ship_date format="yyyymmdd"&gt;2008-06-25&lt;/ship_date&gt; &lt;total&gt;1345.89&lt;/total&gt; &lt;/order&gt;</pre>
Address =	Street + (Apartment) + City + State + Zip + Country	<pre>&lt;order customer_number="C15008"&gt; &lt;order_number&gt;00127&lt;/order_number&gt; &lt;order_date format="yyyymmdd"&gt;2008-09-18&lt;/order_date&gt; &lt;ship_date format="yyyymmdd"&gt;2008-09-26&lt;/ship_date&gt; &lt;total&gt;240.00&lt;/total&gt; &lt;/order&gt;</pre>
Order Information =	Order Number + Order Date + Ship Date + Total	<pre>&lt;payment&gt; &lt;check&gt; &lt;check_number&gt;7234&lt;/check_number&gt; &lt;/check&gt; &lt;payment_date format="yyyymmdd"&gt;2008-09-30&lt;/payment_date&gt; &lt;payment_amt&gt;1585.89&lt;/payment_amt&gt; &lt;/payment&gt; &lt;/customer&gt; &lt;/customers&gt;</pre>
Payment =	[Check   Credit Card] + Payment Date + Payment Amt	
Check =	Check Number	
Credit Card =	Credit Card Number + Expiration Date	

to the order and type of data that must be present in the document. The DTD is easy to create and well supported by standard software. Once the DTD has been completed, it may be used to validate the XML document using standard XML tools. The DTD is easier to create if a data dictionary has been completed, since the analyst has worked with users and made decisions on the structure of the data.

Figure 8.17 illustrates the document type definition for the Customer XML document. Key-words, such as !DOCTYPE, indicating the start of the DTD, must be in capital letters. !ELEMENT describes an element, and !ATTLIST describes an attribute, listing the element name followed by the attribute name. An element that has the keyword #PCDATA, for parsed character data, is a primitive element, not further defined. An element that has a series of other elements within parentheses means that they are child elements and must be in the order listed. The statement <!ELEMENT name (lastname, firstname, middle\_initial?)> means that the name must have the last name followed by the first name followed by the middle initial. The question mark after “middle\_initial” means that the element is optional and may be left out of the document for

### FIGURE 8.16

Using a data dictionary entry to develop XML content. The XML document mirrors the data dictionary structure.

## FIGURE 8.17

A document type definition for the customer XML document.

a particular customer. A plus sign means that there are one or more repeatable elements. Customers must contain at least one customer tag but could contain many customer tags. An asterisk means that there is zero or more of the elements. Each customer may have zero to many orders. A vertical bar separates two or more child elements that are mutually exclusive. Payment contains either check or credit card as options.

The attribute list definition for a customer number contains a keyword ID (in uppercase letters). This means that the attribute number must appear only once in the XML document as an attribute for an element with an ID. That it is somewhat similar to a primary key. The difference is that, if the document had several different elements, each with an ID attribute, the given ID (C15008 in this example) could appear only once. An ID must start with a letter or an underscore and cannot be solely a number. The reason behind putting the customer number as an ID is to ensure that it is not repeated in a longer document. The keyword #REQUIRED means that the attribute must be present. A keyword of #IMPLIED means that the attribute is optional. A document may also have an IDREF attribute, which links one element with another that is an ID. The ORDER tag has a customer\_number attribute defined as an IDREF, and the value C15008 must be present in an ID somewhere in the document. An attribute list containing values in parentheses means that the attribute must contain one of the values. A DTD definition `<!ATTLIST credit_card type (M|V|A|D|O) #REQUIRED>` means that the credit card type must be either an M, V, A, D, or O.

## XML Schemas

A schema is another, more precise way to define the content of an XML document. Schemas may include the exact number of times an element may occur as well as the type of data within elements.



## HYPERCASE® EXPERIENCE 8

**“Y**ou’re really doing very well. Snowden says you’ve given him all sorts of new ideas for running the new department. That’s saying quite a lot, when you consider that he has a lot of his own ideas. By now I hope you’ve had a chance to speak with everyone you would like to: certainly Snowden himself, Tom Ketcham, Daniel Hill, and Mr. Hyatt.

“Mr. Hyatt is an elusive soul, isn’t he? I guess I didn’t meet him until well into my third year. I hope you get to find out about him much sooner. Oh, but when you do get to see him, he cuts quite a figure, doesn’t he? And those crazy airplanes. I’ve almost been conked on the head by one in the parking lot. But how can you get angry, when it’s The Boss who’s flying it? He’s also got a secret—or should I say private—oriental garden off his office suite. No, you’ll never see it on the building plans. You have to get to know him very well before he’ll show you that, but I would wager it’s the only one like it in Tennessee and maybe in the whole United States. He fell in love with the wonderful gardens he saw in Southeast Asia as a young man. It goes deeper than that, however. Mr. Hyatt knows the value of contemplation and

meditation. If he has an opinion, you can be sure it has been well thought through.”

### HYPERCASE Questions

1. Briefly list the data elements that you have found on three different reports produced at MRE.
2. Based on your interviews with Snowden Evans and others, list the data elements that you believe you should add to the Management Unit’s project reporting systems to better capture important data on project status, project deadlines, and budget estimates.
3. Create a data dictionary entry for a new data store, a new data flow, and a new data process that you are suggesting based on your response to Question 2.
4. Suggest a list of new data elements that might be helpful to Jimmy Hyatt but are clearly not being made available to him currently.

**FIGURE 8.HC1**

In HyperCase, you can look at the data dictionary kept at MRE.

DATA FLOW DESCRIPTION	
Name: Assignment Inquiry Response	
Description: A screen containing all Assignment information	
Source: Process 6.3.4, Format Assignment Response (and parent processes)	Destination: External Entity, Team Leader
Type of data flow: Screen	Volume/Time: Several per hour, varies
Data Structure Traveling with the Flow:	
<a href="#">Resource Number</a> + <a href="#">Resource Name</a> + <a href="#">Resource Availability Code</a> + <a href="#">Resource Fee Amount</a> + <a href="#">Fee Basis</a> + <a href="#">Task Number</a> + <a href="#">Task Description</a> + <a href="#">Task Calendar Duration</a> + <a href="#">Task Completion Date</a> + <a href="#">Assignment Duration</a> + <a href="#">Assignment Start Date</a> + <a href="#">Assignment Scheduled Duration</a> + <a href="#">Assignment Scheduled Start Date</a> + <a href="#">Assignment Percent Completed</a>	
Comments: All codes should be turned into code meanings for display on the screen. The Assignment Inquiry data flow contains the input fields, which should be included on the Assignment Inquiry screen.	

such as character or numeric values, including the length of the element, limits on the data, and the number of places to the left and right of a decimal number.

A data dictionary is an excellent starting point for developing an XML document and a document type of definition or schema. The advantage of using XML to define data is that, in the XML format, data are stored in a pure text format and not dependent on any proprietary software. The document may be easily validated and transformed into many different output formats.

Industry groups or organizations may be involved in defining an industry-specific XML structure so that all involved parties understand what the data mean. This is very important when

an element name may have several meanings. An example is “state,” which may mean a postal state abbreviation or the state of an order or account. Examples of industry-specific XML document type definitions and schemas may be found at [www.xml.org](http://www.xml.org).

## SUMMARY

Using a top-down approach, the systems analyst uses data flow diagrams to begin compiling a data dictionary, which is a reference work containing data about data, or metadata, on all data processes, stores, flows, structures, and logical and physical elements in the system being studied. One way to begin is by including all data items from data flow diagrams.

A larger collection of project information is called a repository. CASE tools permit the analyst to create a repository that may include information about data flows, stores, record structures, and elements; about procedural logic screen and report design; and about data relationships. A repository can also contain information about project requirements and final system deliverables; and about project management information.

Each entry in the data dictionary contains the item name, an English description, aliases, related data elements, the range, the length, encoding, and necessary editing information. The data dictionary is useful in all phases of analysis, design, and ultimately documentation, because it is the authoritative source on how a data element is used and defined by users in the system. Many large systems feature computerized data dictionaries that cross-reference all programs in the database using a particular data element. The data dictionary can also be used to create XML that enables businesses with different systems, software, or database management systems to exchange data.

## KEYWORDS AND PHRASES

base element	packed decimal
binary format	physical data structure
data dictionary	repeating group
data element	repeating item
data structure	repository
derived element	schema
document type definition (DTD)	structural record
extensible markup language (XML)	system deliverables
ID	varchar
IDREF	zoned decimal

## REVIEW QUESTIONS

1. Define the term *data dictionary*. Define *metadata*.
2. What are four reasons for compiling a complete data dictionary?
3. What information is contained in the data repository?
4. What is a structural record?
5. List the eight specific categories that each entry in the data dictionary should contain. Briefly give the definition of each category.
6. What are the basic differences among data dictionary entries prepared for data stores, data structures, and data elements?
7. Why are structural records used?
8. What is the difference between logical and physical data structures?
9. Describe the difference between base and derived elements.
10. How do the data dictionary entries relate to levels in a set of data flow diagrams?
11. List the four steps to take in compiling a data dictionary.
12. Why shouldn’t compiling the data dictionary be viewed as an end in itself?
13. What are the main benefits of using a data dictionary?
14. What does extensible markup language (XML) describe?
15. What is a document type definition?
16. How does a document type definition help to ensure that an XML document contains all necessary elements?
17. When should attributes be used in an XML document?
18. What does an ID attribute ensure?
19. What does an IDREF attribute validate?

## PROBLEMS

1. Based on Figure 7.EX1 in Chapter 7, Joe, one of your systems analysis team members, made the following entry for the data dictionary used by Marilyn's Tours:

DATA ELEMENT = TOURIST\* \* \* PAYMENT

ALIAS = TOURIST PAY

CHARACTERS = 12-24

RANGE = \$5.00-\$1,000

VARIABLES = \$5.00, \$10.00, \$15.00 up to \$1,000, and anything in between in dollars and cents.

TO CALCULATE = TOTAL COST OF ALL TOURS, ANY APPLICABLE N.Y. STATE TAX, minus any RESERVATION DEPOSITS made.

- a. Is this truly a data element? Why or why not?
  - b. Rewrite the data dictionary entry for TOURIST PAYMENT, reclassifying it if necessary. Use the proper form for the classification you choose.
2. Sue Kong, the systems analyst, has made significant progress in understanding the data movement at Shanghai Megabank. To share what she has done with other members of her team as well as the head of regional operations, she is composing a data dictionary.
- a. Write an entry in Sue's data dictionary for three of the data flows in regional banking. Be as complete as possible.
  - b. Write an entry in Sue's data dictionary for three of the data stores in regional banking. Be as complete as possible.
3. Jorge Alvarez, the manager of the bookstore that your systems analysis team has been working with to build a computerized inventory system, thinks that one of your team members is making a nuisance of himself by asking him extremely detailed questions about data items used in the system. For example, he asks, "Jorge, how much space, in characters, does the listing of an ISBN take?"
- a. What are the problems created by going directly to the manager with questions concerning data dictionary entries? Use a paragraph to list the problems you can see with your team member's approach.
  - b. In a paragraph, explain to your team member how he can better gather information for the data dictionary.
4. Michael Bush owns a store specializing in travel gear and clothes. Manufacturers have their own coding, but there are many manufacturers. Set up data elements for six different travel hats from three different suppliers.
5. Michael (from Problem 4) also assembles packages of camping kits. Each kit is a group of separate products that are sold as a package. Each package (called a PRODUCT) is built using many parts, which vary from product to product. Interviews with the head parts clerk have resulted in a list of elements for the PRODUCT PART Web page, showing which parts are used in the manufacture of each product. A prototype of the PRODUCT-PART Web page is illustrated in Figure 8.EX1. Create a data structure dictionary entry for the PRODUCT-PART.

Part Description	Part Number	Quantity	Warehouse Location	Price	Part Cost
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Xxxxxxxxxxxxxxxxxxxxxxx	9999999	ZZZ9	Xxxxxxxxxxxxxxxxxxxxxxx	ZZ.ZZ9.99	ZZ.ZZ9.99
Total Number Of Unique Parts In Product				229	
<a href="#">Click Part Number to show part detail</a>					

**FIGURE 8.EX1**

A prototype of the PRODUCT-PART Web page.

6. Analyze the elements found on the PRODUCT-PART Web page and create the data structure for the PRODUCT MASTER and the PART MASTER data stores.
7. Which of the elements on the PRODUCT-PART Web page are derived elements?
8. The Pacific Holiday Company arranges cruise vacations of varying lengths at several locations. When customers call to check on the availability of a cruise, a CRUISE AVAILABILITY INQUIRY, illustrated in Figure 8.EX2, is used to supply them with information. Create the data dictionary structure for the CRUISE AVAILABILITY INQUIRY.

**FIGURE 8.EX2**

A display screen showing cruise availability.

9. List the master files that would be necessary to implement the CRUISE AVAILABILITY INQUIRY.
10. The following ports of call are available for the Pacific Holiday Company:

Apia	Nuku Hiva	Auckland
Pago Pago	Papeete	Wellington
Bora Bora	Raiatea	Christ Church
Moorea	Napier	Dunedin

Create the PORT OF CALL element. Examine the data to determine the length and format of the element.

11. Raúl Esparza, the ecommerce manager for Moonlight Mugs, a company that sells customized coffee mugs, would like to send information to another company that maintains the warehouse and provides shipping services. Order information is obtained from a secure Web site, including customer number, name and address, telephone number, email address, product number and quantity, as well as credit card information. There may be several different products shipped on one order. The shipping company handles items for other small businesses as well. Define an XML document that will include only the information that the shipping company needs to ship goods to the customer.
12. Once the order in Problem 11 has been shipped, the shipping company sends information back to Moonlight Mugs, including the customer name and address, shipper tracking number, data shipped, quantity ordered, quantity shipped, and quantity backordered. Define an XML document that will include the information sent to Moonlight Mugs.
13. Create a document type definition for Problem 11.
14. Western Animal Rescue is a nonprofit organization that supports the fostering and adoption of animals, such as cats, dogs, and birds. People can register to adopt animals. Others register and add animals for adoption. Create the data dictionary structure representing a person registering to adopt an animal. Include name, address (street, city, state or province, zip or mailing code), telephone number, email address, date of birth, current pets (type, breed, age of pet), and references. Each person may have multiple pets and must have at least three references. References must include

- name, address, telephone number, email address, and how they know the person registering to adopt an animal. Be sure to include notation for repeating elements and optional elements.
15. Define the length, the type of data, and the validation criteria for each of the elements in Problem 14.
  16. List the data stores that would be required to implement the person registering in Problem 14.
  17. Create an XML document with sample data for one person registering to adopt an animal.

## GROUP PROJECTS

1. Meet with your group and use a CASE tool or a manual procedure to develop data dictionary entries for a process, data flow, data store, and data structure based on the data flow diagrams you completed for Maverick Transport in the Chapter 7 group exercises. As a group, agree on any assumptions necessary to make complete entries for each data element.
2. Your group should develop a list of methods to help you make complete data dictionary entries for this exercise as well as for future projects. For example, study existing reports, base them on new or existing data flow diagrams, and so on.

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## EPISODE 8

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Defining What You Mean

“We can use the data flow diagrams we completed to create data dictionary entries for all data flow and data stores,” Chip says to Anna at their next meeting. Each of these components has a composition entry in the repository. The records created for the computer system are thus linked directly to the data flow diagram components that describe data.

Anna and Chip meet to divide the work of creating records and elements. “I’ll develop the data dictionary for the software portion of the system,” Anna says.

“Good thing I enjoy doing the hardware,” Chip kids her good-naturedly.

Records, or data structures, are created first. They may contain elements, the basic building blocks of the data structure, and they may also contain other records in them called structural records. Visible Analyst also maintains relationships among graph components, records, and elements that may be used for analysis and reporting. Since Microsoft Visio does not have a repository for data flow diagram objects, Visible Analyst repository will be used to illustrate the repository in this episode.

Using information from interviews and the prototype screens, Anna starts to create the Software records. Because the output of a system will determine what data need to be both stored and obtained via data entry screens, the starting point is the output data flow SOFTWARE INSTALLATION LIST. This prototype identifies some of the elements that should be stored in the SOFTWARE MASTER:

SOFTWARE INVENTORY NUMBER  
VERSION NUMBER  
NUMBER OF CDs  
CAMPUS LOCATION  
TITLE  
HARDWARE INVENTORY  
NUMBER  
ROOM LOCATION

Other output prototype reports and screens are also examined. Additional elements are obtained from the ADD SOFTWARE prototype screen. These elements are arranged into a logical sequence for the SOFTWARE MASTER database table. The following standards for arranging elements within a record are used:

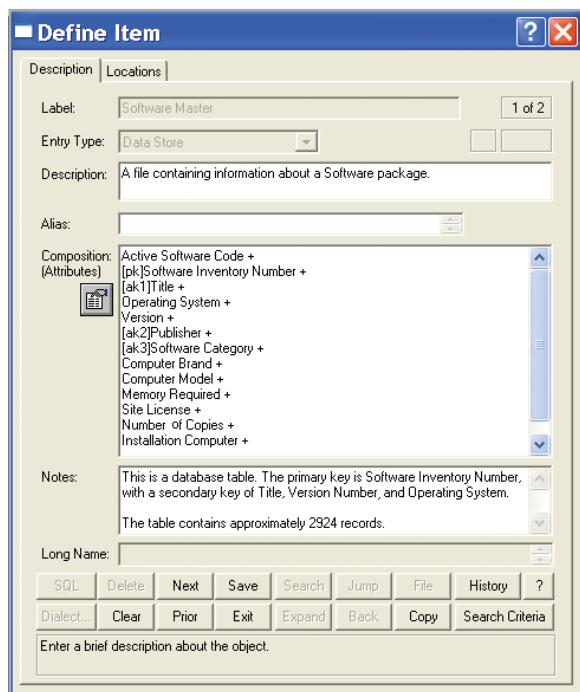
1. The major key element that uniquely identifies the record. An example is the SOFTWARE INVENTORY NUMBER.
2. Descriptive information, such as TITLE, VERSION NUMBER, and PUBLISHER.
3. Information that is periodically updated, such as NUMBER OF COPIES.
4. Any repeating elements, such as HARDWARE INVENTORY NUMBER, denoting the machines on which the software has been installed.

Next, the SOFTWARE MASTER record is created using the Visible Analyst repository. The description screen for creating a record is shown in Figure E8.1. (*Note:* This screen may differ from the data structure screen in your copy of Visible Analyst. To view the screen that is in the same format, click the **Options** menu and then click so there is a check in front of **Classical User Interface**.) Notice the entry area for an alias, or a different name for the record, used by a different user group. Because each user may refer to the same record by a different name, all such names should be documented, resulting in enriched communication among users.

Each element or structural record needs to be defined as part of the whole record, and it is entered in the **Composition** area. If the element or structural record is a repeating group, the name is enclosed in curly brackets ( { } ) and the number of times it repeats is placed in front of the name. If the data are keys, a code is put in brackets ([ ]) in front of the name. The symbol [pk] represents a primary key. The symbol [akn] represents an alternate key, where n is 1, 2, 3, and so on, and defines each different key or group of fields that, when combined, make a secondary key. When a group of fields makes up a secondary key, that key is called a concatenated key. The symbol [fk] represents a foreign key.

Examine the SOFTWARE MASTER. It contains a primary key of SOFTWARE INVENTORY NUMBER and secondary keys of TITLE, PUBLISHER, and SOFTWARE CATEGORY.

Visible Analyst allows you to easily describe each structural record or element composing the larger record. Anna places the cursor in each name in the **Composition** area and clicks the **Jump** button. Further record and element screens are displayed and detailed information is entered.

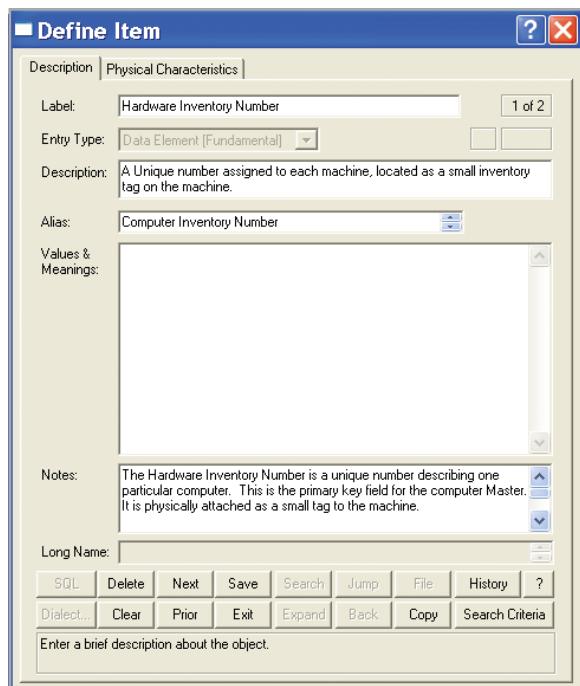
**FIGURE E8.1**

Record description screen,  
SOFTWARE MASTER.

“This is great!” Anna thinks to herself. “It’s so easy to enter the details, and by using this method, I won’t accidentally forget to describe an element.”

Chip is also impressed with the simplicity of creating the data dictionary. Following a process similar to Anna’s, he creates a record description for the COMPUTER MASTER. It contains a table of five internal boards and two structural records, PERIPHERAL EQUIPMENT and MAINTENANCE INFORMATION. The **Composition** area for entering element or record names is a scroll region, meaning that more lines may be keyed than will fit in the display area. As entries are added to the bottom of the region, top entries scroll out of the area.

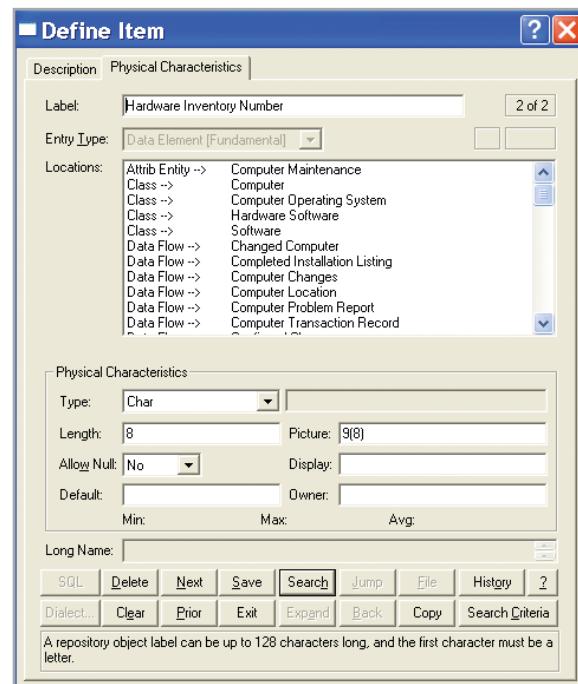
As elements are added to the record, Chip decides to describe each in detail. The element description screen for the HARDWARE INVENTORY NUMBER is shown in Figure E8.2. Observe the areas for entering element attributes. Several aliases may be included along with a definition. A **Notes** area contains any other useful information about the element. Chip and Anna employ this area to enter further edit criteria and

**FIGURE E8.2**

Element description screen,  
HARDWARE INVENTORY  
NUMBER.

**FIGURE E8.3**

HARDWARE INVENTORY NUMBER, element characteristics display.



other useful notation. The description for the HARDWARE INVENTORY NUMBER details how this number is used to keep physical track of the machines.

Clicking on the **Physical Characteristics** tab displays a second screen for the HARDWARE INVENTORY NUMBER, illustrated in Figure E8.3. It contains an area showing within which structures the element is contained, as well as an area for the type of data, the length, and the picture used to describe how the data are formatted. Each such picture is a coded entry, indicating how the element should be formatted. Examples of some of the codes are as follows:

- 9 Represents numeric data: Only numbers may be entered when prototyping.
- A Alphabetic: Only alphabetic characters may be entered.
- X Alphanumeric: Any characters may be entered.
- Z Zero suppression: Replace leading zeros with spaces.
- \$ Dollar sign: Replace leading zeros with a dollar sign.

Chip is careful to include complete entries for these areas, including any default values and whether the entry may be null or not.

Anna and Chip repeat this process for all elements found on each record. This effort is time consuming but worthwhile. After the first few records are created, it becomes easier to create the remaining record structures. Visible Analyst has a search feature that provides lists of the elements contained in the design.

"I think that we've designed a complete set of elements," Chip says at a checkpoint meeting.

"Yes," replies Anna. "There are reports that will show us the details of the data structures and help us to spot duplications and omissions. Let's put Visible Analyst to work producing record layouts for us."

The **Reports** feature was used to print record layouts for all master data stores.

### Record and Element Analysis

"Now let's really put the power of Visible Analyst to use," Anna says. "Let's see how well we've really designed our data."

"What do you mean?" Chip asks.

"I've been studying the analysis features contained in Visible Analyst, and there's a wealth of options for checking our design for consistency and correctness," Anna replies. "The first step is to use the **Reports** feature to produce a summary report of the elements we've added. Then we can examine the list for duplications and redundancy."

Figure E8.4 is an example of a portion of the element summary report displayed using Firefox. Analysts would examine the contents carefully and look for redundancy, or elements defined more than once.

VA Repository Reports - Mozilla Firefox																																					
Date: 4/27/2010	Project: CPU																																				
Time: 2:03:54 PM	Page: 1																																				
Summary Listing -- Alphabetically All Data Element Entries -- Data Flow Diagrams																																					
<table border="1"> <thead> <tr> <th>Active Software Code</th> <th>Data Element</th> </tr> </thead> <tbody> <tr> <td>Description:</td> <td>Code to determine if software is currently in use.</td> </tr> <tr> <td>Brand Name</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>The name of the computer manufacturer</td> </tr> <tr> <td>Brand Subtotal</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>The total for one brand of computer.</td> </tr> <tr> <td>Campus Code</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>A code used to store a campus building.</td> </tr> <tr> <td>Campus Description</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>The description of a Central Pacific University campus building. This field matches the Campus Code.</td> </tr> <tr> <td>Campus Location</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>Campus where computer is located.</td> </tr> <tr> <td>Campus Name</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>The campus name that matches the campus code.</td> </tr> <tr> <td>Category of Software</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td>A coded entry for the type of software. Stored as an Access table.</td> </tr> <tr> <td>City</td> <td>Data Element</td> </tr> <tr> <td>Description:</td> <td></td> </tr> </tbody> </table>		Active Software Code	Data Element	Description:	Code to determine if software is currently in use.	Brand Name	Data Element	Description:	The name of the computer manufacturer	Brand Subtotal	Data Element	Description:	The total for one brand of computer.	Campus Code	Data Element	Description:	A code used to store a campus building.	Campus Description	Data Element	Description:	The description of a Central Pacific University campus building. This field matches the Campus Code.	Campus Location	Data Element	Description:	Campus where computer is located.	Campus Name	Data Element	Description:	The campus name that matches the campus code.	Category of Software	Data Element	Description:	A coded entry for the type of software. Stored as an Access table.	City	Data Element	Description:	
Active Software Code	Data Element																																				
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Category of Software	Data Element																																				
Description:	A coded entry for the type of software. Stored as an Access table.																																				
City	Data Element																																				
Description:																																					

**FIGURE E8.4**

Element summary preview.

These redundancies are usually easy to spot because the list is sorted by element name. The elements HARDWARE INVENTORY NUMBER and HARDWARE NUMBER and the elements SOFTWARE INVENTORY NUMBER and SOFTWARE NUM appear to be duplicate elements. Other duplicates, such as ROOM LOCATION and LOCATION, are harder to spot.

"Next we should use the **No Location References** option, which shows all the elements that are not included on any record," says Anna.

"This is terrific!" exclaims Chip. "This **No Location References** shows design work that needs to be completed. We should produce this report for all the design components."

The elements were either added to other structures or deleted as duplicates. Producing the **No Location References** report a second time revealed no further isolated elements.

"Well, I guess that wraps up the data portion of the system design," Chip says.

"Guess again," replies Anna. "We've only begun to analyze. The **Report Query** feature will provide us with a lot of design information, both for analysis and documentation."

The analysts select a report called **Def Entities without Composition** as their first choice. The report shows entries that are a data store or data structure and do have a composition entry. The output shows that there are no records in error. The next report query is **Elements without Pictures**, and it shows all elements that do not have pictures defined for them. A last report that Chip and Anna create is called **Undefined Elements**, indicating all elements that have not been defined; that is, they exist in the repository as a name only, but with no physical characteristics.

"We're not finished yet. There are some useful matrices that will provide documentation for any changes that may be made in the future. Let's produce the **Data Elements versus Data Structures** matrix, which shows records and their elements," Anna suggests.

The **Report** feature has the ability to produce reports as well as matrices in a grid representation. It shows all elements and the data structures in which they are contained. This matrix is used to access the effect of changing an element by showing which corresponding data structures must be changed.

The next matrix created is the **Diagram Location Matrix**, showing all data stores and the diagrams in which they are located. This information is useful if a change needs to be made to the data store, because it will indicate where programs and documentation need to be changed.

A final matrix is the **Composition Matrix**, showing all data elements and the data stores in which they are contained. This matrix gives Chip and Anna a picture of which elements may be stored redundantly, that is, in several data stores rather than one.

"There are many other reports and matrices that would be useful for us to produce," Anna says. "Some of these should be used later for documentation and tracking any proposed changes. I'm really pleased with what we've accomplished."

## EXERCISES

Note: If you are not using Visible Analyst, some of the following exercises may be done using a Microsoft Word or Microsoft Excel template. The repository information is included in a repository.html Web page that you may save.



E-1. Use Visible Analyst to view the COMPUTER MASTER data store. Jump to the data structure and browse the elements and structural records.



E-2. Print the SOFTWARE MASTER record using the **Report** feature.



E-3. Use the **Jump** button to move to the **Software Record Structure**. Delete the following elements:

ACTIVE SOFTWARE CODE  
INSTALLATION COMPUTER  
SOFTWARE EXPERT



E-4. Modify the SOFTWARE CHANGES record, supplying changes to the SOFTWARE MASTER record. The modifications are as follows:

- Add a [pk], for primary key, in front of the SOFTWARE INVENTORY NUMBER.
- Add the following elements: COMPUTER BRAND, COMPUTER MODEL, MEMORY REQUIRED, SITE LICENSE, and NUMBER OF COPIES.



E-5. Modify the COMPUTER ADD TRANSACTION record, which contains new computer records to be placed on the COMPUTER MASTER data store.

- Insert the BRAND NAME and MODEL above the SERIAL NUMBER.
- Place the CAMPUS LOCATION and ROOM LOCATION after the SERIAL NUMBER.
- Add the following elements at the bottom of the list: HARD DRIVE, SECOND HARD DRIVE, and OPTICAL DRIVE.



E-6. Modify the INSTALLED SOFTWARE TRANSACTION, which is used to update the SOFTWARE MASTER and to produce the SOFTWARE INSTALLATION LISTING. Delete the TITLE and VERSION NUMBER, because they may be obtained from the SOFTWARE MASTER and are redundant keying. Add the HARDWARE INVENTORY NUMBER, specifying the installation computer. Delete the CAMPUS LOCATION and ROOM LOCATION, because they are elements of the installation computer.



E-7. View the alias entry for the SOFTWARE CHANGES.



E-8. Modify the INSTALLED SOFTWARE data store. Add the composition record INSTALLED SOFTWARE TRANSACTION. The index elements are SOFTWARE INVENTORY NUMBER and HARDWARE INVENTORY NUMBER.



E-9. Define the data store SOFTWARE LOG FILE. This file is used to store information on the new software records, plus the date, time, and user ID of the person entering the record. Index elements are SOFTWARE INVENTORY NUMBER, TITLE, VERSION (a concatenated key), and SOFTWARE CATEGORY.



E-10. Define the data store PENDING COMPUTER ORDERS. This file is created when a purchase order is made for ordering new computers, and it is updated by the computer system. Place a comment in the **Notes** area stating that the average number of records is 100. Index elements are PURCHASE ORDER NUMBER and a concatenated key consisting of BRAND NAME and MODEL.



E-11. View the entry for the SOFTWARE RECORD data flow. Click **Jump** with the cursor in the **Composition** area and examine the SOFTWARE MASTER record. Click **Back** to return to the data flow description screen.



E-12. Modify the SOFTWARE UPGRADE INFORMATION data flow. The composition record is SOFTWARE UPGRADE INFORMATION.



E-13. Modify the SOFTWARE CROSS-REFERENCE REPORT data flow. The composition record is SOFTWARE CROSS-REFERENCE REPORT.



E-14. Modify the data flow entity for INSTALL UPDATE. This flow updates the COMPUTER MASTER record with installation information. Its data structure is INSTALL UPDATE RECORD. Include a comment that it processes about 50 records per month in updating the COMPUTER MASTER.



E-15. Use the INSTALL UPDATE data flow to jump to (and create) the INSTALL UPDATE RECORD. Provide a definition based on information supplied in the previous problem. Enter the following elements:

HARDWARE INVENTORY NUMBER (primary key)  
CAMPUS LOCATION

ROOM  
HARD DRIVE  
MAINTENANCE INTERVAL  
DATE INSTALLED

- E-16. Create the data flow description for the SOFTWARE INSTALLATION LIST. This flow contains information on specific software packages and the machines on which the software should be installed. The composition should include the SOFTWARE INSTALLATION LISTING, a data structure.



- E-17. Use the SOFTWARE INSTALL LIST to jump to (and therefore create) the SOFTWARE INSTALLATION LISTING. The elements on the listing are as follows:



SOFTWARE INVENTORY NUMBER  
TITLE  
VERSION NUMBER  
HARDWARE INVENTORY NUMBER  
CAMPUS LOCATION  
ROOM LOCATION

- E-18. Modify and print the element HARDWARE SUBTOTAL. Change the type to Decimal, the length to 7,2, and the picture to Z, ZZZ, ZZ9.99.



- E-19. Modify the COMPUTER TYPE element. The description should be: The physical type of computer. Values & Meanings should contain: L—Laptop, D—Desktop, N—Netbook, H—Handheld. The type is Char with a Length of 1, and a Picture and Display of X. Do not allow a null value.



- E-20. Modify and print the DEPARTMENT NAME element. Create an alias of STAFF DEPARTMENT NAME. In the Notes area, enter the following comment: Table of codes: Department Table. The type should be Character, the length 25, and the picture X(25).



- E-21. Create the following element descriptions. Use the values supplied in the table. Create any alternate names and definitions based on your understanding of the element.



Name	PURCHASE ORDER NUMBER	PROBLEM DESCRIPTION
Type	Character	Character
Length	7	70
Picture	9999999	X(70)
Name	TOTAL	NEXT PREVENTIVE
	COMPUTER COST	MAINTENANCE DATE
Type	Numeric	Date
Length	7,2	8
Picture	Z, ZZZ, ZZ9.99	Z9/99/9999
Notes		The NEXT PREVENTIVE MAINTENANCE DATE is calculated by adding the MAINTENANCE INTERVAL to the LAST PREVENTIVE MAINTENANCE DATE
Name	PHONE NUMBER	REPAIR STATUS
Type	Character	Character
Length	7	1
Picture	999-9999	X
Notes		Table of codes: Repair Table
Default		C

- E-22. Use the **Repository Reports** feature of Visible Analyst to produce the following reports and matrices, either by printing the reports or by previewing them using your Web browser. The selection criteria from the **Repository Reports** dialogue box are listed, separated with a slash (/). Explain in a paragraph where the information produced may be effectively used.



- a. Data Flow/Cross-Reference Listing/Data Element/Entire Project
- b. Data Flow/Cross-Reference Listing/Data Structure/Entire Project

- c. Record Contains Element (One Level) Matrix
- d. Data Flow/Single-Entry Listing/Software Master—Normalized
- e. Data Flow/Diagram Location Matrix/Data Stores versus Diagrams
- f. Data Flow/Composition Matrix/Data Elements versus Data Flows
- g. Data Flow/Composition Matrix/Data Elements versus Data Structures
- h. Data Flow/Composition Matrix/Data Element versus Data Stores



**E-23.** Use the **Report Query** feature of Visible Analyst to produce the following reports. Explain in a sentence what information the report is providing you with.

- a. The **Undefined Elements** report
- b. The **Elements without Pictures** report
- c. The **Coded Elements** report
- d. The **Any Item with Components** report



**E-24.** Use Visible Analyst to print a summary report for all data flow components that do not have a description. (*Hint:* Click the **No Descriptive Info.** radio button.)



**E-25.** Use Visible Analyst to print a summary report for all data flow components that are not on a diagram. (*Hint:* Click the **No Location References** radio button.)



**E-26.** Use Visible Analyst to print a detailed report for all elements. Include only the physical information and the values and meanings. (*Hint:* Click the **Fields** button and then the **Invert** button and select the fields that you want printed.) Why would this report be useful to the analyst?

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

# CHAPTER 9

# Process Specifications and Structured Decisions

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand the purpose of process specifications.
2. Recognize the difference between structured and semistructured decisions.
3. Use structured English, decision tables, and decision trees to analyze, describe, and document structured decisions.
4. Choose an appropriate decision analysis method for analyzing structured decisions and creating process specifications.



The systems analyst approaching process specifications and structured decisions has many options for documenting and analyzing them. In Chapters 7 and 8 you noted processes such as VERIFY AND COMPUTE FEES, but you did not explain the logic necessary to execute these tasks. The methods available for documenting and analyzing the logic of decisions include structured English, decision tables, and decision trees. It is important to be able to recognize logic and structured decisions that occur in a business and how they are distinguishable from semistructured decisions that tend to involve human judgment. Then it is critical to recognize that structured decisions lend themselves particularly well to analysis with systematic methods that promote completeness, accuracy, and communication.

## OVERVIEW OF PROCESS SPECIFICATIONS

To determine the human information requirements of a decision analysis strategy, the systems analyst must first determine the users' objectives, along with the organization's objectives, using either a top-down approach or an object-oriented approach. The systems analyst must understand the principles of organizations and have a working knowledge of data-gathering techniques. The top-down approach is critical because all human decisions in the organization should be related, at least indirectly, to the broad objectives of the entire organization.

Process specifications—sometimes called *minispecs*, because they are a small portion of the total project specifications—are created for primitive processes on a data flow diagram as well as for some higher-level processes that explode to a child diagram. They also may be created for class methods in object-oriented design, and, in a more general sense, for the steps in a use case (as discussed in Chapters 2 and 10). These specifications explain the decision-making logic and formulas that will transform process input data into output. Each derived element must have process logic to show how it is produced from the base elements or other previously created derived elements that are input to the primitive process.

The three goals of producing process specifications are as follows:

1. To reduce the ambiguity of the process. This goal compels the analyst to learn details about how the process works. Any vague areas should be noted, written down, and consolidated for all process specifications. These observations form a basis and provide the questions for follow-up interviews with the user community.
2. To obtain a precise description of what is accomplished, which is usually included in a packet of specifications for the programmer.
3. To validate the system design. This goal includes ensuring that a process has all the input data flow necessary for producing the output. In addition, all input and output must be represented on the data flow diagram.

You will find many situations in which process specifications are not created. Sometimes the process is very simple or the computer code already exists. This eventuality would be noted in the process description, and no further design would be required. Categories of processes that generally *do not* require specifications are as follows:

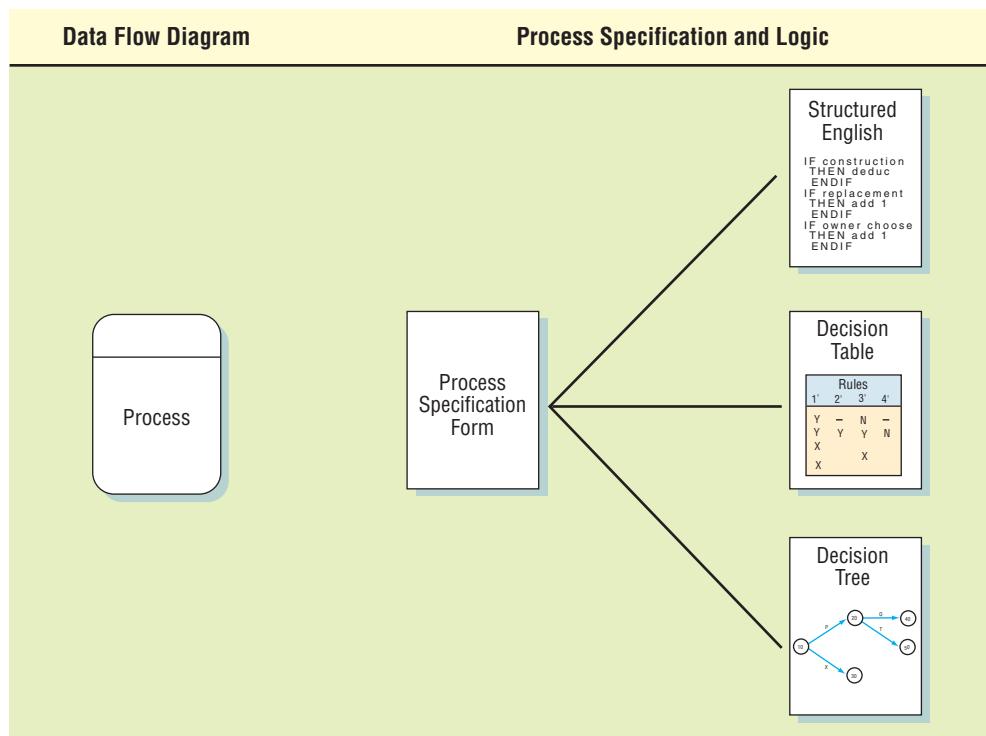
1. Processes that represent physical input or output, such as read and write. These processes usually require only simple logic.
2. Processes that represent simple data validation, which is usually fairly easy to accomplish. The edit criteria are included in the data dictionary and incorporated into the computer source code. Process specifications may be produced for complex editing.
3. Processes that use prewritten code. These processes are generally included in a system as procedures, methods, and functions or in class libraries (that are either purchased or available free on the Web).

These blocks are computer program code that is stored on the computer system. They usually perform a general system function, such as validating a date or a check digit. These general-purpose subprograms are written and documented only once but form a series of building blocks that may be used in many systems throughout the organization. Thus, these subprograms appear as processes on many data flow diagrams (or as class methods discussed in Chapter 10).

### Process Specification Format

Process specifications link the process to the data flow diagram, and hence the data dictionary, as illustrated in Figure 9.1. Each process specification should be entered on a separate form or into a CASE tool screen such as the one used for Visible Analyst and shown in the CPU case at the end of this chapter. Enter the following information:

1. The process number, which must match the process ID on the data flow diagram. This specification allows an analyst to work on or review any process, and to locate the data flow diagram containing the process easily.
2. The process name, which again must be the same as the name displayed in the process symbol on the data flow diagram.
3. A brief description of what the process accomplishes.
4. A list of input data flows, using the names found on the data flow diagram. Data names used in the formula or logic should match those in the data dictionary to ensure consistency and good communication.
5. The output data flows, also using data flow diagram and data dictionary names.
6. An indication of the type of process: batch, online, or manual. All online processes require screen designs, and all manual processes should have well-defined procedures for employees performing the process tasks.
7. If the process uses prewritten code, include the name of the subprogram or function containing that code.
8. A description of the process logic that states policy and business rules in everyday language, not computer language pseudo-code. Business rules are the procedures, or perhaps a set of conditions or formulas, that allow a corporation to run its business. The early problem definition (as explained in Chapter 3) that you completed initially may provide a starting place for this description. Common business rule formats include the following:
  - Definitions of business terms.
  - Business conditions and actions.

**FIGURE 9.1**

How process specifications relate to the data flow diagram.

- Data integrity constraints.
- Mathematical and functional derivations.
- Logical inferences.
- Processing sequences.
- Relationships among facts about the business.

9. If there is not enough room on the form for a complete structured English description, or if there is a decision table or tree depicting the logic, include the corresponding table or tree name.
10. List any unresolved issues, incomplete portions of logic, or other concerns. These issues form the basis of the questions used for follow-up interviews with users or business experts you have added to your project team.

These items should be entered to complete a process specification form, which includes a process number, process name, or both from the data flow diagram, as well as the eight other items shown in the World's Trend example (Figure 9.2). Notice that completing this form thoroughly facilitates linking the process to the data flow diagram and the data dictionary.

## STRUCTURED ENGLISH

When the process logic involves formulas or iteration, or when structured decisions are not complex, an appropriate technique for analyzing the decision process is the use of structured English. As the name implies, structured English is based on (1) structured logic, or instructions organized into nested and grouped procedures, and (2) simple English statements such as add, multiply, and move. A word problem can be transformed into structured English by putting the decision rules into their proper sequence and using the convention of IF-THEN-ELSE statements throughout.

### Writing Structured English

To write structured English, you may want to use the following conventions:

1. Express all logic in terms of one of these four types: sequential structures, decision structures, case structures, or iterations (see Figure 9.3 for examples).

**Process Specification Form**

Number <u>1.3</u> Name <u>Determine Quantity Available</u> Description <u>Determine if an item is available for sale. If it is not available, create a backordered item record. Determine the quantity available.</u>		
<b>Input Data Flow</b> <u>Valid item from Process 1.2</u> <u>Quantity on Hand from Item Record</u>		
<b>Output Data Flow</b> <u>Available Item (Item Number + Quantity Sold) to Processes 1.4 &amp; 1.5</u> <u>Backordered item to Inventory Control</u>		
<input checked="" type="checkbox"/> Online <input type="checkbox"/> Batch <input type="checkbox"/> Manual		Subprogram/Function Name
<b>Process Logic:</b> <u>IF the Order Item Quantity is greater than Quantity on Hand</u> <u>Then Move Order Item Quantity to Available Item Quantity</u> <u>Move Order Item Number to Available Item Number</u> <u>ELSE</u> <u>Subtract Quantity on Hand from Order Item Quantity</u> <u>giving Quantity Backordered</u> <u>Move Quantity Backordered to Backordered Item Record</u> <u>Move Item Number to Backordered Item Record</u> <u>DO write Backordered Record</u> <u>Move Quantity on Hand to Available Item Quantity</u> <u>Move Order Item Number to Available Item Number</u> <u>ENDIF</u>		
<b>Refer to:</b> Name: _____ <input type="checkbox"/> Structured English <input type="checkbox"/> Decision Table <input type="checkbox"/> Decision Tree		
<b>Unresolved Issues:</b> <u>Should the amount that is on order for this item be taken into account?</u> <u>Would this, combined with the expected arrival date of goods on order, change how the quantity available is calculated?</u>		

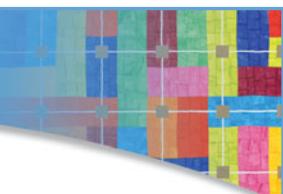
**FIGURE 9.2**

An example of a completed process specification form for determining whether an item is available.

2. Use and capitalize accepted keywords such as IF, THEN, ELSE, DO, DO WHILE, DO UNTIL, and PERFORM.
3. Indent blocks of statements to show their hierarchy (nesting) clearly.
4. When words or phrases have been defined in a data dictionary (as in Chapter 8), underline those words or phrases to signify that they have a specialized, reserved meaning.
5. Be careful when using “and” and “or,” and avoid confusion when distinguishing between “greater than” and “greater than or equal to” and like relationships. “A and B” means both A and B; “A or B” means either A or B, but not both. Clarify the logical statements now rather than waiting until the program coding stage.



## CONSULTING OPPORTUNITY 9.1



### Kit Chen Kaboodle, Inc.

**I** don't want to get anyone stirred up, but I think we need to sift through our unfilled order policies," says Kit Chen. "I wouldn't want to put a strain on our customers. As you know already, Kit Chen Kaboodle is a Web and mail-order cookware business specializing in 'klassy kitsch for kitchens,' as our latest catalog says. I mean, we've got everything you need to do gourmet cooking and entertaining: nutmeg grinders, potato whisks, egg separators, turkey basters, placemats with cats on 'em, ice cube trays in shamrock shapes, and more.

"Here's how we've been handling unfilled orders. We search our unfilled orders file from the Internet as well as mail-order sales once a week. If the order was filled this week, we delete the record, and the rest is gravy. If we haven't written to the customer in four weeks, we send 'em this cute card with a chef peeking into the oven, saying, 'Not ready yet.' (It's a notification that their item is still on back order.)

"If the back order date changed to greater than 45 days from now, we send out a notice. If the merchandise is seasonal (as with

Halloween treat bags, Christmas cookie cutters, or Valentine's Day cake molds) and the back order date is 30 days or more, though, we send out a notice with a chef glaring at his egg timer.

"If the back order date changed at all and we haven't sent out a card in the last two weeks, we send out a card with a chef checking his recipe. If the merchandise is no longer available, we send a notice (complete with chef crying in the corner) and delete the record. We haven't begun to use email in place of mailed cards, but I'd like to.

"Thanks for listening to all this. I think we've got the right ingredients for a good policy; we just need to blend them together and cook up something special."

Because you are the systems analyst whom Kit hired, go through the narrative of how Kit Chen Kaboodle, Inc., handles unfilled orders, drawing boxes around each action Kit mentions and circling each condition brought up. Make a list of any ambiguities you would like to clarify in a later interview, and then write five questions to address them.

Structured English Type	Example
Sequential Structure A block of instructions in which no branching occurs	Action #1 Action #2 Action #3
Decision Structure Only IF a condition is true, complete the following statements; otherwise, jump to the ELSE	IF Condition A is True THEN implement Action A ELSE implement Action B ENDIF
Case Structure A special type of decision structure in which the cases are mutually exclusive (if one occurs, the others cannot)	IF Case #1 implement Action #1 ELSE IF Case #2 Implement Action #2 ELSE IF Case #3 Implement Action #3 ELSE IF Case #4 Implement Action #4 ELSE print error ENDIF
Iteration Blocks of statements that are repeated until done	DO WHILE there are customers. Action #1 ENDDO

**FIGURE 9.3**

Examples of logic expressed in a sequential structure, a decision structure, a case structure, and an iteration.

**A STRUCTURED ENGLISH EXAMPLE.** The following example demonstrates how a spoken procedure for processing medical claims is transformed into structured English:

We process all our claims in this manner. First, we determine whether the claimant has ever sent in a claim before; if not, we set up a new record. The claim totals for the year



## CONSULTING OPPORTUNITY 9.2

### Kneading Structure

**K**it Chen has risen to the occasion and answered your questions concerning the policy for handling unfilled orders at Kit Chen Koodle, Inc. Based on those answers and any assumptions you need to make, pour Kit's narrative (from Consulting Opportunity 9.1)

into a new mold by rewriting the recipe for handling unfilled orders in structured English. In a paragraph, describe how this process might change if you used email for notification rather than regular mail.

are then updated. Next, we determine if a claimant has policy A or policy B, which differ in deductibles and copayments (the percentage of the claim claimants pay themselves). For both policies, we check to see if the deductible has been met (\$100 for policy A and \$50 for policy B). If the deductible has not been met, we apply the claim to the deductible. Another step adjusts for the copayment; we subtract the percentage the claimant pays (40 percent for policy A and 60 percent for policy B) from the claim. Then we issue a check if there is money coming to the claimant, print a summary of the transaction, and update our accounts. We do this until all claims for that day are processed.

In examining the foregoing statements, one notices some simple sequence structures, particularly at the beginning and end. There are a couple of decision structures, and it is most appropriate to nest them, first by deter-

**FIGURE 9.4**

Structured English for the medical-claim processing system. Underlining signifies that the terms have been defined in the data dictionary.

```

DO WHILE there are claims remaining
  IF claimant has not sent in a claim
    THEN set up new claimant record
  ELSE continue
  Add claim to YTD Claim
  IF claimant has policy-plan A
    THEN IF deductible of $100.00 has not been met
      THEN subtract deductible-not-met from claim
      Update deductible
    ELSE continue
    ENDIF
    Subtract copayment of 40% of claim from claim
  ELSE IF claimant has policy-plan B.
    THEN IF deductible of $50.00 has not been met
      THEN subtract deductible-not-met from claim
      Update deductible
    ELSE continue
    ENDIF
    Subtract copayment of 60% of claim from claim
  ELSE write plan-error-message
  ENDIF
  IF claim is greater than zero
    THEN print check
  ENDIF
  Print summary for claimant
  Update accounts
ENDDO

```

mining which policy (A or B) to use and then by subtracting the correct deductibles and copayments. The last sentence points to an iteration: Either DO UNTIL all the claims are processed or DO WHILE there are claims remaining.

Realizing that it is possible to nest the decision structures according to policy plans, we can write the structured English for the foregoing example (see Figure 9.4). As one begins to work on the structured English, one finds that some logic and relationships that seemed clear at one time are actually ambiguous. For example, do we add the claim to the year-to-date (YTD) claim before or after updating the deductible? Is it possible that an error can occur if something other than policy A or B is stored in the claimant's record? We subtract 40 percent of what from the claim? These ambiguities need to be clarified at this point.

Besides the obvious advantage of clarifying the logic and relationships found in human languages, structured English has another important advantage: It is a communication tool. Structured English can be taught to and hence understood by users in the organization, so if communication is important, structured English is a viable alternative for decision analysis.

## Data Dictionary and Process Specifications

All computer programs may be coded using the three basic constructs: sequence, selection (IF . . . THEN . . . ELSE and the case structure), and iteration or looping. The data dictionary indicates which of these constructs must be included in the process specifications.

If the data dictionary for the input and output data flow contains a series of fields without any iteration—{ }—or selection—[ ]—the process specification will contain a simple sequence of statements, such as MOVE, ADD, and SUBTRACT. Refer to the example of a data dictionary for the SHIPPING STATEMENT, illustrated in Figure 9.5. Notice that the data dictionary for the

**FIGURE 9.5**

Data structure for a shipping statement for World's Trend.

Shipping Statement =	Order Number + Order Date + Customer Number + Customer Name + Customer Address + 5{Order Item Lines} + Number of Items + Merchandise Total + (Tax) + Shipping and Handling + Order Total
Customer Name =	First Name + (Middle Initial) + Last Name
Address =	Street + (Apartment) + City + State + Zip + (Zip Expansion) + (Country)
Order Item Lines =	Item Number + Quantity Ordered + Quantity Backordered + Item Description + Size Description + Color Description + Unit Price + Extended Amount

**FIGURE 9.6**

Structured English for creating the shipping statement for World's Trend.

**Structured English**

Format the Shipping Statement. After each line of the statement has been formatted, write the shipping line.

1. GET Order Record
2. GET Customer Record
3. Move Order Number to shipping statement
4. Move Order Date to Shipping Statement
5. Move Customer Number to Shipping Statement
6. DO format Customer Name (leave only one space between First/Middle/Last)
7. DO format Customer Address lines
8. DO WHILE there are items for the order
  9. GET Item Record
  10. DO Format Item Line
  11. Multiply Unit Price by Quantity Ordered giving Extended Amount
  12. Move Extended Amount to Order Item Lines
  13. Add Extended Amount to Merchandise Total
  14. IF Quantity Backordered is greater than zero
    15. Move Quantity Backordered to Order Item Lines
  16. ENDIF
17. ENDDO
18. Move Merchandise Total to Shipping Statement
19. Move 0 to Tax
20. IF State is equal to CT
  21. Multiply Merchandise Total by Tax Rate giving Tax
  22. ENDIF
23. Move Tax to Shipping Statement
24. DO calculate Shipping and Handling
25. Move Shipping and Handling to Shipping Statement
26. Add Merchandise Total, Tax, and Shipping and Handling giving Order Total
27. Move Order Total to Shipping Statement

SHIPPING STATEMENT has the ORDER NUMBER, ORDER DATE, and CUSTOMER NUMBER as simple sequential fields. The corresponding logic, shown in lines 3 through 5 in the corresponding structured English in Figure 9.6, consists of simple MOVE statements.

A data structure with optional elements contained in parentheses or either/or elements contained in brackets will have a corresponding IF . . . THEN . . . ELSE statement in the process specification. Also, if an amount, such as QUANTITY BACKORDERED, is greater than zero, the underlying logic will be IF . . . THEN . . . ELSE. Iteration, indicated by braces on a data structure, must have a corresponding DO WHILE, DO UNTIL, or PERFORM UNTIL to control looping on the process specification. The data structure for the ORDER ITEM LINES allows up to five items in the loop. Lines 8 through 17 show the statements contained in the DO WHILE through the END DO necessary to produce the multiple ORDER ITEM LINES.

## DECISION TABLES

A decision table is a table of rows and columns, separated into four quadrants, as shown in Figure 9.7. The upper left quadrant contains the condition(s); the upper right quadrant contains the condition alternatives. The lower half of the table contains the actions to be taken on the left and the rules for executing the actions on the right. When a decision table is used to determine which action needs to be taken, the logic moves clockwise beginning from the upper left.

Conditions and Actions		Rules
Conditions	Condition Alternatives	
Actions	Action Entries	

**FIGURE 9.7**

The standard format used for presenting a decision table.

Suppose a store wanted to illustrate its policy on noncash customer purchases. The company could do so using a simple decision table as shown in Figure 9.8. Each of the three conditions (sale under \$50, pays by check, and uses credit cards) has only two alternatives. The two alternatives are Y (yes, it is true) or N (no, it is not true). Four actions are possible:

1. Complete the sale after verifying the signature.
2. Complete the sale. No signature needed.
3. Call the supervisor for approval.
4. Communicate electronically with the bank for credit card authorization.

The final ingredient that makes the decision table worthwhile is the set of rules for each of the actions. Rules are the combinations of the condition alternatives that precipitate an action. For example, Rule 3 says:

```

IF      N      (the total sale is NOT under $50.00)
          AND
IF      Y      (the customer paid by check and had two forms of ID)
          AND
IF      N      (the customer did not use a credit card)
          THEN
DO      X      (call the supervisor for approval).
    
```

The foregoing example featured a problem with four sets of rules and four possible actions, but that is only a coincidence. The next example demonstrates that decision tables often become large and involved.

### Developing Decision Tables

To build decision tables, the analyst needs to determine the maximum size of the table; eliminate any impossible situations, inconsistencies, or redundancies; and simplify the table as much as possible. The following steps provide the analyst with a systematic method for developing decision tables:

1. Determine the number of conditions that may affect the decision. Combine rows that overlap, such as conditions that are mutually exclusive. The number of conditions becomes the number of rows in the top half of the decision table.

Conditions and Actions	Rules			
	1	2	3	4
Under \$50	Y	Y	N	N
Pays by check with two forms of ID	Y	N	Y	N
Uses credit card	N	Y	N	Y
Complete the sale after verifying signature.	X			
Complete the sale. No signature needed.		X		
Call supervisor for approval.			X	
Communicate electronically with bank for credit card authorization.				X

**FIGURE 9.8**

Using a decision table for illustrating a store's policy of customer checkout with four sets of rules and four possible actions.

2. Determine the number of possible actions that can be taken. That number becomes the number of rows in the lower half of the decision table.
3. Determine the number of condition alternatives for each condition. In the simplest form of decision table, there would be two alternatives (Y or N) for each condition. In an extended-entry table, there may be many alternatives for each condition. Make sure that all possible values for the condition are included. For example, if a problem statement calculating a customer discount mentions one range of values for an order total from \$100 to \$1,000 and another range of greater than \$1,000, the analyst should realize that the range from 0 up to \$100 should also be added as a condition. This is especially true when there are other conditions that may apply to the 0 up to \$100 order total.
4. Calculate the maximum number of columns in the decision table by multiplying the number of alternatives for each condition. If there were four conditions and two alternatives (Y or N) for each of the conditions, there would be 16 possibilities as follows:

Condition 1: X 2 alternatives  
 Condition 2: X 2 alternatives  
 Condition 3: X 2 alternatives  
Condition 4: X 2 alternatives  
16 possibilities

5. Fill in the condition alternatives. Start with the first condition and divide the number of columns by the number of alternatives for that condition. In the foregoing example, there are 16 columns and two alternatives (Y or N), so 16 divided by 2 is 8. Then choose one of the alternatives, say Y, and write it in the first eight columns. Finish by writing N in the remaining eight columns as follows:

Condition 1: Y Y Y Y Y Y Y Y N N N N N N N N

Repeat this step for each condition, using a subset of the table,

Condition 1: Y Y Y Y Y Y Y Y N N N N N N N N  
 Condition 2: Y Y Y Y N N N N  
 Condition 3: Y Y N N  
 Condition 4: Y N

and continue the pattern for each condition:

Condition 1: Y Y Y Y Y Y Y Y N N N N N N N N  
 Condition 2: Y Y Y Y N N N N Y Y Y Y N N N N  
 Condition 3: Y Y N N Y Y N N Y Y N N Y Y N N  
 Condition 4: Y N Y N Y N Y N Y N Y N Y N Y N

6. Complete the table by inserting an X where rules suggest certain actions.
7. Combine rules where it is apparent that an alternative does not make a difference in the outcome. For example,

Condition 1:	YY
Condition 2:	Y N
Action 1:	XX

can be expressed as:

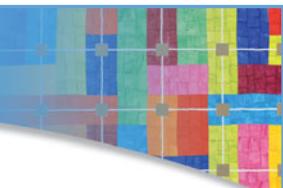
Condition 1:	Y
Condition 2:	—
Action 1:	X

The dash [—] signifies that Condition 2 can be either Y or N, and the action will still be taken.

8. Check the table for any impossible situations, contradictions, and redundancies. They are discussed in more detail later.
9. Rearrange the conditions and actions (or even rules) if it makes the decision table more understandable.



## CONSULTING OPPORTUNITY 9.3



### Saving a Cent on Citron Car Rental

**“W**e feel lucky to be this popular. I think customers feel we have so many options to offer that they ought to rent an auto from us,” says Ricardo Limon, who manages several outlets for Citron Car Rental. “Our slogan is, ‘You’ll never feel squeezed at Citron.’ We have five sizes of cars that we list as A through E.

- A Subcompact
- B Compact
- C Midsize
- D Full-size
- E Luxury

“Standard transmission is available only for A, B, and C. Automatic transmission is available for all cars.”

“If a customer reserves a subcompact (A) and finds on arriving that we don’t have one, that customer gets a free upgrade to the next-sized car, in this case a compact (B). Customers also get a free

upgrade from their reserved car size if their company has an account with us. There’s a discount for membership in any of the frequent-flyer clubs run by cooperating airlines, too. When customers step up to the counter, they tell us what size car they reserved, and then we check to see if we have it in the lot ready to go. They usually bring up any discounts, and we ask them if they want insurance and how long they will use the car. Then we calculate their rate and write out a slip for them to sign right there.”

Ricardo has asked you to computerize the billing process for Citron so that customers can get their cars quickly and still be billed correctly. Draw a decision table that represents the conditions, condition alternatives, actions, and action rules you gained from Ricardo’s narrative that will guide an automated billing process.

Ricardo wants to expand the ecommerce portion of his business by making it possible to reserve a car over the Web. Draw an updated decision table that shows a 10-percent discount for booking a car over the Web.

**A DECISION TABLE EXAMPLE.** Figure 9.9 is an illustration of a decision table developed using the steps previously outlined. In this example a company is trying to maintain a meaningful mailing list of customers. The objective is to send out only the catalogs from which customers will buy merchandise.

The managers realize that certain loyal customers order from every catalog and that some people on the mailing list never order. These ordering patterns are easy to observe, but deciding which catalogs to send customers who order only from selected catalogs is more difficult. Once these decisions are made, a decision table is constructed for three conditions (C1: customer ordered from Fall catalog; C2: customer ordered from Christmas catalog; and C3: customer ordered from specialty catalog), each having two alternatives (Y or N). Three actions can be taken (A1: send out this year’s Christmas catalog; A2: send out the new specialty catalog; and A3: send out both catalogs). The resulting decision table has six rows (three conditions and three actions) and eight columns (two alternatives × two alternatives × two alternatives).

The decision table is now examined to see if it can be reduced. There are no mutually exclusive conditions, so it is not possible to get by with fewer than three condition rows. No rules allow the combination of actions. It is possible, however, to combine some of the rules as shown in

Conditions and Actions	Rules							
	1	2	3	4	5	6	7	8
Customer ordered from Fall catalog.	Y	Y	Y	Y	N	N	N	N
Customer ordered from Christmas catalog.	Y	Y	N	N	Y	Y	N	N
Customer ordered from specialty catalog.	Y	N	Y	N	Y	N	Y	N
Send out this year’s Christmas catalog.		X		X		X		X
Send out specialty catalog.				X			X	
Send out both catalogs.		X			X			

**FIGURE 9.9**

Constructing a decision table for deciding which catalog to send to customers who order only from selected catalogs.

**FIGURE 9.10**

Combining rules to simplify the customer-catalog decision table.

The diagram illustrates the simplification of a decision table. The top table, titled "Conditions and Actions", has columns for "Rules" (1 through 8) and rows for actions: "Customer ordered from Fall catalog.", "Customer ordered from Christmas catalog.", "Customer ordered from specialty catalog.", and "Send out this year's Christmas catalog.", "Send out specialty catalog.", "Send out both catalogs.". Rules 2, 4, 6, and 8 are grouped together because they all have two things in common: they instruct us to send out this year's Christmas catalog, and the alternative for Condition 3 is always N. Arrows point from these four rows to the bottom table, which is titled "Conditions and Actions" and has columns for "Rules" (1', 2', and 3'). The simplified table shows that Rules 2', 3', and 1' cover the same set of conditions and actions as the original rules 2, 4, 6, and 8.

Conditions and Actions	1	2	3	4	5	6	7	8	Rules
Customer ordered from Fall catalog.	Y	Y	Y	Y	N	N	N	N	1
Customer ordered from Christmas catalog.	Y	Y	N	N	Y	Y	N	N	2
Customer ordered from specialty catalog.	Y	N	Y	N	Y	N	Y	N	3
Send out this year's Christmas catalog.		X		X		X			4
Send out specialty catalog.			X				X		5
Send out both catalogs.	X			X	X		X	X	6
									7
									8

Conditions and Actions	1'	2'	3'	Rules
Customer ordered from Fall catalog.	—	—	—	1'
Customer ordered from Christmas catalog.	Y	—	N	2'
Customer ordered from specialty catalog.	Y	—	Y	3'
Send out this year's Christmas catalog.		X		
Send out specialty catalog.				
Send out both catalogs.	X		X	

Figure 9.10. For instance, Rules 2, 4, 6, and 8 can be combined because they all have two things in common:

1. They instruct us to send out this year's Christmas catalog.
2. The alternative for Condition 3 is always N.

It doesn't matter what the alternatives are for the first two conditions, so it is possible to insert dashes [—] in place of the Y or N.

The remaining rules—Rules 1, 3, 5, and 7—cannot be reduced to a single rule because two different actions remain. Instead, Rules 1 and 5 can be combined; likewise, Rules 3 and 7 can be combined.

### Checking for Completeness and Accuracy

Checking over your decision tables for completeness and accuracy is essential. Four main problems can occur in developing decision tables: incompleteness, impossible situations, contradictions, and redundancy.

Ensuring that all conditions, condition alternatives, actions, and action rules are complete is of utmost importance. Suppose an important condition—if a customer ordered less than \$50—had been left out of the catalog store problem discussed earlier. The whole decision table would change because a new condition, new set of alternatives, new action, and one or more new action rules would have to be added. Suppose the rule is: IF the customer did not order more than \$50, THEN do not send any catalogs. A new Rule 4 would be added to the decision table, as shown in Figure 9.11.

**FIGURE 9.11**

Adding a rule to the customer-catalog decision table changes the entire table.

Conditions and Actions	1'	2'	3'	4'	Rules
Customer ordered from Fall catalog.	—	—	—	—	1'
Customer ordered from Christmas catalog.	Y	—	N	—	2'
Customer ordered from specialty catalog.	Y	N	Y	—	3'
Customer ordered \$50 or more.	Y	Y	Y	N	4'
Send out this year's Christmas catalog.			X		
Send out specialty catalog.				X	
Send out both catalogs.	X				
Do not send out any catalog.				X	

Conditions and Actions	Rules			
	1	2	3	4
Salary > \$50,000/year	Y	Y	N	N
Salary < \$2,000/month	Y	N	Y	N
Action 1				
Action 2				

This is an impossible situation.

**FIGURE 9.12**

Checking the decision table for impossible situations is important.

When building decision tables as outlined in the foregoing steps, it is sometimes possible to set up impossible situations. An example is shown in Figure 9.12. Rule 1 is not feasible, because a person cannot earn greater than \$50,000 per year and less than \$2,000 per month at the same time. The other three rules are valid. The problem went unnoticed because the first condition was measured in years and the second condition in months.

Contradictions occur when rules suggest different actions but satisfy the same conditions. The fault could lie with the way the analyst constructed the table or with the information the analyst received. Contradictions often occur if dashes [—] are incorrectly inserted into the table. Redundancy occurs when identical sets of alternatives require the exact same action. Figure 9.13 illustrates a contradiction and a redundancy. The analyst has to determine what is correct and then resolve the contradiction or redundancy.

Decision tables are an important tool in the analysis of structured decisions. One major advantage of using decision tables over other methods is that tables help the analyst ensure completeness. When using decision tables, it is also easy to check for possible errors, such as impossible situations, contradictions, and redundancy. Decision table processors, which take the table as input and provide computer program code as output, are also available.

## DECISION TREES

Decision trees are used when complex branching occurs in a structured decision process. Trees are also useful when it is essential to keep a string of decisions in a particular sequence. Although the decision tree derives its name from natural trees, decision trees are most often drawn on their side, with the root of the tree on the left side of the paper; from there, the tree branches out to the right. This orientation allows the analyst to write on the branches to describe conditions and actions.

Unlike the decision tree used in management science, the analyst's tree does not contain probabilities and outcomes. In systems analysis, trees are used mainly for identifying and organizing conditions and actions in a completely structured decision process.

Conditions and Actions	Rules						
	1	2	3	4	5	6	7
Condition 1	Y	Y	Y	Y	Y	N	N
Condition 2	Y	Y	Y	N	N	Y	N
Condition 3	—	N	—	—	—	N	Y
Action 1	X	X	X	X	X	X	
Action 2	X						
Action 3							X

Contradiction                          Redundancy

**FIGURE 9.13**

Checking the decision table for inadvertent contradictions and redundancy is important.



## CONSULTING OPPORTUNITY 9.4

### A Tree for Free

**I** know you've got a plane to catch, but let me try to explain it once again to you, sir," pleads Glen Curtiss, a marketing manager for Premium Airlines. Curtiss has been attempting (unsuccessfully) to explain the airline's new policy for accumulating miles for awards (such as upgrades to first class and free flights) to a member of Premium's "Flying for Prizes" club.

Glen takes another pass at getting the policy off the ground, saying, "You see, sir, the traveler (that's you, Mr. Icarus) will be awarded the miles actually flown. If the actual mileage for the leg was less than 500 miles, the traveler will get 500 miles credit. If the trip was made on a Saturday, the actual mileage will be multiplied by two. If the trip was made on a Tuesday, the multiplication factor is 1.5. If this is the ninth leg traveled during the calendar month, the

mileage is doubled no matter what day, and if it is the 17th leg traveled, the mileage is tripled. If the traveler booked the flight on the Web or through a travel service such as Orbitz or Travelocity, 100 miles are added.

"I hope that clears it up for you, Mr. Icarus. Enjoy your flight, and thanks for flying Premium."

Mr. Icarus, whose desire to board the Premium plane has all but melted away during Glen's long explanation, fades into the sea of people wading through the security lanes, without so much as a peep in reply.

Develop a decision tree for Premium Airlines' new policy for accumulating award miles so that the policy becomes clearer, is easier to grasp visually, and hence is easier to explain.

### Drawing Decision Trees

It is useful to distinguish between conditions and actions when drawing decision trees. This distinction is especially relevant when conditions and actions take place over a period of time and their sequence is important. For this purpose, use a square node to indicate an action and a circle to represent a condition. Using notation makes the decision tree more readable, as does numbering the circles and squares sequentially. Think of a circle as signifying IF, whereas the square means THEN.

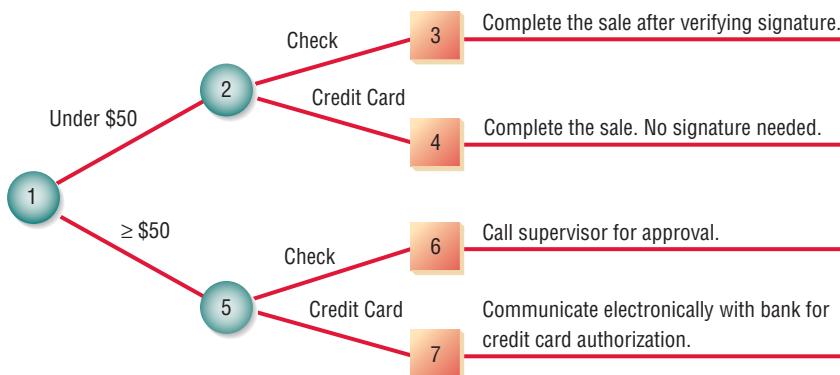
When decision tables were discussed in an earlier section, a point-of-sale example was used to determine the purchase approval actions for a department store. Conditions included the amount of the sale (under \$50) and whether the customer paid by check or credit card. The four actions possible were to: complete the sale after verifying the signature; complete the sale with no signature needed; call the supervisor for approval; or communicate electronically with the bank for credit card authorization. Figure 9.14 illustrates how this example can be drawn as a decision tree. In drawing the tree:

1. Identify all conditions and actions and their order and timing (if they are critical).
2. Begin building the tree from left to right, making sure you list all possible alternatives before moving to the right.

This simple tree is symmetrical, and the four actions at the end are unique. A tree does not need to be symmetrical. Most decision trees have conditions that have a different number of branches. Also, identical actions may appear more than once.

**FIGURE 9.14**

Drawing a decision tree to show the noncash purchase approval actions for a department store.



The decision tree has three main advantages over a decision table. First, it takes advantage of the sequential structure of decision tree branches so that the order of checking conditions and executing actions is immediately noticeable. Second, conditions and actions of decision trees are found on some branches but not on others, which contrasts with decision tables, in which they are all part of the same table. Those conditions and actions that are critical are connected directly to other conditions and actions, whereas those conditions that do not matter are absent. In other words, the tree does not have to be symmetrical. Third, compared with decision tables, decision trees are more readily understood by others in the organization. Consequently, they are more appropriate as a communication tool.

## CHOOSING A STRUCTURED DECISION ANALYSIS TECHNIQUE

We have examined the three techniques for analysis of structured decisions: structured English, decision tables, and decision trees. Although they need not be used exclusively, it is customary to choose one analysis technique for a decision rather than employing all three. The following guidelines provide you with a way to choose one of the three techniques for a particular case:

1. Use structured English when
  - a. There are many repetitious actions,  
OR
  - b. Communication to end users is important.
2. Use decision tables when
  - a. Complex combinations of conditions, actions, and rules are found,  
OR
  - b. You require a method that effectively avoids impossible situations, redundancies, and contradictions.
3. Use decision trees when
  - a. The sequence of conditions and actions is critical,  
OR
  - b. When not every condition is relevant to every action (the branches are different).

## SUMMARY

Once the analyst works with users to identify data flows and begins constructing a data dictionary, it is time to turn to process specification and decision analysis. The three methods for decision analysis and describing process logic discussed in this chapter are structured English, decision tables, and decision trees.

Process specifications (or minispecs) are created for primitive processes on a data flow diagram as well as for some higher-level processes that explode to a child diagram. These specifications explain the decision-making logic and formulas that will transform process input data into output. The three goals of process specification are to reduce the ambiguity of the process, to obtain a precise description of what is accomplished, and to validate the system design.

One way to describe structured decisions is to use the method referred to as structured English, in which logic is expressed in sequential structures, decision structures, case structures, or iterations. Structured English uses accepted keywords such as IF, THEN, ELSE, DO, DO WHILE, and DO UNTIL to describe the logic used, and it indents to indicate the hierarchical structure of the decision process.

Decision tables provide another way to examine, describe, and document decisions. Four quadrants (viewed clockwise from the upper left corner) are used to (1) describe the conditions, (2) identify possible decision alternatives (such as Y or N), (3) indicate which actions should be performed, and (4) describe the actions. Decision tables are advantageous because the rules for developing the table itself, as well as the rules for eliminating redundancy, contradictions, and impossible situations, are straightforward and manageable. The use of decision tables promotes completeness and accuracy in analyzing structured decisions.

The third method for decision analysis is the decision tree, consisting of nodes (a square for actions and a circle for conditions) and branches. Decision trees are appropriate when actions must be accomplished in a certain sequence. There is no requirement that the tree be symmetrical, so only those conditions and actions that are critical to the decisions at hand are found on a particular branch.

Each of the decision analysis methods has its own advantages and should be used accordingly. Structured English is useful when many actions are repeated and when communicating with others is important. Decision tables provide a complete analysis of complex situations while limiting the need for change attributable to impossible situations, redundancies, or contradictions. Decision trees are important when proper sequencing of conditions and actions is critical and when each condition is not relevant to each action.

## HYPERCASE® EXPERIENCE 9



**I**t's really great that you've been able to spend all of this time with us. One thing's for sure, we can use the help. And clearly, from your conversations with Snowden and others, you must realize we all believe that consultants have a role to play in helping companies change. Well, most of us believe it anyway.

"Sometimes structure is good for a person. Or even a company. As you know, Snowden is keen on any kind of structure. That's why some of the Training people can drive him wild sometimes. They're good at structuring things for their clients, but when it comes to organizing their own work, it's another story. Oh well, let me know if there's any way I can help you."

### HYPERCASE Question

1. Assume you will create the specifications for an automated project tracking system for the Training employees. One of the system's functions will be to allow project members to update or add names, addresses, and phone/fax numbers of new clients. Using structured English, write a procedure for carrying out the process of entering a new client name, address, and phone/fax number. [Hint: The procedure should ask for a client name, check to see if the name is already in an existing client file, and let the user either validate and update the current client address and phone/fax number (if necessary) or add a new client's address and phone/fax number to the client file.]

## KEYWORDS AND PHRASES

action  
action rule  
condition  
condition alternative  
decision table

decision tree  
minispecs  
process specifications  
structured decision  
structured English

## REVIEW QUESTIONS

1. List three reasons for producing process specifications.
2. Define what is meant by a structured decision.
3. What four elements must be known for the systems analyst to design systems for structured decisions?
4. What are the two building blocks of structured English?
5. List five conventions that should be followed when using structured English.
6. What is the advantage of using structured English to communicate with people in the organization?
7. Which quadrant of the decision table is used for conditions? Which is used for condition alternatives?
8. What is the first step to take in developing a decision table?
9. List the four main problems that can occur in developing decision tables.
10. What is one of the major advantages of decision tables over other methods of decision analysis?
11. What are the main uses of decision trees in systems analysis?
12. List the four major steps in building decision trees.
13. What three advantages do decision trees have over decision tables?
14. In which two situations should you use structured English?
15. In which two situations do decision tables work best?
16. In which two situations are decision trees preferable?

## PROBLEMS

1. Clyde Clerk is reviewing his firm's expense reimbursement policies with the new salesperson, Trav Farr. "Our reimbursement policies depend on the situation. You see, first we determine if it is a local

trip. If it is, we only pay mileage of 18.5 cents a mile. If the trip was a one-day trip, we pay mileage and then check the times of departure and return. To be reimbursed for breakfast, you must leave by 7:00 A.M., lunch by 11:00 A.M., and have dinner by 5:00 P.M. To receive reimbursement for breakfast, you must return later than 10:00 A.M., lunch later than 2:00 P.M., and have dinner by 7:00 P.M. On a trip lasting more than one day, we allow hotel, taxi, and airfare, as well as meal allowances. The same times apply for meal expenses.” Write structured English for Clyde’s narrative of the reimbursement policies.

2. Draw a decision tree depicting the reimbursement policy in Problem 1.
3. Draw a decision table for the reimbursement policy in Problem 1.
4. A computer supplies firm called True Disk has set up accounts for countless businesses in Dosville. True Disk sends out invoices monthly and will give discounts if payments are made within 10 days. The discounting policy is as follows: If the amount of the order for computer supplies is greater than \$1,000, subtract 4 percent for the order; if the amount is between \$500 and \$1,000, subtract a 2 percent discount; if the amount is less than \$500, do not apply any discount. All orders made via the Web automatically receive an extra 5 percent discount. Any special order (computer furniture, for example) is exempt from all discounting.

Develop a decision table for True Disk discounting decisions, for which the condition alternatives are limited to Y and N.

5. Develop an extended-entry decision table for the True Disk company discount policy described in Problem 4.
6. Develop a decision tree for the True Disk company discount policy in Problem 4.
7. Write structured English to solve the True Disk company situation in Problem 4.
8. Premium Airlines has recently offered to settle claims for a class-action suit, which was originated for alleged price fixing of tickets. The proposed settlement is stated as follows:

Initially, Premium Airlines will make available to the settlement class a main fund of \$25 million in coupons. If the number of valid claims submitted is 1.25 million or fewer, the value of each claim will be the result obtained by dividing \$25 million by the total number of valid claims submitted. For example, if there are 500,000 valid claims, each person submitting a valid claim will receive a coupon with a value of \$50.

The denomination of each coupon distributed will be in a whole dollar amount not to exceed \$50. Thus, if there are fewer than 500,000 valid claims, the value of each claim will be divided among two coupons or more. For example, if there are 250,000 valid claims, each person submitting a valid claim will receive two coupons, each having a face value of \$50, for a total coupon value of \$100.

If the number of valid claims submitted is between 1.25 million and 1.5 million, Premium Airlines will make available a supplemental fund of coupons, with a potential value of \$5 million. The supplemental fund will be made available to the extent necessary to provide one \$20 coupon for each valid claim.

If there are more than 1.5 million valid claims, the total amount of the main fund and the supplemental fund, \$30 million, will be divided evenly to produce one coupon for each valid claim. The value of each such coupon will be \$30 million divided by the total number of valid claims.

Draw a decision tree for the Premium Airlines settlement.

9. Write structured English for the Premium Airlines settlement in Problem 8.
10. “Well, it’s sort of hard to describe,” says Sharon, a counselor at Less Is More Nutrition Center. “I’ve never had to really tell anybody about the way we charge clients or anything, but here goes.

“When clients come into Less Is More, we check to see if they’ve ever used our service before. Unfortunately for them, I guess, we have a lot of repeat clients who keep bouncing back. Repeat clients get a reduced rate (pardon the pun) of \$100 for the first visit if they return within a year of the end of their program.

“Everyone new pays an initial fee, which is \$200 for a physical evaluation. The client may bring in a coupon at this time, and then we deduct \$50 from the up-front fee. Half of our clients use our coupons and find out about us from them. We just give our repeaters their \$100 off, though; they can’t use a coupon, too! Clients who transfer in from one of our centers in another city get \$75 off their first payment fee, but the coupon doesn’t apply. Customers who pay cash get 10 percent off the \$200, but they can’t use a coupon with that.”

Create a decision table with Y and N conditions for the client charge system at Less Is More Nutrition Center.

11. Reduce the decision table in Figure 9.EX1 to the minimum number of rules.

**FIGURE 9.EX1**

A decision table for a warehouse.

Conditions and Actions	Rules															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sufficient quantity on hand	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N
Quantity large enough for discount	Y	Y	Y	Y	N	N	N	N	Y	Y	Y	Y	N	N	N	N
Wholesale customer	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N	Y	Y	N	N
Sales tax exemption filed	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Ship items and prepare invoice	X	X	X	X	X	X	X	X								
Set up backorder										X	X	X	X	X	X	X
Deduct discount	X	X														
Add sales tax	X	X	X		X	X	X									

12. Azure Isle Resort has a pricing structure for vacationers in one of its three dwelling categories: the hotel, villas, and beach bungalows. The base price is for staying in the hotel. Beach bungalows have a 10 percent surcharge and renting a villa has a 15 percent surcharge. The final price includes a discount of 4 percent for returning customers. Further conditions apply to how close the resort is filled to capacity and whether the requested date is within one month from the current date. If the resort is 50 percent full and the time is within one month, there is a 12 percent discount. If the resort is 70 percent full and the time is within one month, there is a 6 percent discount. If the resort is 85 percent full and it is within one month, there is a 4 percent discount.

Develop an optimized decision table for the Azure Isle Resort pricing structure.

13. Create a decision tree for Problem 12.
14. The base ticket price for Cloudliner Airlines is determined by the distance traveled and the day of the week a passenger is traveling. In addition, the airline adjusts its ticket prices based on a number of categories. If the seats remaining are greater than 50 percent of capacity and the number of days before the flight is less than 7, the price is deeply discounted with a special Web offer for the flight. If the seats remaining are greater than 50 percent and the flight date is from 7 to 21 days in the future, there is a medium price discount. If the seats remaining are greater than 50 percent and the number of days before travel are greater than 21, there is only a small discount.

If the seats remaining are from 20 to 50 percent and the days before the flight are fewer than 7, the ticket has a medium discount. If the seats remaining are from 20 to 50 percent and the flight date is from 7 to 21 days in the future, there is a low discount for prices. If the seats remaining are from 20 to 50 percent and the number of days before travel are greater than 21, there is no discount.

If the seats remaining are less than 20 percent and the number of days before the flight is less than 7, the ticket has the highest increase in price. If the seats remaining are less than 20 percent and the flight date is from 7 to 21 days in the future, there is a large increase in price. If the seats remaining are less than 20 percent and number of days before travel are greater than 21, there is a small increase in price.

Develop an optimized decision table for the Cloudliner Airlines ticket price adjustment policies.

15. Develop a decision tree for the situation in Problem 14.

## GROUP PROJECTS

- Each group member (or each subgroup) should choose to become an “expert” and prepare to explain how and when to use one of the following structured decision techniques: structured English, decision tables, or decision trees. Each group member or subgroup should then make a case for the usefulness of its assigned decision analysis technique for studying the types of structured decisions made by Maverick Transport on dispatching particular trucks to particular destinations. Each group should make a presentation of its preferred technique.
- After hearing each presentation, the group should reach a consensus on which technique is most appropriate for analyzing the dispatching decisions of Maverick Transport and why that technique is best in this instance.

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## EPISODE 9

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

## Tabling a Decision

After doing many follow-up interviews with Dot Matricks, Anna tells Chip, “I’ve determined the logic needed to update the PENDING COMPUTER ORDERS data store. Because many computers may be ordered on the same purchase order, as each computer is entered, the matching record is located and one is subtracted from the number of outstanding computers per purchase order.”

Anna shows Chip the **Process** repository screen print. “The name of the corresponding process, UPDATE PENDING COMPUTER ORDER (process 2.5), links the process specification to the data flow diagram,” she explains. Inputs and outputs are listed and should match the data flow into or out of the process. “The VALID COMPUTER TRANSACTION record is input, and the updated PENDING ORDER is the output flow.”

“That will be useful,” Chip says, “even though it took a while to untangle it all.”

Anna points out, “The **Process Description** area contains the logic, shown in structured English.”

When the logic is complete, Anna further enters a few notes on the nature of the process, notes that it is a batch process, and also adds timing information.

A decision table may be created for control or process logic. Before the decision table is keyed, it is a good idea to create it on paper and optimize the table. This way only the essential conditions and actions will be entered.

“I’ve been busy, too,” Chip assures Anna. “I’ve spoken with Cher Ware several times since you interviewed her. I’ve finally captured some of the logic for calculating the cost of a software upgrade.

“Cher indicated three different conditions affecting the cost. The site license provides unlimited copies and is used for popular software installed on many computers. An educational discount is provided by many publishers, and a discount for quantity is usually available,” he continues.

“First I determined the values for the conditions and the number of combinations,” Chip says. He set out the three conditions and their values as follows:

Condition	Values	Number of Values
SITE LICENSE	Y/N	2
EDUCATIONAL DISCOUNT	Y/N	2
DISCOUNT FOR QUANTITY	Y/N	2

“The total number of combinations is found by multiplying the number of values for each of the conditions,  $2 \times 2 \times 2 = 8$ . The next step is to decide which conditions should be first.” Chip continues, “I reason that a site license would not have a discount for quantity or an additional educational discount, because the actual site license cost already reflects this kind of discount. Therefore, SITE LICENSE should be the first condition. Each of the two other conditions would not have any particular advantage over the other, so the order is unimportant.

“Because the total number of conditions is eight and the SITE LICENSE condition has two possible values, the repeat factor would be  $8/2$ , or 4.” Chip continues by noting that the first row of the decision table would be

Condition	1	2	3	4	5	6	7	8
SITE LICENSE	Y	Y	Y	Y	N	N	N	N

“The next condition is EDUCATIONAL DISCOUNT, which also has two values. Dividing these two into the previous factor of four yields  $4/2 = 2$  for the next repeat factor.” Chip notes that the decision table now expands to

Condition	1	2	3	4	5	6	7	8
SITE LICENSE	Y	Y	Y	Y	N	N	N	N
EDUCATIONAL DISCOUNT	Y	Y	N	N	Y	Y	N	N

Chip continues, “The last condition, DISCOUNT FOR QUANTITY, also has two values, and dividing these two into the previous repeat factor of two gives  $2/2 = 1$ , which should always be the repeat factor for the last row of the conditions.” He notes that the completed condition entry is

<u>Condition</u>	1	2	3	4	5	6	7	8
SITE LICENSE	Y	Y	Y	Y	N	N	N	N
EDUCATIONAL DISCOUNT	Y	Y	N	N	Y	Y	N	N
DISCOUNT FOR QUANTITY	Y	N	Y	N	Y	N	Y	N

Chip points out that when the actions are included, the completed decision table is

<u>Condition</u>	1	2	3	4	5	6	7	8
SITE LICENSE	Y	Y	Y	Y	N	N	N	N
EDUCATIONAL DISCOUNT	Y	Y	N	N	Y	Y	N	N
DISCOUNT FOR QUANTITY	Y	N	Y	N	Y	N	Y	N

<u>Actions</u>								
COST = SITE LICENSE COST	X	X	X	X				
COST = EDUCATIONAL COST × COPIES						X		
COST = DISCOUNT COST × COPIES							X	
COST = UPGRADE COST × COPIES								X
COST = (EDUC COST – DISC) × COPIES								X

“I have proceeded to reduce some of the redundant actions, specifically those occurring when a site license has been obtained,” Chip continues. “Because the actions are the same for Site License values of Y, the educational and quantity discounts are meaningless to the condition and don’t have to be considered. Rules 1 through 4 may be reduced to one rule.” Chip concludes by noting that the final, optimized decision table is

<u>Condition</u>	1	2	3	4	5
SITE LICENSE	Y	N	N	N	N
EDUCATIONAL DISCOUNT	—	Y	Y	N	N
DISCOUNT FOR QUANTITY	—	Y	N	Y	N

<u>Actions</u>					
COST = SITE LICENSE COST	X				
COST = EDUCATIONAL COST × COPIES		X			
COST = DISCOUNT COST × COPIES			X		
COST = UPGRADE COST × COPIES				X	
COST = (EDUC COST – DISC) × COPIES					X

The final decision table, shown in Figure E9.1, contains the optimized decision table. There are three conditions: whether a site license, an educational discount, or a quantity discount is available. The top left quadrant contains the conditions. Directly below it are the actions. The condition alternatives are in the upper right quadrant, and the action entries are in the lower right quadrant. The actions show how the upgrade cost is determined for each condition, indicated by an X in the rule columns.

**FIGURE E9.1**

Decision Table,  
UPGRADE COST.

<u>Conditions and Actions</u>		1	2	3	4	5
Site license	Y					
Educational discount	Y					
Discount for quantity	Y					

Upgrade cost = Site license cost	X					
Upgrade cost = Educational cost * Number of copies		X				
Upgrade cost = Discount cost * Number of copies			X			
Upgrade cost = Cost per copy * Number of copies				X		
Upgrade cost = (Educational cost – Discount) * Number of copies					X	

## EXERCISES

Note: If you are not using Visible Analyst, some of the following exercises may be done using a Microsoft Word or a Microsoft Excel template for decision tables. The repository is also available as a Web page.

- E-1. Use Visible Analyst to view the **Process** repository entry for UPDATE PENDING COMPUTER ORDER.



- E-2. Use Visible Analyst to modify and print the ACCUMULATIVE HARDWARE SUBTOTALS **Process** entry. Add the **Process Description**, “Accumulate the hardware subtotals. These include the number of machines for each hardware brand.”



- E-3. Use Visible Analyst to modify and print the CONFIRM COMPUTER DELETION **Process** entry. Add the following **Process Description**:



Use the COMPUTER RECORD to format the **Deletion Confirmation** screen (refer to the **Delete Computer Prototype** screen).

Prompt the user to click the **OK** button to confirm the deletion; otherwise, click the **Cancel** button to cancel the deletion.

If the operator clicks **OK** to delete the record, delete the record and display a “Record Deleted” message; otherwise, display a “Deletion Canceled” message.

- E-4. Create **Process** specifications for process 6.6, VALIDATE COMPUTER CHANGES. The **Process Description** for the process is as follows:



Validate the changes to the COMPUTER MASTER. Include a note to use the edit criteria established for each element. Provide the following additional editing criteria:

The ROOM LOCATION must be valid for a particular campus.

There must not be a second hard drive without the first one.

The LAST PREVENTIVE MAINTENANCE DATE must not be greater than the current date.

The DATE PURCHASED must not be greater than the LAST PREVENTIVE MAINTENANCE DATE or greater than the current date.

The MODEL must conform to the type supported by the BRAND name.

No changes may be made to an inactive record.

- E-5. Create process specifications for process 1.4, CREATE SOFTWARE LOG FILE. Use the data flow diagram examples to determine inputs and outputs. Process details are as follows:



Format the SOFTWARE LOG RECORD from the following information:

The confirmed NEW SOFTWARE RECORD elements.

The following system elements: SYSTEM DATE, SYSTEM TIME, USER ID.

When the record has been formatted, write to the SOFTWARE LOG FILE.

- E-6. Produce process specifications for process 9.7.2, FIND MATCHING HARDWARE RECORD. This process is part of a program producing a report showing all computers on which each software package is located. Use Visible Analyst or Microsoft Visio to view data flow diagram 9.7. Use structured English to depict the following logic:



For each SOFTWARE RECORD, loop while there is a matching hardware inventory number.

Within the loop, accomplish the following tasks:

Read the COMPUTER MASTER.

If a record is found, format the MATCHING COMPUTER RECORD information.

If no record is found, format a NO MATCHING error line.

Furthermore, if the found COMPUTER RECORD is inactive, indicating that it has been removed from service, format an INACTIVE MATCHING COMPUTER error line.

- E-7. Create the FIND SOFTWARE LOCATION decision table, representing the logic for an inquiry program for displaying all locations for a given SOFTWARE TITLE and VERSION. The conditions have been created and optimized, resulting in five rules, illustrated in Figure E9.2. Enter the actions that need to be entered and an **X** in the column related to the conditions. If you are using a word processor, print the final decision table. The conditions and actions are represented by the following logic:



The SOFTWARE MASTER file is located for the specified TITLE. If the matching record is not found, an error message is displayed. Because there may be several versions, the VERSION NUMBER on the record is checked for a match to the version entered. If the requested version is not found, further records are read using the alternate index. If all records are read and the version number is not found, an error message, VERSION NOT AVAILABLE, is displayed.

**FIGURE E9.2**

Decision Table, FIND SOFTWARE LOCATION.

Conditions and Actions	1	2	3	4	5
Matching software record found	Y	Y	Y	Y	N
Version of software found	Y	Y	Y	N	
Matching computer record found	Y	Y	N		
Campus code found in table	Y	N			
Display 'No Matching Software Record' error message					X
Display 'Version Not Available' error message					X
Display 'Machine Not Found' error message			X		
Display 'Campus Code Not Found' error message				X	
Display location information	X				

Once the correct software has been located, a matching COMPUTER MASTER record is obtained. If the COMPUTER MASTER is not found, the error message MACHINE NOT FOUND is displayed. For each matching machine, the CAMPUS TABLE is searched for the CAMPUS LOCATION code. If the code is not found, the message CAMPUS CODE NOT FOUND is displayed.

If no errors occur, the requested information is displayed.

-  E-8. Create a decision table for a batch update of the COMPUTER MASTER database table. Information is sent from a regional campus in an XML format containing three types of updates: Add, Delete, and Change.

The COMPUTER MASTER record must be read. If the transaction is an Add and the master is not found, format and write the new COMPUTER MASTER record. Print a valid transaction line on an UPDATE REPORT. For a Change or Delete transaction, print a CHANGE ERROR LINE or a DELETE ERROR LINE if the COMPUTER MASTER record is not found.

If the COMPUTER MASTER record is found, check the active code. If the record is inactive and the transaction is an Add, format and rewrite the new COMPUTER MASTER record. Print a valid transaction line on an UPDATE REPORT. For a Change or Delete transaction, print a CHANGE ERROR LINE or a DELETE ERROR LINE.

If the COMPUTER MASTER record is active and the transaction is an Add, print an ADD ERROR LINE. For a Change transaction, format the changes and rewrite the COMPUTER MASTER record. Print the VALID TRANSACTION LINE. For a Delete transaction, change the ACTIVE CODE to inactive and rewrite the COMPUTER MASTER record. Print the VALID TRANSACTION LINE.

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

# CHAPTER 10

## Object-Oriented Systems Analysis and Design Using UML\*

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand what object-oriented systems analysis and design is and appreciate its usefulness.
2. Comprehend the concepts of unified modeling language (UML), the standard approach for modeling a system in the object-oriented world.
3. Apply the steps used in UML to break down the system into a use case model and then a class model.
4. Diagram systems with the UML toolset so they can be described and properly designed.
5. Document and communicate the newly modeled object-oriented system to users and other analysts.



Object-oriented analysis and design can offer an approach that facilitates logical, rapid, and thorough methods for creating new systems responsive to a changing business landscape. Object-oriented techniques work well in situations in which complicated information systems are undergoing continuous maintenance, adaptation, and redesign.

In this chapter, we introduce the unified modeling language (UML), the industry standard for modeling object-oriented systems. The UML toolset includes diagrams that allow you to visualize the construction of an object-oriented system. Each design iteration takes a successively more detailed look at the design of the system until the things and relationships in the system are clearly and precisely defined in UML documents. UML is a powerful tool that can greatly improve the quality of your systems analysis and design, and thereby help create higher-quality information systems.

When the object-oriented approach was first introduced, advocates cited reusability of the objects as the main benefit of their approach. It makes intuitive sense that the recycling of program parts should reduce the costs of development in computer-based systems. It has proved to be very effective in the development of GUIs and databases. Although reusability is the main goal, maintaining systems is also very important, and because the object-oriented approach creates objects that contain both data and program code, a change in one object has a minimal impact on other objects.

\*By Julie E. Kendall, Kenneth E. Kendall, and Allen Schmidt.

## OBJECT-ORIENTED CONCEPTS

Object-oriented programming differs from traditional procedural programming by examining the objects that are part of a system. Each object is a computer representation of some actual thing or event. General descriptions of the key object-oriented concepts of objects, classes, and inheritance are presented in this section, with further details on other UML concepts introduced later in this chapter.

### Objects

Objects are persons, places, or things that are relevant to the system we are analyzing. Object-oriented systems describe entities as objects. Typical objects may be customers, items, orders, and so on. Objects may also be GUI displays or text areas on the display.

### Classes

Objects are typically part of a group of similar items called classes. The desire to place items into classes is not new. Describing the world as being made up of animals, vegetables, and minerals is an example of classification. The scientific approach includes classes of animals (such as mammals), and then divides the classes into subclasses (such as egg-laying animals and pouched mammals).

The idea behind classes is to have a reference point and describe a specific object in terms of its similarities to or differences from members of its own class. In doing so, it is more efficient for someone to say, “The koala bear is a marsupial (or pouched animal) with a large round head and furry ears,” than it is to describe a koala bear by describing all of its characteristics as a mammal. It is more efficient to describe characteristics, appearance, and even behavior in this way. When you hear the word *reusable* in the object-oriented world, it means you can be more efficient, because you do not have to start at the beginning to describe an object every time it is needed for software development.

Objects are represented by and grouped into classes that are optimal for reuse and maintainability. A class defines the set of shared attributes and behaviors found in each object in the class. For example, records for students in a course section have similar information stored for each student. The students could be said to make up a class (no pun intended). The values may be different for each student, but the type of information is the same. Programmers must define the various classes in the program they are writing. When the program runs, objects can be created from the established class. The term *instantiate* is used when an object is created from a class. For example, a program could instantiate a student named Peter Wellington as an object from the class labeled as student.

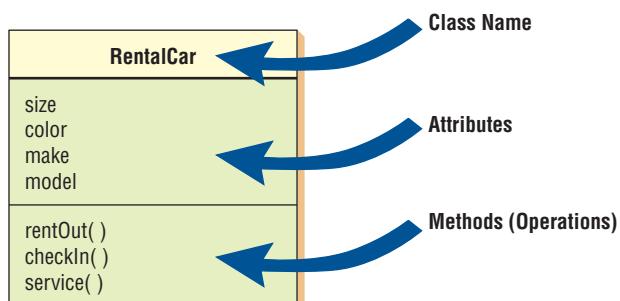
What makes object-oriented programming, and thus object-oriented analysis and design, different from classical programming is the technique of putting all of an object’s attributes and methods within one self-contained structure, the class itself. This is a familiar occurrence in the physical world. For example, a packaged cake mix is analogous to a class since it has the ingredients as well as instructions on how to mix and bake the cake. A wool sweater is similar to a class because it has a label with care instructions sewn into it that caution you to wash it by hand and lay it flat to dry.

Each class should have a name that differentiates it from all other classes. Class names are usually nouns or short phrases and begin with an uppercase letter. In Figure 10.1 the class is called **RentalCar**. In UML, a class is drawn as a rectangle. The rectangle contains two other important features: a list of attributes and a series of methods. These items describe a class, the unit of analysis that is a large part of what we call object-oriented analysis and design.

An attribute describes some property that is possessed by all objects of the class. Notice that the **RentalCar** class possesses the attributes of size, color, make, and model. All cars possess these

**FIGURE 10.1**

An example of a UML class. A class is depicted as a rectangle consisting of the class name, attributes, and methods.



attributes, but each car will have different values for its attributes. For example, a car can be blue, white, or some other color. Later on we will demonstrate that you can be more specific about the range of values for these properties. When specifying attributes, the first letter is usually lowercase.

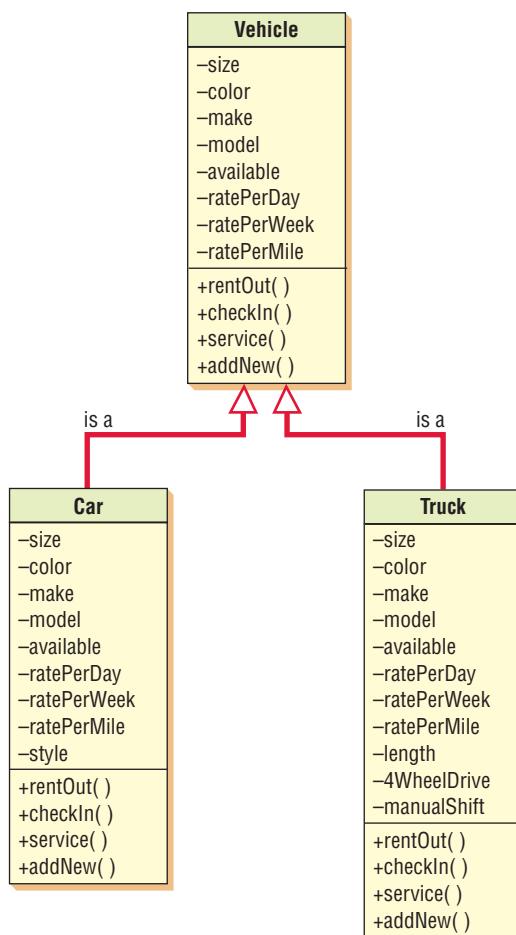
A method is an action that can be requested from any object of the class. Methods are the processes that a class knows to carry out. Methods are also called operations. For the class of **RentalCar**, **rentOut()**, **checkIn()**, and **service()** are examples of methods. When specifying methods, the first letter is usually lowercase.

## Inheritance

Another key concept of object-oriented systems is inheritance. Classes can have children; that is, one class can be created out of another class. In UML, the original—or parent—class is known as a base class. The child class is called a derived class. A derived class can be created in such a way that it will inherit all the attributes and behaviors of the base class. A derived class, however, may have additional attributes and behaviors. For example, there might be a **Vehicle** class for a car rental company that contains attributes such as **size**, **color**, and **make**.

Inheritance reduces programming labor by using common objects easily. The programmer only needs to declare that the **Car** class inherits from the **Vehicle** class, and then provide any additional details about new attributes or behaviors that are unique to a car. All the attributes and behaviors of the **Vehicle** class are automatically and implicitly part of the **Car** class and require no additional programming. This enables the analyst to define once but use many times, and is similar to data that is in the third normal form, defined only once in one database table (as discussed in Chapter 13).

The derived classes shown in Figure 10.2 are **Car** or **Truck**. Here the attributes are preceded by minus signs and methods are preceded by plus signs. We will discuss this in more detail later in the chapter, but for now take note that the minus signs mean that these attributes are private (not shared with other classes) and these methods are public (may be invoked by other classes).



**FIGURE 10.2**

A class diagram showing inheritance. Car and Truck are specific examples of vehicles and inherit the characteristics of the more general class, **Vehicle**.



## CONSULTING OPPORTUNITY 10.1

### Around the World in 80 Objects

**B**ecause you have described the advantages of using object-oriented approaches, Jules and Vern, two top executives at World's Trend, would like you to analyze their business using this approach. You can find a summary of World's Trend business activities in Figure 7.15. Notice also the series of data flow diagrams in that chapter to help you conceptualize the problem and begin making the transition to Object Think.

Because you are such good friends with Jules and Vern and because you wouldn't mind a little practical experience using O-O thinking, you agree to apply what you know and give them a report.

Once you have reread the business activities for World's Trend, provide a timely review by completing the following tasks:

- Use the CRC cards technique to list classes, responsibilities, and collaborators.
- Use the Object Think technique to list “knows” and corresponding attributes for the objects in those classes identified in the previous stage.

Write up both steps and fly over to World's Trend headquarters with your report in hand. Clearly, Jules and Vern are hoping for a fantastic voyage into the new world of object-oriented methods.

Program code reuse has been a part of structured systems development and programming languages (such as COBOL) for many years, and there have been subprograms that encapsulate data. Inheritance, however, is a feature that is only found in object-oriented systems.

### CRC CARDS AND OBJECT THINK

Now that we have covered the fundamental concepts of object-oriented systems analysis and design, we need to examine ways to create classes and objects from the business problems and systems we are facing. One way to begin enacting the object-oriented approach is to start thinking and talking in this new way. One handy approach is to develop CRC cards.

CRC stands for class, responsibilities, and collaborators. The analyst can use these concepts when beginning to talk about or model the system from an object-oriented perspective. CRC cards are used to represent the responsibilities of classes and the interaction between the classes. Analysts create the cards based on scenarios that outline system requirements. These scenarios model the behavior of the system under study. If they are to be used in a group, CRC cards can be created manually on small note cards for flexibility, or they can be created using a computer.

We have added two columns to the original CRC card template: the Object Think column and the property column. The Object Think statements are written in plain English, and the property, or attribute, name is entered in its proper place. The purpose of these columns is to clarify thinking and help move toward creating UML diagrams.

#### Interacting During a CRC Session

CRC cards can be created interactively with a handful of analysts who can work together to identify the class in the problem domain presented by the business. One suggestion is to find all the nouns and verbs in a problem statement that has been created to capture the problem. Nouns usually indicate the classes in the system, and responsibilities can be found by identifying the verbs.

With your analyst group, brainstorm to identify all the classes you can. Follow the standard format for brainstorming, which is not to criticize any participant's response at this point, but rather to elicit as many responses as possible. When all classes have been identified, the analysts can then compile them, weed out the illogical ones, and write each one on its own card. Assign one class to each person in the group, who will “own” it for the duration of the CRC session.

Next, the group creates scenarios that are actually walk-throughs of system functions by taking desired functionality from the requirements document previously created. Typical systems methods should be considered first, with exceptions such as error recovery taken up after the routine ones have been covered.

As the group decides which class is responsible for a particular function, the analyst who owns the class for the session picks up that card and declares, “I need to fulfill my responsibility.” When a card is held in the air, it is considered an object and can do things. The group then

The figure displays four CRC cards, each representing a class with its responsibilities, collaborators, object think statements, and properties. The cards are arranged vertically and overlap slightly.

Class Name: Department			
Superclasses:			
Subclasses:			
Responsibilities	Collaborators	Object Think	Property
Add a new department	Course	I know my name	Department Name
Provide department information		I know my department chair	Chair Name

Class Name: Course			
Superclasses:			
Subclasses:			
Responsibilities	Collaborators	Object Think	Property
Add a new course	Department	I know my course number	Course Number
Change course information	Textbook	I know my description	Course Description
Display course information	Assignment	I know my number of credits	Credits
	Exam		

Class Name: Textbook			
Superclasses:			
Subclasses:			
Responsibilities	Collaborators	Object Think	Property
Add a new textbook	Course	I know my ISBN	ISBN
Change textbook information		I know my author	Author
Find textbook information		I know my title	Title
Remove obsolete textbooks		I know my edition	Edition
		I know my publisher	Publisher
		I know if I am required	Required

Class Name: Assignment			
Superclasses:			
Subclasses:			
Responsibilities	Collaborators	Object Think	Property
Add a new assignment	Course	I know my assignment number	Task Number
Change an assignment		I know my description	Task Description
View an assignment		I know how many points I am worth	Points
		I know when I am due	Due Date

proceeds to refine the responsibility into smaller and smaller tasks, if possible. These tasks can be fulfilled by the object if it is appropriate, or the group can decide that it can be fulfilled by interacting with other things. If there are no other appropriate classes in existence, the group may need to create one.

The four CRC cards depicted in Figure 10.3 show four classes for course offerings. Notice that in a class called **Course**, the systems analyst is referred to four collaborators: the department,

### FIGURE 10.3

Four CRC cards for course offerings show how analysts fill in the details for classes, responsibilities, and collaborators, as well as for object think statements and property names.

the textbook, the course assignment, and the course exam. These collaborators are then described as classes of their own on the other CRC cards.

The responsibilities listed will eventually evolve into what are called methods in UML. The Object Think statements seem elementary, but they are conversational so as to encourage a group of analysts during a CRC session to describe as many of these statements as possible. As shown in the example, all dialog during a CRC session is carried out in the first person, so that even the **textbook** speaks: “I know my ISBN.” “I know my author.” These statements can then be used to describe attributes in UML. These attributes can be called by their variable names, such as **edition** and **publisher**.

## THE UNIFIED MODELING LANGUAGE (UML) CONCEPTS AND DIAGRAMS

The UML approach is well worth investigating and understanding, due to its wide acceptance and usage. UML provides a standardized set of tools to document the analysis and design of a software system. The UML toolset includes diagrams that allow people to visualize the construction of an object-oriented system, similar to the way a set of blueprints allows people to visualize the construction of a building. Whether you are working independently or with a large systems development team, the documentation that you create with UML provides an effective means of communication between the development team and the business team on a project.

UML consists of things, relationships, and diagrams, as illustrated in Figure 10.4. The first components, or primary elements, of UML are called things. You may prefer another word, such

**FIGURE 10.4**

An overall view of UML and its components: Things, Relationships, and Diagrams.

UML Category	UML Elements	Specific UML Details
<b>Things</b>	Structural Things	Classes Interfaces Collaborations Use Cases Active Classes Components Nodes
	Behavioral Things	Interactions State Machines
	Grouping Things	Packages
	Annotational Things	Notes
<b>Relationships</b>	Structural Relationships	Dependencies Aggregations Associations Generalizations
	Behavioral Relationships	Communicates Includes Extends Generalizes
<b>Diagrams</b>	Structural Diagrams	Class Diagrams Component Diagrams Deployment Diagrams
	Behavioral Diagrams	Use Case Diagrams Sequence Diagrams Communication Diagrams Statechart Diagrams Activity Diagrams

as object, but in UML they are called things. Structural things are most common. Structural things are classes, interfaces, use cases, and many other elements that provide a way to create models. Structural things allow the user to describe relationships. Behavioral things describe how things work. Examples of behavioral things are interactions and state machines. Group things are used to define boundaries. An example of a group thing is a package. Finally, we have annotational things, so that we can add notes to the diagrams.

Relationships are the glue that holds the things together. It is useful to think of relationships in two ways. Structural relationships are used to tie the things together in the structural diagrams. Structural relationships include dependencies, aggregations, associations, and generalizations. Structural relationships show inheritance, for example. Behavioral relationships are used in the behavioral diagrams. The four basic types of behavioral relationships are communicates, includes, extends, and generalizes.

There are two main types of diagrams in UML: structural diagrams and behavioral diagrams. Structural diagrams are used, for example, to describe the relationships between classes. They include class diagrams, object diagrams, component diagrams, and deployment diagrams. Behavioral diagrams, on the other hand, can be used to describe the interaction between people (called actors in UML) and the thing we refer to as a use case, or how the actors use the system. Behavioral diagrams include use case diagrams, sequence diagrams, communication diagrams, statechart diagrams, and activity diagrams.

In the remainder of this chapter, we first discuss use case modeling, the basis for all UML techniques. Next, we look at how a use case is used to derive activities, sequences, and classes—the most commonly used UML diagrams. Because entire books are dedicated to the syntax and usage of UML (the actual UML specification document is over 800 pages long), we provide only a brief summary of the most valuable and commonly used aspects of UML.

The six most commonly used UML diagrams are:

1. A use case diagram, describing how the system is used. Analysts start with a use case diagram.
2. A use case scenario (although technically it is not a diagram). This scenario is a verbal articulation of exceptions to the main behavior described by the primary use case.
3. An activity diagram, illustrating the overall flow of activities. Each use case may create one activity diagram.
4. Sequence diagrams, showing the sequence of activities and class relationships. Each use case may create one or more sequence diagrams. An alternative to a sequence diagram is a communication diagram, which contains the same information but emphasizes communication instead of timing.
5. Class diagrams, showing the classes and relationships. Sequence diagrams are used (along with CRC cards) to determine classes. An offshoot of a class diagram is a gen/spec diagram (which stands for generalization/specialization).
6. Statechart diagrams, showing the state transitions. Each class may create a statechart diagram, which is useful for determining class methods.

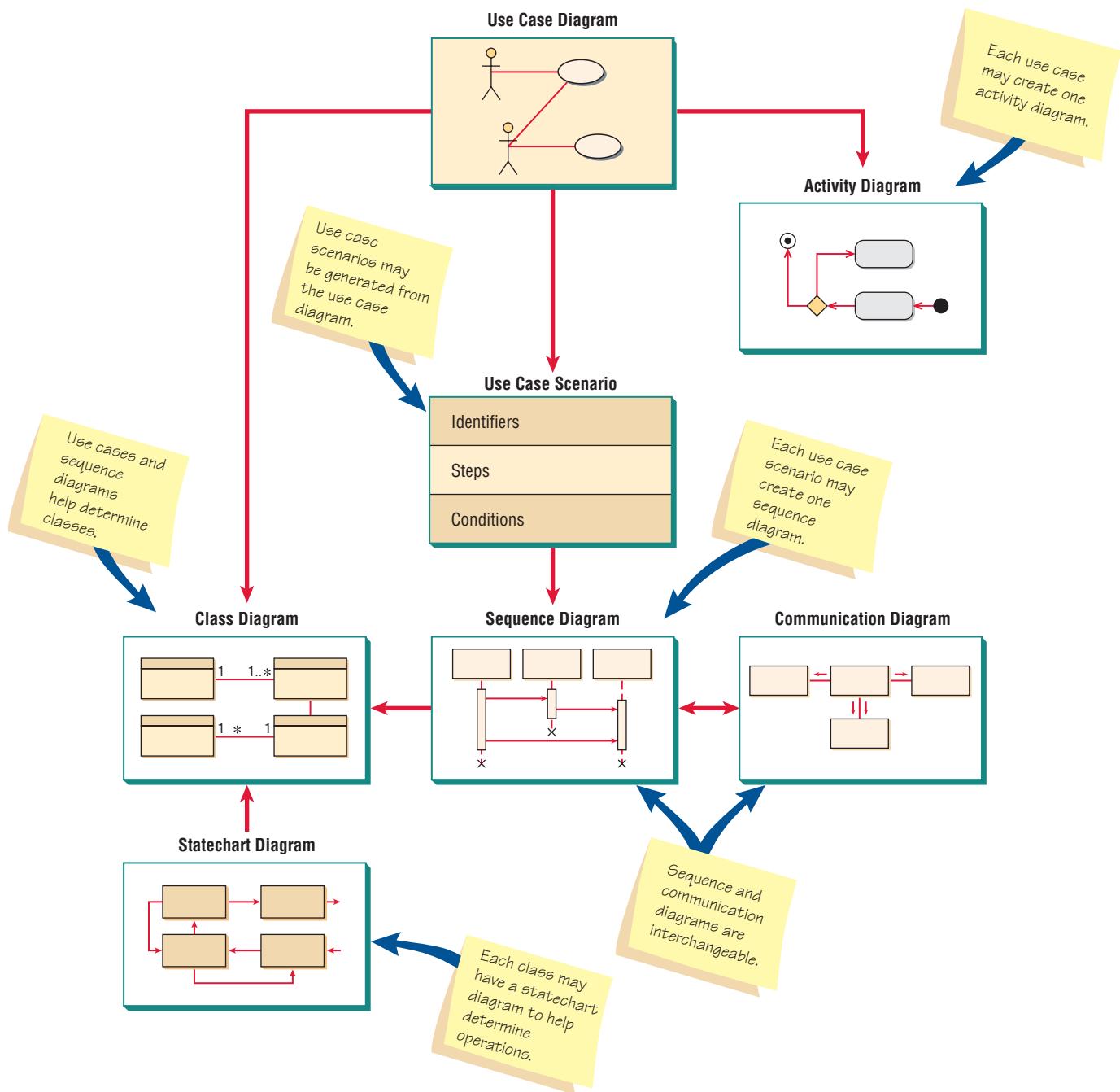
How these diagrams relate to one another is illustrated in Figure 10.5. We will discuss each of these diagrams in the following sections.

## USE CASE MODELING

UML is fundamentally based on an object-oriented analysis technique known as use case modeling, which was introduced in Chapter 2. A use case model shows a view of the system from the user perspective, thus describing *what* a system does without describing *how* the system does it. UML can be used to analyze the use case model, and to derive system objects and their interactions with each other and with the users of the system. Using UML techniques, you further analyze the objects and their interactions to derive object behavior, attributes, and relationships.

A use case provides developers with a view of what the users want. It is free of technical or implementation details. We can think of a use case as a sequence of transactions in a system. The use case model is based on the interactions and relationships of individual use cases.

A use case always describes three things: an actor that initiates an event; the event that triggers a use case; and the use case that performs the actions triggered by the event. In a use case,

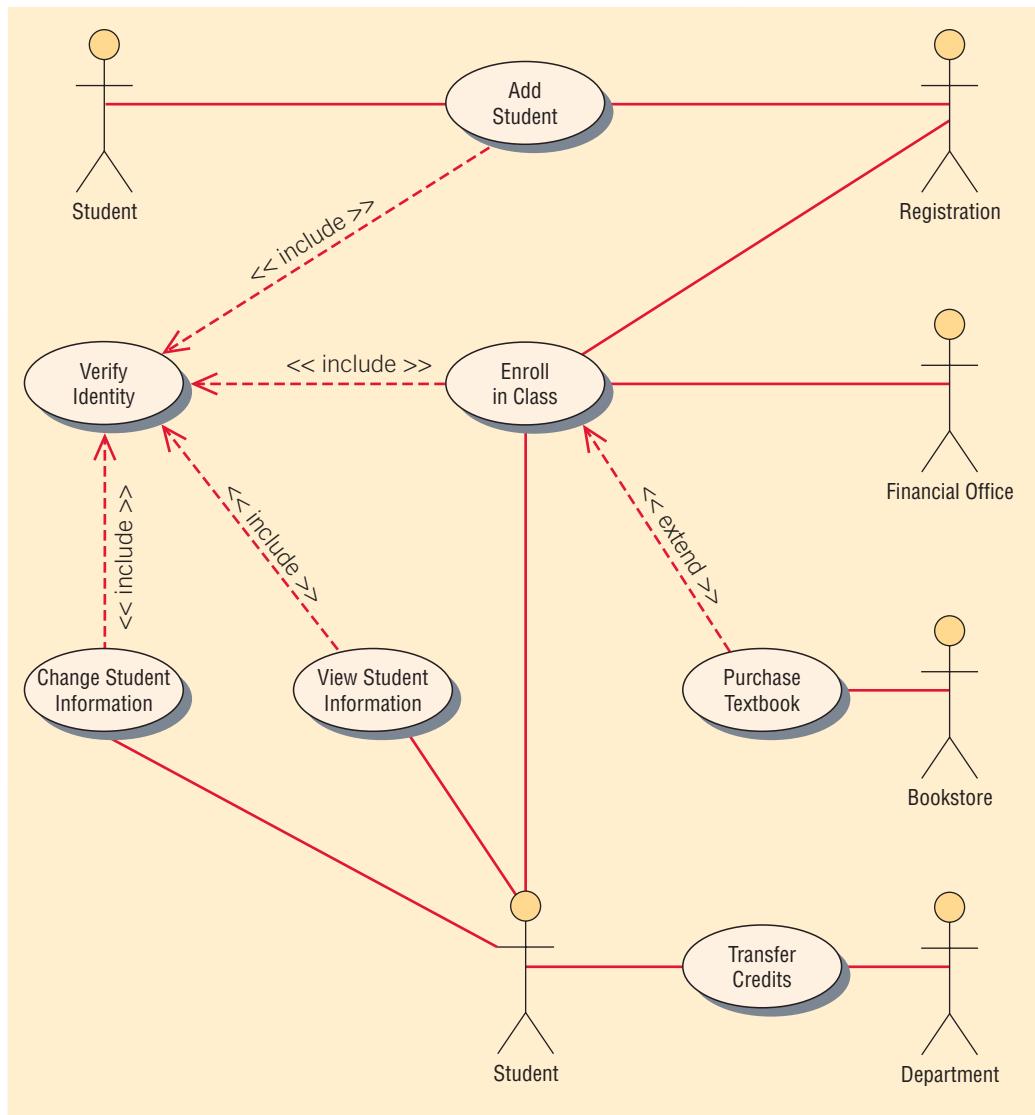
**FIGURE 10.5**

An overall view of UML diagrams showing how each diagram leads to the development of other UML diagrams.

an actor using the system initiates an event that begins a related series of interactions in the system. Use cases are used to document a single transaction or event. An event is an input to the system that happens at a specific time and place and causes the system to do something. For more information about use case symbols and how to draw use case diagrams, see Chapter 2.

Figure 10.6 is a use case example of student enrollment at a university. Notice that only the most important functions are represented. The **Add Student** use case does not indicate how to add students, the method of implementation. Students could be added in person, using the Web, using a touch-tone telephone, or any combination of these methods. The **Add Student** use case includes the **Verify Identity** use case to verify the identity of the student. The **Purchase Textbook** use case extends the **Enroll in Class** use case, and may be part of a system to enroll students in an online course.

It may seem as if the **Change Student Information** use case is a minor system feature and should not be included on the use case diagram, but because this information changes fre-

**FIGURE 10.6**

A use case example of student enrollment.

quently, administration has a keen interest in allowing students to change their own personal information. The fact that the administrators deem this to be important not only justifies, but calls for, the use case to be written up.

Students would not be allowed to change grade point average, outstanding fees, and other information. This use case also includes the **Verify Identity** use case, and in this situation, it means having the student enter a user ID and password before gaining access to the system. **View Student Information** allows students to view their personal information, as well as courses and grades.

A use case scenario example is shown in Figure 10.7. Some of the areas included are optional, and may not be used by all organizations. The three main areas are:

1. A header area containing case identifiers and initiators.
2. Steps performed.
3. A footer area containing preconditions, assumptions, questions, and other information.

In the first area the use case is identified by its name, **Change Student Information**; the actor is identified as a **Student**; and the Use Case and Triggering Event are described. The second area contains a series of steps that are performed as long as no errors are encountered. Finally, in the third area, all of the pre- and postconditions and assumptions are identified. Some of these are obvious, such as the precondition that the student is on the correct Web page and the assumption that the student has a valid student ID and password. Others are not so obvious, such as the outstanding issue regarding how many times the student is allowed to log on to the system.

<b>Use case name:</b>	Change Student Information	<b>UniqueId:</b> Student UC 005
<b>Area:</b>	Student System	
<b>Actor(s):</b>	Student	
<b>Description:</b>	Allow student to change his or her own information, such as name, home address, home telephone, campus address, campus telephone, cell phone, and other information using a secure Web site.	
<b>Triggering Event:</b>	Student uses Change Student Information Web site, enters student ID and password, and clicks the <b>Submit</b> button.	
<b>Trigger type:</b>	<input checked="" type="checkbox"/> External <input type="checkbox"/> Temporal	
<b>Steps Performed (Main Path)</b>	<b>Information for Steps</b>	
1. Student logs on to the secure Web server.	Student ID, Password	
2. Student record is read and password is verified.	Student Record, Student ID, Password	
3. Current student personal information is displayed on the Change Student Web page.	Student Record	
4. Student enters changes on the Change Student Web form and clicks <b>Submit</b> button.	Change Student Web Form	
5. Changes are validated on the Web server.	Change Student Web Form	
6. Change Student Journal record is written.	Change Student Web Form	
7. Student record is updated on the Student Master.	Change Student Web Form, Student Record	
8. Confirmation Web page is sent to the student.	Confirmation Page	
<b>Preconditions:</b>	Student is on the Change Student Information Web page.	
<b>Postconditions:</b>	Student has successfully changed personal information.	
<b>Assumptions:</b>	Student has a browser and a valid user ID and password.	
<b>Requirements Met:</b>	Allow students to be able to change personal information using a secure Web site.	
<b>Outstanding Issues:</b>	Should the number of times a student is allowed to logon be controlled?	
<b>Priority:</b>	Medium	
<b>Risk:</b>	Medium	

**FIGURE 10.7**

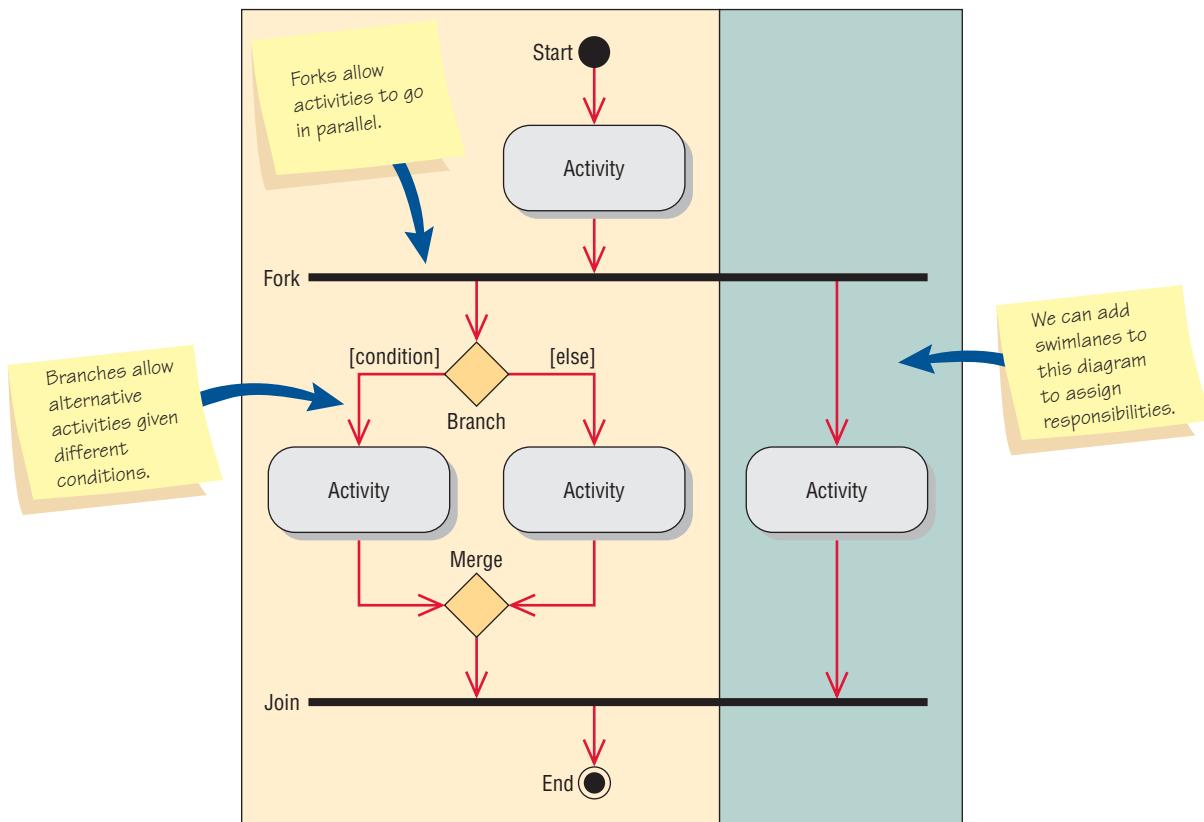
A use case scenario is divided into three sections: identification and initiation, steps performed, and conditions, assumptions, and questions.

Use case diagrams provide the basis for creating other types of diagrams, such as class diagrams and activity diagrams. Use case scenarios are helpful in drawing sequence diagrams. Both use case diagrams and use case scenarios are powerful tools to help us understand how a system works in general.

## ACTIVITY DIAGRAMS

Activity diagrams show the sequence of activities in a process, including sequential and parallel activities, and decisions that are made. An activity diagram is usually created for one use case and may show the different possible scenarios.

The symbols on an activity diagram are illustrated in Figure 10.8. A rectangle with rounded ends represents an activity, either a manual one, such as signing a legal document, or an automated one, such as a method or program.

**FIGURE 10.8**

Specialized symbols are used to draw an activity diagram.

An arrow represents an event. Events represent things that happen at a certain time and place.

A diamond represents either a decision (also called a branch) or a merge. Decisions have one arrow going into the diamond and several going out. A guard condition, showing the condition values, may be included. Merges show several events combining to form one event.

A long, flat rectangle represents a synchronization bar. These are used to show parallel activities, and may have one event going into the synchronization bar and several events going out of it, called a fork. A synchronization in which several events merge into one event is called a join.

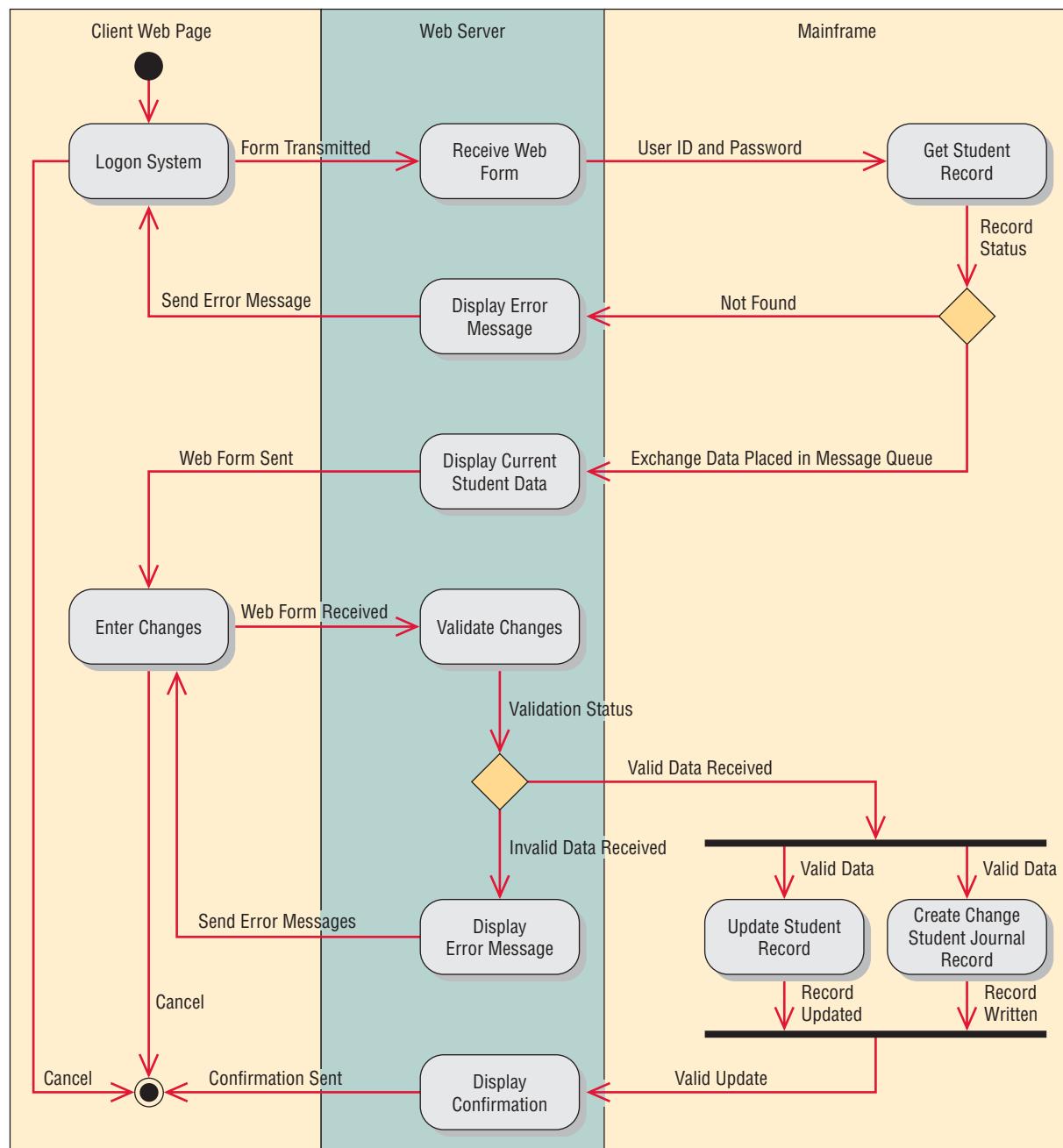
There are two symbols that show the start and end of the diagram. The initial state is shown as a filled-in circle. The final state is shown as a black circle surrounded by a white circle.

Rectangles surrounding other symbols, called swimlanes, indicate partitioning and are used to show which activities are done on which platform, such as a browser, server, or mainframe computer; or to show activities done by different user groups. Swimlanes are zones that can depict logic as well as the responsibility of a class.

You can see an example of swimlanes in Figure 10.9, which illustrates an activity diagram for the **Change Student Information** use case. It starts with the student logging onto the system by filling out a Web form and clicking the **Submit** button. The form is transmitted to the Web server, which then passes the data to the mainframe computer. The mainframe accesses the STUDENT database and passes either a “Not Found” message or selected student data to the Web server.

The diamond below the **Get Student Record** state indicates this decision. If the student record has not been found, the Web server displays an error message on the Web page. If the student record has been found, the Web server formats a new Web page containing the current student data in a Web form. The student may cancel the change from either the **Logon System** or the **Enter Changes** states, and the activity halts.

If the student enters changes on the Web form and clicks the **Submit** button, the change data is transmitted to the server and a program starts running that validates the changes. If there are errors, an error message is sent to the Web page. If the data are valid, the student record is updated and a Change Student Journal Record is written. After a valid update, a confirmation Web page is sent to the browser and the activity terminates.

**FIGURE 10.9**

This activity diagram shows three swimlanes: Client Web Page, Web Server, and Mainframe.

### Creating Activity Diagrams

Activity diagrams are created by asking what happens first, what happens second, and so on. You must determine whether activities are done in sequence or in parallel. If physical data flow diagrams (as described in Chapter 7) have been created, they may be examined to determine the sequence of activities. Look for places where decisions are made, and ask what happens for each of the decision outcomes. Activity diagrams may be created by examining all the scenarios for a use case.

Each path through the various decisions included on the use case is a different scenario. In the main path would be **Logon System**, **Receive Web Form**, **Get Student Record**, **Display Current Student Data**, **Enter Changes**, **Validate Changes**, **Update Student Record**, **Create Change Student Journal Record**, and **Display Confirmation**.

This isn't the only scenario that comes from this use case. Other scenarios may occur. One possibility could be **Logon System**, **Receive Web Form**, **Get Student Record**, and **Display Error Message**. Another scenario could be **Logon System**, **Receive Web Form**, **Get Student Record**, **Display Current Student Data**, **Enter Changes**, **Validate Changes**, and **Display Error Message**.



## CONSULTING OPPORTUNITY 10.2

### Recycling the Programming Environment

“I feel like I’m writing the same code over and over again,” says Benito Pérez, a programmer working on a new automated warehouse design. “I have written so many programs lately that dealt with robotic-type things that control themselves: automated mailroom trolleys, building surveillance robots, automatic pool cleaners, automatic lawn mowers, monorail trains, and now warehouse trolleys. They are all variations on a theme.”

Lisa Bernoulli, the project manager, had heard this sort of complaint for years. She replies, “Oh come on, Ben. These things aren’t really that close. How can you compare a mailroom robot, an automated warehouse, and a monorail train? I’ll bet less than 10 percent of the code is the same.”

“Look,” says Benito. “All three involve machines that have to find a starting point, follow a circuitous route, make stops for loading and unloading, and eventually go to a stopping point. All three have to make decisions at branches in their routes. All three have to avoid colliding with things. I’m tired of redesigning code that is largely familiar to me.”

“Hmmm,” Lisa muses as she looks over the basic requirements for the warehouse system and remembers the monorail system she and Benito had worked on last year. The requirements regarded a small-lot electronics manufacturing firm that was automating its warehouse and product movement system. The warehouse contains incoming parts, work in progress, and finished goods. The auto-

mated warehouse uses a flatbed robot trolley. This robot is a four-wheel electric cart, similar to a golf cart except that it has no seats. Flatbed robot trolleys have a flat, 6' × 4' cargo surface about 3' above ground level. These trolleys have a radio communications device that provides a real-time data link to a central warehouse computer. Flatbed trolleys have two sensors: a path sensor that detects a special type of paint and a motion sensor that detects movement. These trolleys follow painted paths around the factory floor. Special paint codes mark forks and branches in the paths, trolley start and stop points, and general location points.

The facility includes three loading dock stations and 10 workstations. Each station has a video terminal or computer connected to the central computer. When products are needed or are ready to be collected from a workstation, the central computer is informed by the worker at the station. The central computer then dispatches trolleys accordingly. Each station has a drop point and a pickup point. Flatbed trolleys move about the factory picking up work at pickup points and dropping off work at drop points. The program that will run the trolleys must interact heavily with the existing job-scheduling program that helps schedule workstation tasks.

How should Lisa go about reusing Benito Pérez’s work on the monorail in their current task of creating a trolley object? Explain in two paragraphs.

The swimlanes are useful to show how the data must be transmitted or converted, such as from Web to server or from server to mainframe. For example, the **Change Student Record** activity diagram has three swimlanes.

The swimlane on the left shows activities that occur on the client browser. Web pages must be created for these activities. The middle swimlane shows activities that happen on the server. Events, such as **Form Transmitted**, represent data transmitted from the browser to the server, and there must be programs on the server to receive and process the client data.

The swimlane on the right represents the mainframe computer. In large organizations it is typical for many Web applications to work with a mainframe computer. Much of the data in large organizations exists on mainframe databases and there is an enormous number of mainframe programs in existence.

When an event crosses the swimlane from the server to the mainframe computer, there must be a mechanism for transmitting the event data between the two platforms. Servers use a different format to represent data (ASCII) than do mainframe computers (they use a format called EBCDIC). Middleware must be present to take care of the conversion. IBM computers often use an mqueue (for message queue). The mqueue receives data from the server programs, places it in a holding area, and calls a mainframe program, usually written in a language called CICS. This program retrieves or updates the data, and sends the results back to the mqueue.

In the example activity diagram shown, the decision below the **Get Student Record** state is made on the mainframe computer. This means that the message queue receives either a “Not Found” message or the database record for the student. If the mainframe simply placed the **Record Status Received** in the message queue and the decision was evaluated on the server, the server would have to call the mainframe again to obtain the valid data. This would slow down the response to the person waiting at the browser.

Swimlanes also help to divide up the tasks in a team. Web designers would be needed for the Web pages displayed on the client browser. Other members would work with programming languages, such as Java, PHP, Ruby on Rails, PERL, or .NET, on the server. Mainframe CICS programmers would write programs that would work with the message queue. The analyst must ensure that the data that the various team members need is available and correctly defined. Sometimes the data in the message queue is an XML document. If an outside organization is involved, the data also might be an XML document.

The activity diagram provides a map of a use case, and allows the analyst to experiment with moving portions of the design to different platforms and ask “What if?” for a variety of decisions. The use of unique symbols and swimlanes makes this diagram one that people want to use to communicate with others.

Activity diagrams may be used to construct test plans. Each event must be tested to see whether the activity diagram goes to the next state. Each decision must be tested to see whether the correct path is taken when the decision conditions occur.

Activity diagrams are not used for all use cases. Use the activity diagram when:

1. It helps to understand the activities of a use case.
2. The flow of control is complex.
3. There is a need to model workflow.
4. All scenarios need to be shown.

The analyst would not need an activity diagram when the use case is simple or there is a need to model the change of state.

Activity diagrams may also be used to model a lower-level method, showing detailed logic.

### Repository Entries for an Activity Diagram

Each state and event may be further defined using a text description in a repository, which is a collection of text descriptions for the project. Describe states with information about the state, such as the Web page name, elements on the Web page, and so on. Describe events with the information that is required to communicate with the next state, such as the data from the Web form, the data that is put into a message queue, or with a description of the event that caused the transition, such as a button click.

## SEQUENCE AND COMMUNICATION DIAGRAMS

An interaction diagram is either a sequence diagram or a communication diagram, both of which show essentially the same information. These diagrams, along with class diagrams, are used in a use case realization, which is a way to achieve or accomplish a use case.

### Sequence Diagrams

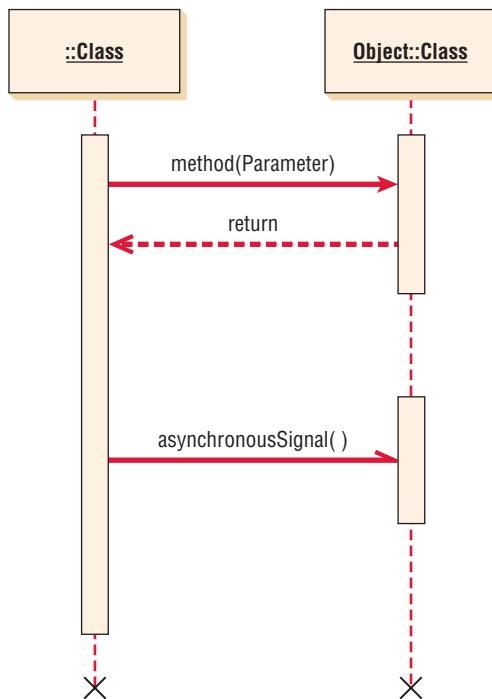
Sequence diagrams can illustrate a succession of interactions between classes or object instances over time. Sequence diagrams are often used to illustrate the processing described in use case scenarios. In practice, sequence diagrams are derived from use case analysis and are used in systems design to derive the interactions, relationships, and methods of the objects in the system. Sequence diagrams are used to show the overall pattern of the activities or interactions in a use case. Each use case scenario may create one sequence diagram, although sequence diagrams are not always created for minor scenarios.

The symbols used in sequence diagrams are shown in Figure 10.10. Actors and classes or object instances are shown in boxes along the top of the diagram. The leftmost object is the starting object and may be a person (for which a use case actor symbol is used), window, dialog box, or other user interface. Some of the interactions are physical only, such as signing a contract. The top rectangles use indicators in the name to indicate whether the rectangle represents an object, a class, or a class and object.

---

<b>objectName:</b>	A name with a colon after it represents an object.
<b>:class</b>	A colon with a name after it represents a class.
<b>objectName:class</b>	A name, followed by a colon and another name, represents an object in a class.

---

**FIGURE 10.10**

Specialized symbols used to draw a sequence diagram.

A vertical line represents the lifeline for the class or object, which corresponds to the time from when it is created through when it is destroyed. An X on the bottom of the lifeline represents when the object is destroyed. A lateral bar or vertical rectangle on the lifeline shows the focus of control when the object is busy doing things.

Horizontal arrows show messages or signals that are sent between the classes. Messages belong to the receiving class. There are some variations in the message arrows. Solid arrowheads represent synchronous calls, which are the most common. These are used when the sending class waits for a response from the receiving class, and control is returned to the sending class when the class receiving the message finishes executing. Half (or open) arrowheads represent asynchronous calls, or those that are sent without an expectation of returning to the sending class. An example would be using a menu to run a program. A return is shown as an arrow, sometimes with a dashed line. Messages are labeled using one of the following formats:

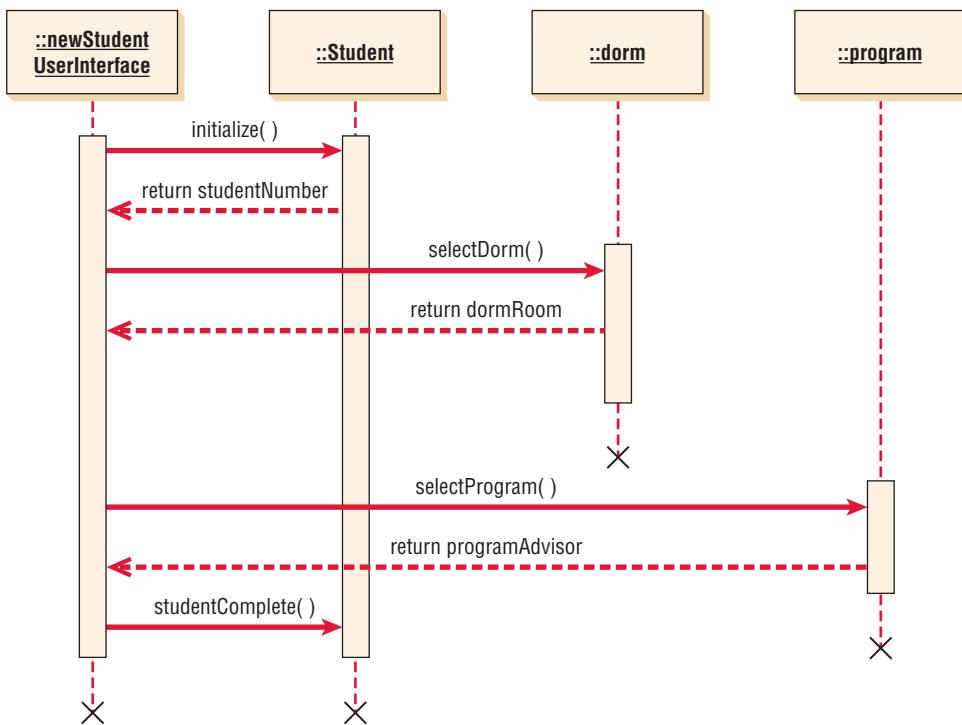
- The name of the message followed by empty parentheses: **messageName()**.
- The name of the message followed by parameters in parentheses:  
**messageName(parameter1, parameter2 ...)**.
- The message name followed by the parameter type, parameter name, and any default value for the parameter in parentheses:  
**messageName(parameterType:parameterName(defaultValue))**. Parameter types indicate the type of data, such as string, number, or date.
- The message may be a stereotype, such as **«Create»**, indicating that a new object is created as a result of the message.

Timing in the sequence diagram is displayed from top to bottom; the first interaction is drawn at the top of the diagram, and the interaction that occurs last is drawn at the bottom of the diagram. The interaction arrows begin at the bar of the actor or object that initiates the interaction, and they end pointing at the bar of the actor or object that receives the interaction request. The starting actor, class, or object is shown on the left. This may be the actor that initiates the activity or it may be a class representing the user interface.

Figure 10.11 is a simplified example of a sequence diagram for a use case that admits a student to a university. On the left is the **newStudentUserInterface** class that is used to obtain student information. The **initialize()** message is sent to the **Student** class, which creates a new student record and returns the student number. To simplify the diagram, the parameters that are sent to the **Student** class have been omitted, but would include the student name, address, and so

**FIGURE 10.11**

A sequence diagram for student admission. Sequence diagrams emphasize the time ordering of messages.



on. The next activity is to send a **selectDorm** message to the **Dorm** class. This message would include dorm selection information, such as a health dorm or other student requirements. The **Dorm** class returns the dorm name and room number. The third activity is to send a **selectProgram** message to the **Program** class, including the program name and other course of study information. The program advisor name is returned to the **newStudentUserInterface** class. A **studentComplete** message is sent to the **Student** class with the dorm, advisor name, and other information.

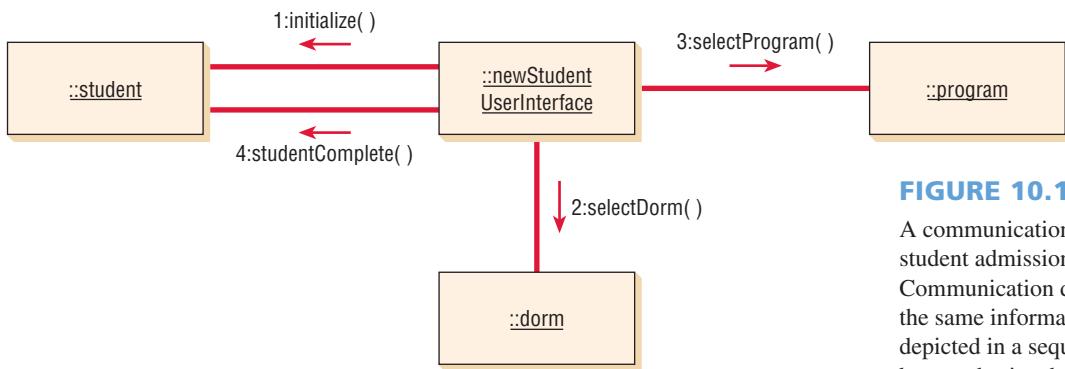
Sequence diagrams can be used to translate the use case scenario into a visual tool for systems analysis. The initial sequence diagram used in systems analysis shows the actors and classes in the system and the interactions between them for a specific process. You can use this version of the sequence diagram to verify processes with the business area experts who have assisted you in developing the system requirements. A sequence diagram emphasizes the time ordering (sequence) of messages.

During the systems design phase, the sequence diagrams are refined to derive the methods and interactions between classes. Messages from one class are used to identify class relationships. The actors in the earlier sequence diagrams are translated to interfaces, and class interactions are translated to class methods. Class methods used to create instances of other classes and to perform other internal system functions become apparent in the system design using sequence diagrams.

### Communication Diagrams

Communication diagrams were introduced in UML 2.0. Their original name in UML 1.x was collaboration diagrams. Communication diagrams describe the interactions of two or more things in the system that perform a behavior that is more than any one of the things can do alone. For instance, a car can be broken down into several thousand individual parts. The parts are put together to form the major subsystems of the vehicle: the engine, the transmission, the brake system, and so forth. The individual parts of the car can be thought of as classes, because they have distinct attributes and functions. The individual parts of the engine form a collaboration, because they “communicate” with each other to make the engine run when the driver steps on the accelerator.

A communication diagram is made up of three parts: objects (also called participants), the communication links, and the messages that can be passed along those links. Communication di-

**FIGURE 10.12**

A communication diagram for student admission. Communication diagrams show the same information that is depicted in a sequence diagram but emphasize the organization of objects rather than the time ordering.

ograms show the same information as a sequence diagram but may be more difficult to read. In order to show time ordering, you must indicate a sequence number and describe the message.

A communication diagram emphasizes the organization of objects, whereas a sequence diagram emphasizes the time ordering of messages. A communication diagram will show a path to indicate how one object is linked to another.

Some UML modeling software, such as IBM's Rational Rose, will automatically convert a sequence diagram to a communication diagram or a communication diagram to a sequence diagram with the click of a button. A communication diagram for the student admission example is illustrated in Figure 10.12. Each rectangle represents an object or a class. Connecting lines show the classes that need to collaborate or work with each other. The messages sent from one class to another are shown along connecting lines. Messages are numbered to show the time sequence. Return values may also be included and numbered to indicate when they are returned within the time sequence.

## CLASS DIAGRAMS

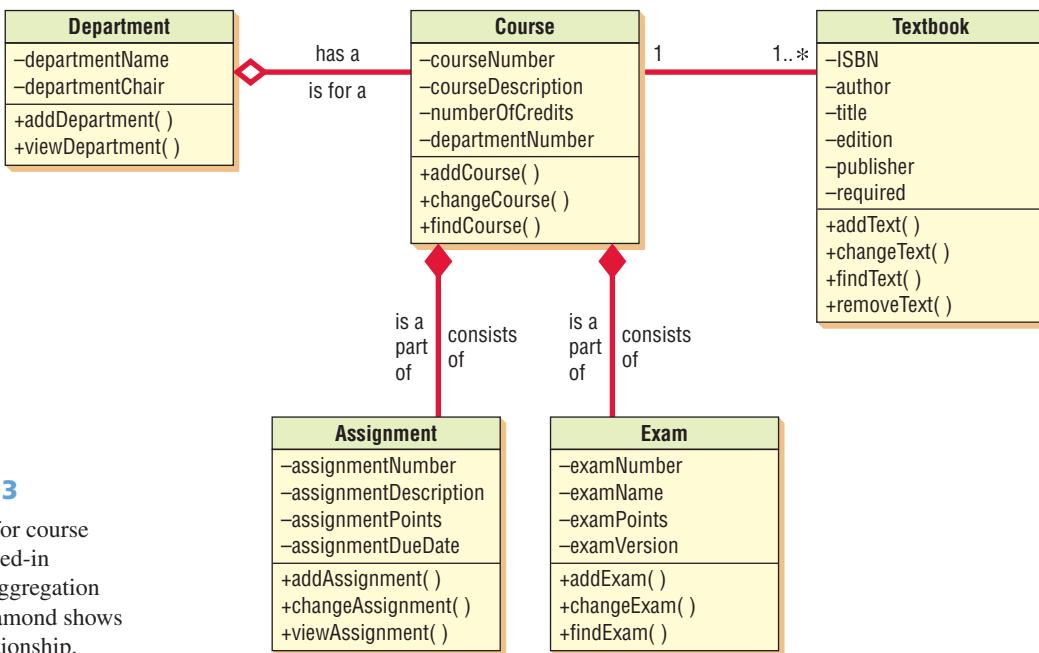
Object-oriented methodologies work to discover classes, attributes, methods, and relationships between classes. Because programming occurs at the class level, defining classes is one of the most important object-oriented analysis tasks. Class diagrams show the static features of the system and do not represent any particular processing. A class diagram also shows the nature of the relationships between classes.

Classes are represented by a rectangle on a class diagram. In the simplest format, the rectangle may include only the class name, but may also include the attributes and methods. Attributes are what the class knows about characteristics of the objects, and methods (also called operations) are what the class knows about how to do things. Methods are small sections of code that work with the attributes.

Figure 10.13 illustrates a class diagram for course offerings. Notice that the name is centered at the top of the class, usually in boldface type. The area directly below the name shows the attributes, and the bottom portion lists the methods. The class diagram shows data storage requirements as well as processing requirements. Later in the chapter we will discuss the meaning of the diamond symbols shown in this figure.

The attributes (or properties) are usually designated as private, or only available in the object. This is represented on a class diagram by a minus sign in front of the attribute name. Attributes may also be protected, indicated with a pound symbol (#). These attributes are hidden from all classes except immediate subclasses. Under rare circumstances, an attribute is public, meaning that it is visible to other objects outside its class. Making attributes private means that the attributes are only available to outside objects through the class methods, a technique called encapsulation, or information hiding.

A class diagram may show just the class name; or the class name and attributes; or the class name, attributes, and methods. Showing only the class name is useful when the diagram is very complex and includes many classes. If the diagram is simpler, attributes and methods may be included. When attributes are included, there are three ways to show the attribute information. The simplest is to include only the attribute name, which takes the least amount of space.

**FIGURE 10.13**

A class diagram for course offerings. The filled-in diamonds show aggregation and the empty diamond shows a whole-part relationship.

The type of data (such as string, double, integer, or date) may be included on the class diagram. The most complete descriptions would include an equal sign (=) after the type of data followed by the initial value for the attribute. Figure 10.14 illustrates class attributes.

If the attribute must take on one of a finite number of values, such as a student type with values of F for full-time, P for part-time, and N for nonmatriculating, these may be included in curly brackets separated by commas: **studentType:char{F,P,N}**.

Information hiding means that objects' methods must be available to other classes, so methods are often public, meaning that they may be invoked from other classes. On a class diagram, public messages (and any public attributes) are shown with a plus sign (+) in front of them. Methods also have parentheses after them, indicating that data may be passed as parameters along with the message. The message parameters, as well as the type of data, may be included on the class diagram.

There are two types of methods: standard and custom. Standard methods are basic things that all classes of objects know how to do, such as create a new object instance. Custom methods are designed for a specific class.

### Method Overloading

Method overloading refers to including the same method (or operation) several times in a class. The method signature includes the method name and the parameters included with the method. The same method may be defined more than once in a given class, as long as the parameters sent as part of the message are different; that is, there must be a different message signature. There may be a different number of parameters, or the parameters might be a different type, such as a

**FIGURE 10.14**

An extended **Student** class that shows the type of data and, in some cases, its initial value or default value.

<b>Student</b>
studentNumber: Integer
lastName: String
firstName: String
creditsCompleted: Decimal=0.0
gradePointAverage: Decimal=0.0
currentStudent: Boolean=Y
dateEnrolled: Date=
new( )
changeStudent( )
viewStudent( )

number in one method and a string in another method. An example of method overloading may be found in the use of a plus sign in many programming languages. If the attributes on either side of the plus sign are numbers, the two numbers are added. If the attributes are strings of characters, the strings are concatenated to form one long string.

In a bank deposit example, a deposit slip could contain just the amount of the deposit, in which case the bank would deposit the entire amount, or it could contain the deposit amount and the amount of cash to be returned. Both situations would use a deposit check method, but the parameters (one situation would also request the amount of cash to be returned) would be different.

## Types of Classes

Classes fall into four categories: entity, interface, abstract, and control. These categories are explained below.

**ENTITY CLASSES.** Entity classes represent real-world items, such as people, things, and so on. Entity classes are the entities represented on an entity-relationship diagram. CASE tools such as Visible Analyst will allow you to create a UML entity class from an entity on an E-R diagram.

The analyst needs to determine which attributes to include in the classes. Each object has many attributes, but the class should include only those that are used by the organization. For example, when creating an entity class for a student at a college, you would need to know attributes that identify the student, such as home and campus address, as well as grade point average, total credits, and so on. If you were keeping track of the same student for an online clothing store, you would have to know basic identifying information, as well as other descriptive attributes such as measurements or color preferences.

**BOUNDARY, OR INTERFACE, CLASSES.** Boundary, or interface, classes provide a means for users to work with the system. There are two broad categories of interface classes: human and system.

A human interface may be a display, window, Web form, dialog box, menu, list box, or other display control. It may also be a touch-tone telephone, bar code, or other way for users to interact with the system. Human interfaces should be prototyped (as described in Chapter 6), and often a storyboard is used to model the sequence of interactions.

System interfaces involve sending data to or receiving data from other systems. This may include databases in the organization. If data are sent to an external organization, they are often in the form of XML files or other well-published interfaces with clearly defined messages and protocols. External interfaces are the least stable, because there is often little or no control over an external partner who may alter the format of the message or data.

XML helps to provide standardization, because an external partner may add new elements to the XML document, but a corporation transforming the data to a format that may be used to append to an internal database may simply choose to ignore the additional elements without any problems.

The attributes of these classes are those found on the display or report. The methods are those required to work with the display, or to produce the report.

**ABSTRACT CLASSES.** Abstract classes are classes that cannot be directly instantiated. Abstract classes are those that are linked to concrete classes in a generalization/specialization (gen/spec) relationship. The name of an abstract class is usually denoted in italics.

**CONTROL CLASSES.** Control, or active, classes are used to control the flow of activities, and they act as a coordinator when implementing classes. To achieve classes that are reusable, a class diagram may include many small control classes. Control classes are often derived during system design.

Often a new control class will be created just to make another class reusable. An example would be the logon process. There might be one control class that handles the logon user interface, containing the logic to check the user ID and password. The problem that arises is that the logon control class is designed for a specific logon display. By creating a logon control class that handles just the unique logon display, the data may be passed to a more general validation control class, which performs a check on user IDs and passwords received from many other control classes receiving messages from specific user interfaces. This increases reusability and isolates the logon verification methods from the user interface handling methods.

The rules for creating sequence diagrams are that all interface classes must be connected to a control class. Similarly, all entity classes must be connected to a control class. Interface classes, unlike the other two, are never connected directly to entity classes.

### Defining Messages and Methods

Each message may be defined using a notation similar to that described for the data dictionary (as shown in Chapter 8). The definition would include a list of the parameters passed with the message as well as the elements contained in the return message. The methods may have logic defined using structured English, a decision table, or a decision tree, as depicted in Chapter 9.

The analyst can use the techniques of horizontal balancing with any class method. All the data returned from an entity class must be obtained either from the attributes stored in the entity class, from the parameters passed on the message sent to the class, or as a result of a calculation performed by the method of the class. The method logic and parameters must be examined to ensure that the method logic has all the information required to complete its work. Horizontal balancing is further described in Chapter 7.

## ENHANCING SEQUENCE DIAGRAMS

Once the class diagram is drawn, it may be desirable to go back to the sequence diagram and include special symbols for each of the different types of classes introduced in the last section. Sequence diagrams in particular can be overbearing if an analyst doesn't have a systematic approach to drawing them. The following steps are a useful approach to enhancing a sequence diagram:

1. Include the *actor* from the use case diagram in the enhanced sequence diagram. This will be a stick figure from the use case diagram. There may be an additional actor on the right side of the diagram, such as a credit card company or bank.
2. Define one or more *interface classes* for each actor. Each actor should have his or her own interface class.
3. Create prototype Web pages for all human interfaces.
4. Ensure each use case has one *control class*, although more may be created during the detailed design. Look for that control class and include it in the sequence diagram.
5. Examine the use case to see what *entity classes* are present. Include these on the diagram.
6. Realize that the sequence diagram may be modified again when doing detailed design, such as creating additional Web pages or control classes (one for each Web form submitted).
7. To obtain a greater degree of reuse, consider moving methods from a control class to an entity class.

### A Class Example for the Web

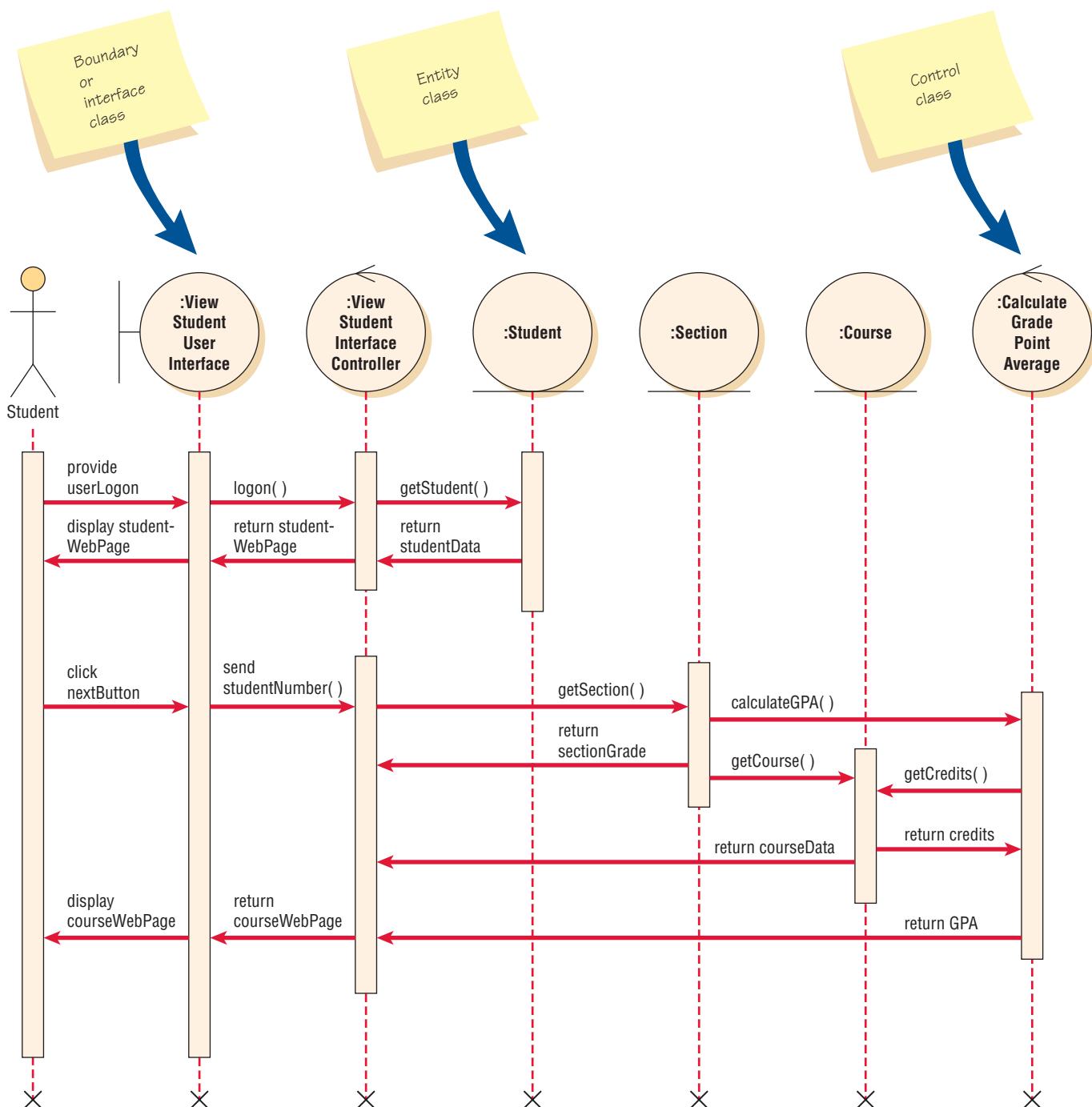
Classes may also be represented using special symbols for entity, boundary (or interface), and control classes. These are called stereotypes, an extension to UML, which are special symbols that may be used during analysis, but are often used when performing object-oriented design. They allow the analyst freedom to play with the design to optimize reusability.

The different types of classes are often used when working in the systems design phase. Figure 10.15 is an example illustrating a sequence diagram representing a student viewing his or her personal and course information. In the diagram, **:View Student User Interface** is an example of an interface class; **:Student**, **:Section**, and **:Course** are examples of entity classes; and **:View Student Interface Controller** and **:Calculate Grade Point Average** are control classes.

The student is shown on the left as an actor, and he or she provides a **userLogon** to the **:View Student User Interface** class. This is a Web form that obtains the student's user ID and password. When the student clicks the **Submit** button, the Web form is passed to a **:View Student Interface Controller**. This class is responsible for the coordination of sending messages and receiving returned information from all the other classes.

The **:View Student Interface Controller** sends a **getStudent()** message to the **:Student** class, which reads a database table and proceeds to return the **studentData**.

The **studentWebPage** is returned to the **:View Student User Interface**, which displays the information in the Web browser. At the bottom of the page is a **nextButton** that the student clicks to view courses. When the user clicks this button, it sends a Web form to the **:View Student Interface Controller**. This form contains the **studentNumber()**, sent along with the **studentWebPage**, and is used to send a message to the **:Section** class to obtain the section grade. If the **studentNumber()** was not automatically sent, it would mean that the student would have

**FIGURE 10.15**

to enter his or her `studentNumber()` again, which would not be a satisfactory user interface because it involves redundant keying. Notice that the **:Student** class is not involved, and that the focus of control (the vertical bar that is connected to the **:Student** class) ends before the second set of activities (the horizontal arrows pointing to the right) begins.

The **:View Student Interface Controller** class sends a `getSection()` message to the **:Section** class, which returns a `sectionGrade`. The **:Section** class also sends a `calculateGPA()` message to the **:Calculate Grade Point Average** class, which sends a message back to the **:Course** class. The **:Course** class returns the `credits`, which enables the **:Calculate Grade Point Average** class to determine the `GPA` and return it to the **:View Student Interface Controller**.

The **:View Student Interface Controller** would repeat sending messages to the **:Section** class until all sections for the student have been included. At this time, the **:View Student**

A sequence diagram for using two Web pages: one for student information, one for course information.

**Interface Controller** would send the **courseWebPage** to the **:View Student User Interface** class, which would display the information in the browser.

Using the user interface, control, and entity classes also allows the analyst to explore and play with the design. The design mentioned previously would display all the student personal information on one page and the course information on a second page. The analyst may modify the design so that the student personal information and the course information appear on one Web page. These two possible scenarios would be reviewed with users to determine the best option.

One of the difficulties for the analyst is to determine how to include the **studentNumber** after clicking the **Next** button, because the **:Student** class is no longer available. There are three ways to store and retransmit data from a Web page:

1. Include the information in the URL displaying in the address or location area of the browser. In this case, the location line might read something like the following:

`http://www.cpu.edu/student/studentinq.html?studentNumber=12345`

Everything after the question mark is data that may be used by the class methods. This means of storing data is easy to implement and is often used in search engines.

There are several drawbacks to using this method, and the analyst must use due caution. The first concern is privacy—anyone can read the Web address. If the application involves medical information, credit card numbers, and so on, this is not a good choice.

Most browsers will also display previous Web address data in subsequent sessions if the user enters the first few characters, and the information may be compromised, leading to identity theft. A second disadvantage is that the data are usually lost after the user closes the browser.

2. Store the information in a cookie, a small file stored on the client (browser) computer.

Cookies are the only way to store data that have persistence, existing beyond the current browser session. This enables the Web page to display a message such as “Welcome back, Robin. If you are not Robin, click here.” Cookies usually store primary key account numbers, but not credit card numbers or other private information. Cookies are limited to 20 per domain (such as www.cpu.edu) and each cookie must be 4,000 characters or less.

The analyst must work with other business units to determine who needs to use cookies, and there must be some central control over the names used in the cookies. If the organization needs to have more than 20 cookies, a common solution is to create different domain names used by the organization, such as support.cpu.edu or instruction.cpu.edu.

3. Use hidden Web form fields. These fields usually contain data that are sent by the server, are invisible, and do not occupy any space on the Web page. In the view student information example, the **:View Student Interface Controller** class added a hidden field containing the **studentNumber** to the **studentWebPage** form along with the **nextButton**. When the student clicks the **nextButton**, the **studentNumber** is sent to the server and the **:View Student Interface Controller** knows which student to obtain course and grade information for. The data in hidden forms is not saved from one browser session to another, so privacy is maintained.

### Presentation, Business, and Persistence Layers in Sequence Diagrams

In the previous example, we showed all of the classes in the same diagram. When it comes to writing code for systems, it has been useful to look at sequence diagrams as having three distinct layers as follows:

1. The presentation layer, which represents what the user sees. This layer contains the interface or boundary classes.
2. The business layer, which contains the unique rules for this application. This layer contains the control classes.
3. The persistence or data access layer, which describes obtaining and storing data. This layer contains the entity classes.

Ideally program code would be written separately for each of these layers.

With the introduction of Ajax, the lines became blurred. Ajax, an acronym for asynchronous JavaScript and XML, is a collection of techniques that allows Web applications to retrieve information from the server without altering the display of the current page. This turns out to be an ad-

vantage because the entire Web page does not need to be reloaded when it gets additional data from the server.

Before Ajax was created a user visiting a Web site would answer some questions by entering data on a Web-based form, then wait until a new page loaded. This was necessary because the code to validate, get the data, then answer the user resided on the server. With the advent of Ajax, the Web page is updated rapidly because much of the validation and other control logic is now included in the browser JavaScript code or on the client side. This means that business rules are included in both the boundary and the control class, so it might not be possible to have three distinct layers.

## ENHANCING CLASS DIAGRAMS

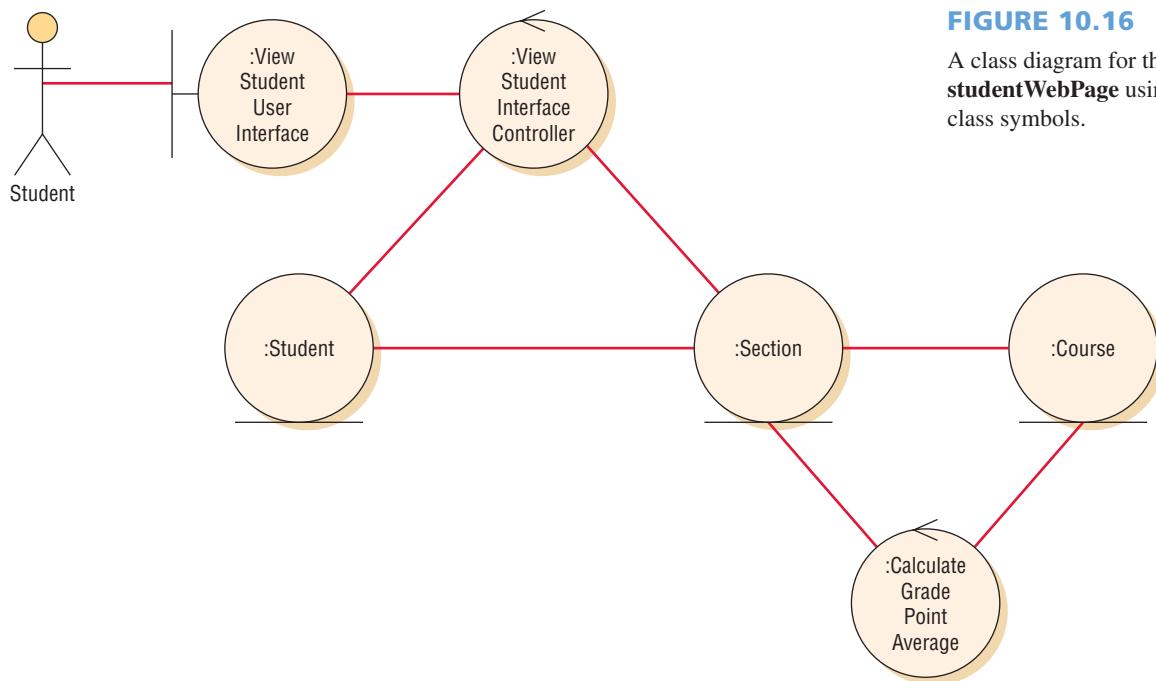
The class symbols also may be used on class and communication diagrams. Figure 10.16 illustrates the class diagram for a student viewing personal and course information on Web pages. Each class has attributes and methods (which are not shown on diagrams using this notation).

If the class is a user interface type of class, the attributes are the controls (or fields) on the screen or form. The methods would be those that work with the screen, such as submit or reset. They might also be JavaScript for a Web page, because the code works directly with the Web page.

If the class is a control class, the attributes would be those needed to implement the class, such as variables used just in the control class. The methods would be those used to perform calculations, make decisions, and send messages to other classes.

If the class is an entity class, the attributes represent those stored for the entity and the methods working directly with the entity, such as creating a new instance, modifying, deleting, obtaining, or printing.

Web sites may use a combination of many different classes to accomplish user objectives. For example, a Web site may use JavaScript to prevalidate data, then pass data to the server control classes, which perform thorough validation, including obtaining data. The server control classes may in turn send JavaScript back to the Web page to do some formatting. It is not uncommon to have a Web application involve many classes, some of them containing only one line of code in a method, in order to achieve the goal of reusability.



**FIGURE 10.16**

A class diagram for the **studentWebPage** using special class symbols.

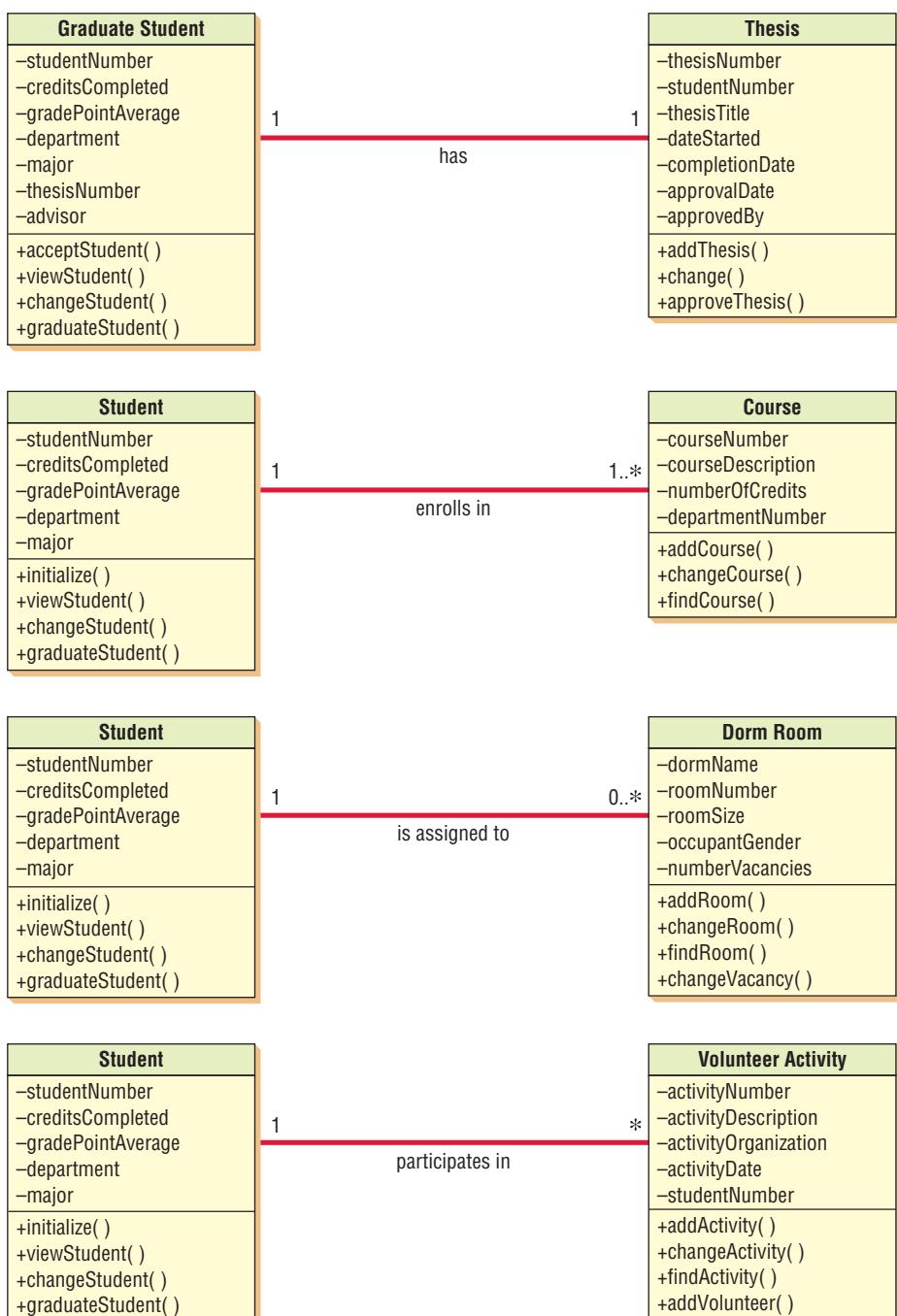
## Relationships

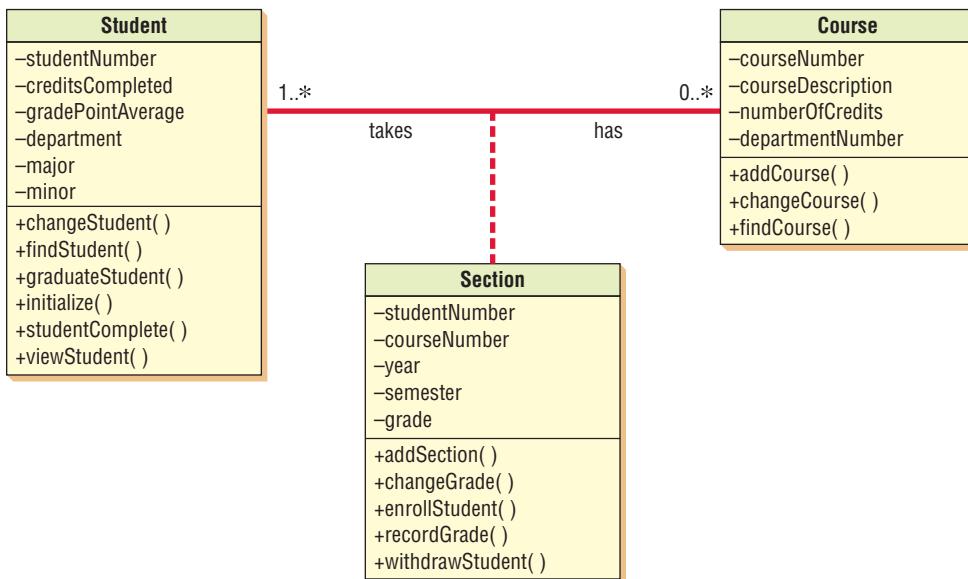
Another way to enhance class diagrams is to show relationships. Relationships are connections between classes, similar to those found on an entity-relationship diagram. These are shown as lines connecting classes on a class diagram. There are two categories of relationships: associations and whole/part relationships.

**ASSOCIATIONS.** The simplest type of relationship is an association, or a structural connection between classes or objects. Associations are shown as a simple line on a class diagram. The end points of the line are labeled with a symbol indicating the multiplicity, which is the same as cardinality on an entity-relationship diagram. A zero represents none, a one represents one and only one, and an asterisk represents many. The notation 0..1 represents from zero to one, and the notation 1..\* represents from one to many. Associations are illustrated in Figure 10.17.

**FIGURE 10.17**

Types of associations that may occur in class diagrams.



**FIGURE 10.18**

An example of an associative class in which a particular section defines the relationship between a student and a course.

Class diagrams do not restrict the lower limit for an association. For example, an association might be 5..\*, indicating that a minimum of five must be present. The same is true for upper limits. For example, the number of courses a student is currently enrolled in may be 1..10, representing from 1 to 10 courses. It can also include a range of values separated by commas, such as 2, 3, 4. In the UML model, associations are usually labeled with a descriptive name.

Association classes are those that are used to break up a many-to-many association between classes. These are similar to associative entities on an entity-relationship diagram. **Student** and **Course** have a many-to-many relationship, which is resolved by adding an association class called **Section** between the classes of **Student** and **Course**. Figure 10.18 illustrates an association class called **Section**, shown with a dotted line connected to the many-to-many relationship line.

An object in a class may have a relationship to other objects in the same class, called a reflexive association. An example would be a task having a precedent task, or an employee supervising another employee. This is shown as an association line connecting the class to itself, with labels indicating the role names, such as task and precedent task.

**WHOLE/PART RELATIONSHIPS.** Whole/part relationships are when one class represents the whole object and other classes represent parts. The whole acts as a container for the parts. These relationships are shown on a class diagram by a line with a diamond on one end. The diamond is connected to the object that is the whole. Whole/part relationships (as well as aggregation, discussed later) are shown in Figure 10.19.

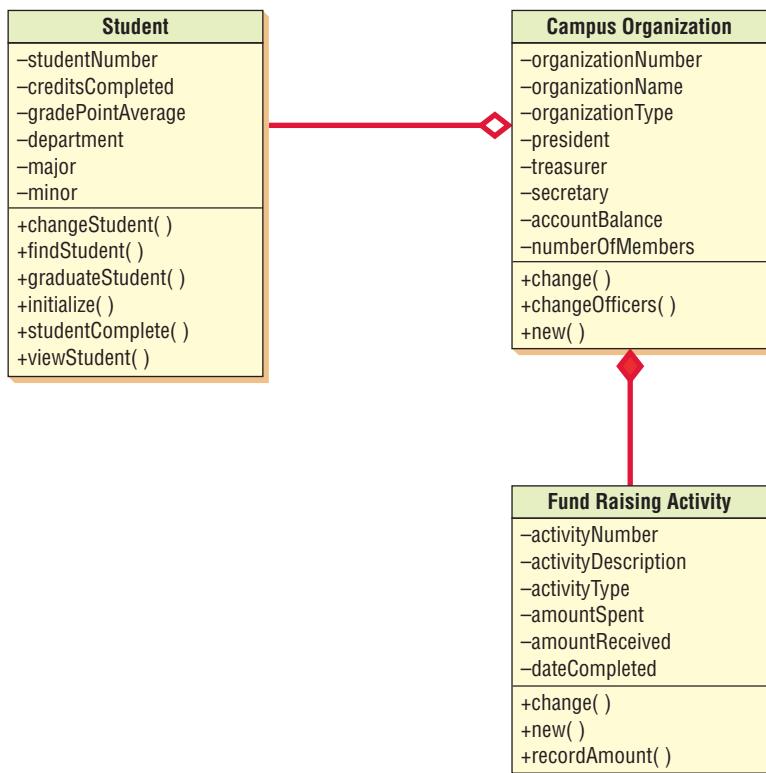
A whole/part relationship may be an entity object that has distinct parts, such as a computer system that includes the computer, printer, display, and so on, or an automobile that has an engine, brake system, transmission, and so on. Whole/part relationships may also be used to describe a user interface, in which one GUI screen contains a series of objects such as lists, boxes, or radio buttons, or perhaps a header, body, and footer area. Whole/part relationships have three categories: aggregation, collection, and composition.

**Aggregation** An aggregation is often described as a “has a” relationship. Aggregation provides a means of showing that the whole object is composed of the sum of its parts (other objects). In the student enrollment example, the department *has a* course and the course *is for* a department. This is a weaker relationship, because a department may be changed or removed and the course may still exist. A computer package may not be available any longer, but the printers and other components still exist. The diamond at the end of the relationship line is not filled in.

**Collection** A collection consists of a whole and its members. This may be a voting district with voters or a library with books. The voters or books may change, but the whole retains its identity. This is a weak association.

**FIGURE 10.19**

An example of whole/part and aggregation relationships.



**Composition** Composition, a whole/part relationship in which the whole has a responsibility for the part, is a stronger relationship, and is usually shown with a filled-in diamond. Keywords for composition are one class “always contains” another class. If the whole is deleted, all parts are deleted. An example would be an insurance policy with riders. If the policy is canceled, the insurance riders are also canceled. In a database, the referential integrity would be set to delete cascading child records. In a university there is a composition relationship between a course and an assignment as well as between a course and an exam. If the course is deleted, assignments and exams are deleted as well.

### Generalization/Specialization (Gen/Spec) Diagrams

A generalization/specialization (gen/spec) diagram may be considered to be an enhanced class diagram. Sometimes it is necessary to separate out the generalizations from the specific instances. As we mentioned at the beginning of this chapter, a koala bear is part of a class of marsupials, which is part of a class of animals. Sometimes we need to distinguish whether a koala bear is an animal or a koala bear is a type of animal. Furthermore, a koala bear can be a stuffed toy animal. So we often need to clarify these subtleties.

**GENERALIZATION.** A generalization describes a relationship between a general kind of thing and a more specific kind of thing. This type of relationship is often described as an “is a” relationship. For example, a car *is a* vehicle and a truck *is a* vehicle. In this case, vehicle is the general thing, whereas car and truck are the more specific things. Generalization relationships are used for modeling class inheritance and specialization. A general class is sometimes called a superclass, base class, or parent class; a specialized class is called a subclass, derived class, or child class.

**INHERITANCE.** Several classes may have the same attributes and/or methods. When this occurs, a general class is created containing the common attributes and methods. The specialized class inherits or receives the attributes and methods of the general class. In addition, the specialized class has attributes and methods that are unique and only defined in the specialized class. Creating generalized classes and allowing the specialized class to inherit the attributes and methods helps to foster reuse, because the code is used many times. It also helps to maintain existing program code. This allows the analyst to define attributes and methods once but use them many times, in each inherited class.

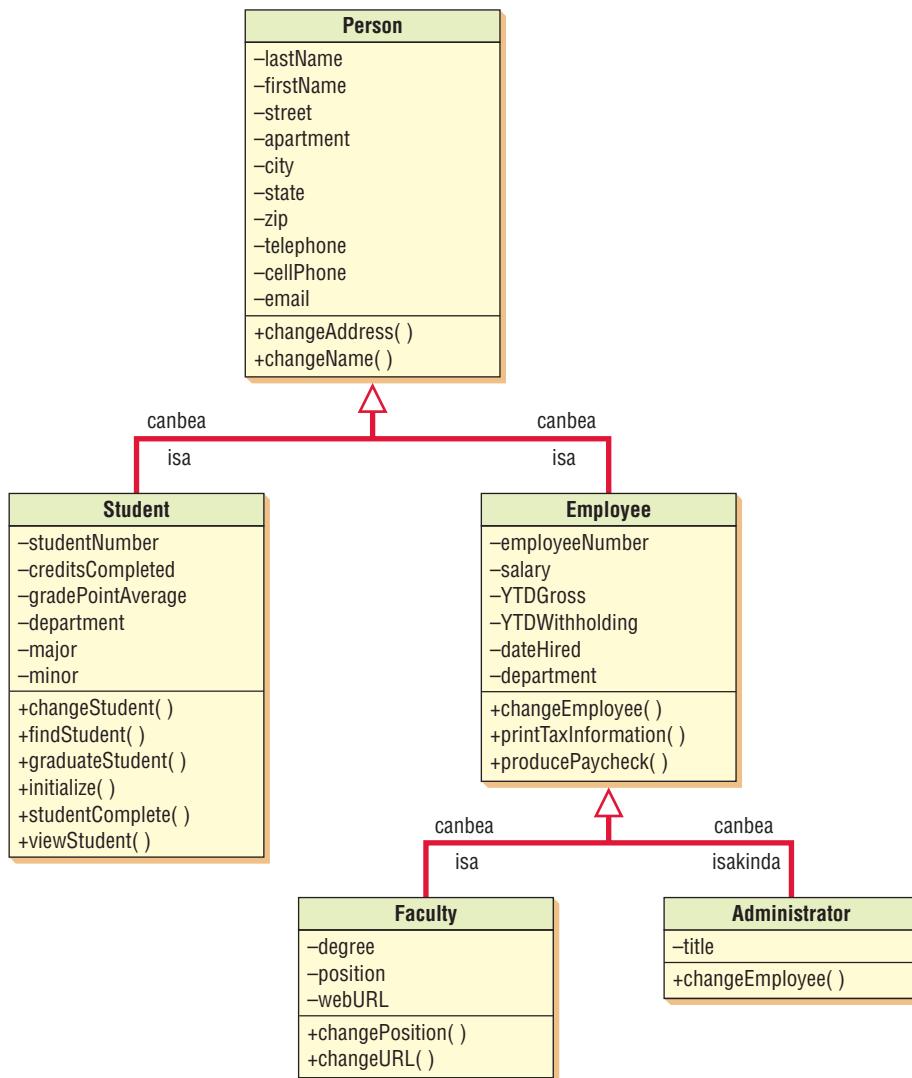
One of the special features of the object-oriented approach is the creation and maintenance of large class libraries that are available in multiple languages. So, for instance, a programmer using Java, .NET, or C# will have access to a huge number of classes that have already been developed.

**POLYMORPHISM.** Polymorphism (meaning many forms), or method overriding (not the same as method overloading), is the capability of an object-oriented program to have several versions of the same method with the same name within a superclass/subclass relationship. The subclass inherits a parent method but may add to it or modify it. The subclass may change the type of data, or change how the method works. For example, there might be a customer who receives an additional volume discount, and the method for calculating an order total is modified. The subclass method is said to override the superclass method.

When attributes or methods are defined more than once, the most specific one (the lowest in the class hierarchy) is used. The compiled program walks up the chain of classes, looking for methods.

**ABSTRACT CLASSES.** Abstract classes are general classes and are used when gen/spec is included in the design. The general class becomes the abstract class. The abstract class has no direct objects or class instances, and is only used in conjunction with specialized classes. Abstract classes usually have attributes and may have a few methods.

Figure 10.20 is an example of a gen/spec class diagram. The arrow points to the general class, or superclass. Often the lines connecting two or more subclasses to a superclass are joined using



**FIGURE 10.20**

A gen/spec diagram is a refined form of a class diagram.

one arrow pointing to the superclass, but these could be shown as separate arrows as well. Notice that the top level is Person, representing any person. The attributes describe qualities that all people at a university have. The methods allow the class to change the name and the address (including telephone and email address). This is an abstract class, with no instances.

Student and Employee are subclasses, because they have different attributes and methods. An employee does not have a grade point average and a student does not have a salary. This is a simple version, and does not include employees that are students and students that work for the university. If these were added, they would be subclasses of the **Employee** and **Student** classes. **Employee** has two subclasses, **Faculty** and **Administrator**, because there are different attributes and methods for each of these specialized classes.

Subclasses have special verbs to define them. These are often run-on words, using *isa* for “is a,” *isakinda* for “is a kind of,” and *canbea* for “can be a.” There is no distinction between “is a” and “is an;” they both use *isa*.

<i>isa</i>	Faculty <i>isa</i> Employee
<i>isakinda</i>	Administrator <i>isakinda</i> Employee
<i>canbea</i>	Employee <i>canbea</i> Faculty

**IDENTIFYING ABSTRACT CLASSES.** You may be able to identify abstract classes by looking to see if a number of classes or database tables have the same elements, or if a number of classes have the same methods. You can create a general class by pulling out the common attributes and methods, or you might create a specialized class for the unique attributes and methods. Using a banking example, such as a withdrawal, a payment on a loan, or a check written, will all have the same method—they subtract money from the customer balance.

**FINDING CLASSES.** There are a number of ways to determine classes. They may be discovered during interviewing or JAD sessions (described in Chapter 4), during facilitated team sessions, or from brainstorming sessions. Analyzing documents and memos may also reveal classes. One of the easiest ways is to use the CRC method described previously in this chapter. The analyst should also examine use cases, looking for nouns. Each noun may lead to a candidate, or potential, class. They are called candidate classes because some of the nouns may be attributes of a class.

Each class should exist for a distinct object that has a clear definition. Ask what the class knows, the attributes; and what the class knows how to do, the methods. Identify class relationships and the multiplicity for each end of the relationship. If the relationship is many-to-many, create an intersection or associative class, similar to the associative entity in an entity-relationship diagram.

**DETERMINING CLASS METHODS.** The analyst must determine class attributes and methods. Attributes are easy to identify, but the methods that work with the attributes may be more difficult. Some of the methods are standard, and are always associated with a class, such as `new()`, or the «create» method, which is an extension to UML created by a person or organization, called a stereotype. The « » symbols are not simply pairs of greater than and less than symbols, but are called guillemots or chevrons.

Another useful way to determine methods is to examine a CRUD matrix (see Chapter 7). Figure 10.21 illustrates a CRUD matrix for course offerings. Each letter requires a different method. If there is a C for create, add a `new()` method. If there is a U for update, add an `update()` or `change()` method. If there is a D for delete, add a `delete()` or `remove()` method. If there is an R for read, add methods for finding, viewing, or printing. In the example shown, the **textbook** class would need a create method to add a textbook, and a read method to initiate a course inquiry, change a textbook, or find a textbook. If a textbook was replaced, an update method would be needed, and if a textbook was removed, a delete method would be required.

**MESSAGES.** In order to accomplish useful work, most classes need to communicate with one another. Information can be sent by an object in one class to an object in another class using a message, similar to a call in a traditional programming language. A message also acts as a command, telling the receiving class to do something. A message consists of the name of the method in the receiving class, as well as the attributes (parameters or arguments) that are passed with the method name. The receiving class must have a method corresponding to the message name.

Activity	Department	Course	Textbook	Assignment	Exam
Add Department	C				
View Department	R				
Add Course	R	C			
Change Course	R	U			
Course Inquiry	R	R	R	R	R
Add Textbook	R	R	C		
Change Textbook		R	RU		
Find Textbook		R	R		
Remove Textbook		R	D		
Add Assignment		R		C	
Change Assignment		R		RU	
View Assignment		R		R	
Add Exam		R			R
Change Exam		R			RU
View Exam		R			R

**FIGURE 10.21**

A CRUD matrix can be used to help determine what methods are needed. This CRUD matrix is used to determine the methods and operations for course offerings.

Since messages are sent from one class to another, they may be thought of as an output or an input. The first class must supply the parameters included with the message and the second class uses the parameters. If a physical child data flow diagram exists for the problem domain, it may help to discover methods. The data flow from one primitive process to another represents the message, and the primitive processes should be examined as candidate methods.

## STATECHART DIAGRAMS

The statechart, or state transition, diagram is another way to determine class methods. It is used to examine the different states that an object may have.

A statechart diagram is created for a single class. Typically objects are created, go through changes, and are deleted or removed.

Objects exist in these various states, which are the conditions of an object at a specific time. An object's attribute values define the state that the object is in, and sometimes there is an attribute, such as Order Status (pending, picking, packaged, shipped, received, and so on) that indicates the state. A state has a name with each word capitalized. The name should be unique and meaningful to the users. A state also has entry and exit actions, the things the object must do every time it enters or leaves a given state.

An event is something that happens at a specific time and place. Events cause a change of the object state, and it is said that a transition “fires.” States separate events, such as an order that is waiting to be filled, and events separate states, such as an Order Received event or an Order Complete event.

An event causes the transition, and happens when a guard condition has been met. A guard condition is something that evaluates to either true or false, and may be as simple as “Click to confirm order.” It also may be a condition that occurs in a method, such as an item that is out of stock. Guard conditions are shown in square brackets next to the event label.

There are also deferred events, or events that are held until an object changes to a state that can accept them. A user keying something in when a word processor is performing a timed backup is an example of a deferred event. After the timed backup has completed, the text appears in the document.

Events fall into three different categories:

1. Signals or asynchronous messages, which occur when the calling program does not wait for a returning message, such as a feature run from a menu.
2. Synchronous messages, which are calls to functions or subroutines. The calling object stops and waits for control to be returned to it, along with an optional message.
3. Temporal events, which occur at a predetermined time. These usually do not involve an actor or any external event.

Material objects have persistence; that is, they exist for a long period of time. Airplane flights, concerts, and sporting events have shorter persistence (they may have states that transition in a shorter time). Some objects, called transient objects, do not survive the end of a session. These include main memory, Web URL (or location) data, Web pages, CICS displays, and so on. The only way to save transient objects is to store information about them, such as storing Web data in a cookie.

Each time an object changes state, some of the attributes change their values. Furthermore, each time an object's attributes change, there must be a method to change the attributes. Each of the methods would need a display or Web form to add or change the attributes. These become the interface objects. The display or Web form would often have more controls (or fields) on them than just the attributes that change. They would usually have primary keys, identifying information (such as a name or address), and other attributes that are needed for a good user interface. The exception is a temporal event, which may use database tables or a queue containing the information.

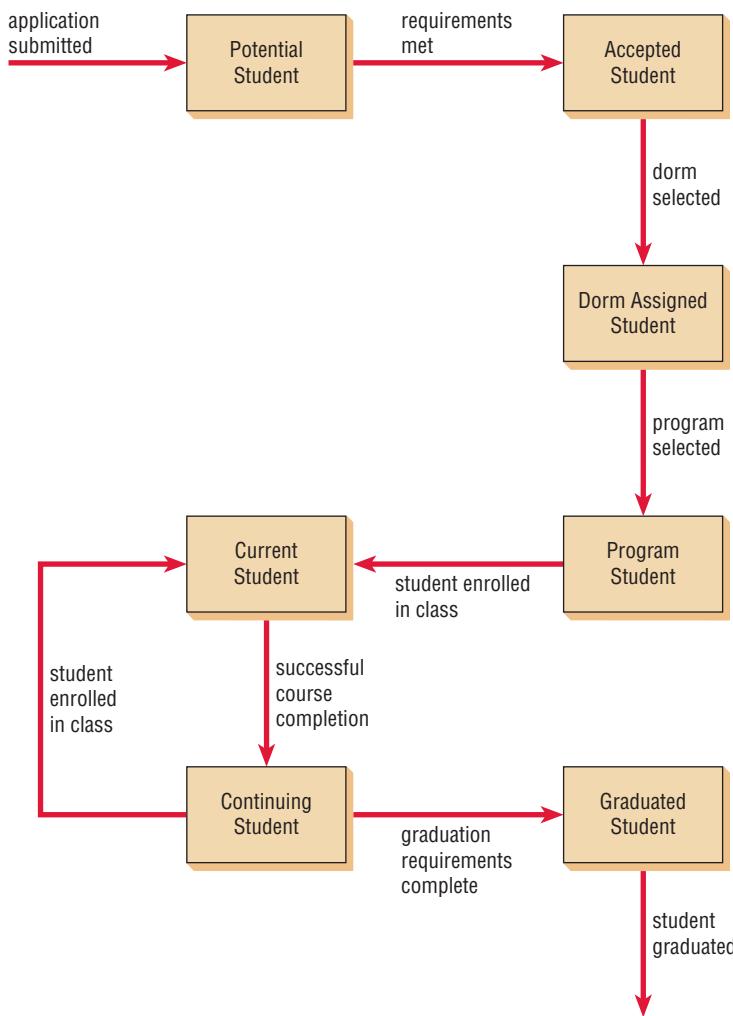
### A State Transition Example

Consider a student enrolling at a university and the various states that he or she would go through. Three of the states are listed below in detail:

<b>State:</b>	Potential Student
<b>Event:</b>	Application Submitted
<b>Method:</b>	new()
<b>Attributes changed:</b>	Number
	Name
	Address
<b>User interface:</b>	Student Application Web Form
<b>State:</b>	Accepted Student
<b>Event:</b>	Requirements Met
<b>Method:</b>	acceptStudent()
<b>Attributes changed:</b>	Admission Date
	Student Status
	Return Acceptance Letter
<b>User interface:</b>	Accept Student Display
<b>State:</b>	Dorm Assigned Student
<b>Event:</b>	Dorm Selected
<b>Method:</b>	assignDorm()
<b>Attributes changed:</b>	Dorm Name
	Dorm Room
	Meal Plan
<b>User interface:</b>	Assign Student Dorm Display

The other states are **Program Student**, **Current Student**, **Continuing Student**, and **Graduated Student**. Each state would have an event, methods, attributes changed, and a user interface associated with it. This series of states can be used to determine the attributes and methods that make up part of the class.

The states and events that trigger the changes may be represented on a statechart diagram (or a state transition diagram). The statechart diagram for **Student** is illustrated in Figure 10.22.

**FIGURE 10.22**

A statechart diagram showing how a student progresses from a potential student to a graduated student.

States are represented by rectangles, and events or activities are the arrows that link the states and cause one state to change to another state. Transition events are named in the past tense, because they have already occurred to create the transition.

Statechart diagrams are not created for all classes. They are created when:

1. A class has a complex life cycle.
2. An instance of a class may update its attributes in a number of ways through the life cycle.
3. A class has an operational life cycle.
4. Two classes depend on each other.
5. The object's current behavior depends on what happened previously.

When you examine a statechart diagram, use the opportunity to look for errors and exceptions. Inspect the diagram to see whether events are happening at the wrong time. Also check that all events and states have been represented. Statechart diagrams have only two problems to avoid. Check to see that a state does not have all transitions going into the state or all transitions coming out of the state.

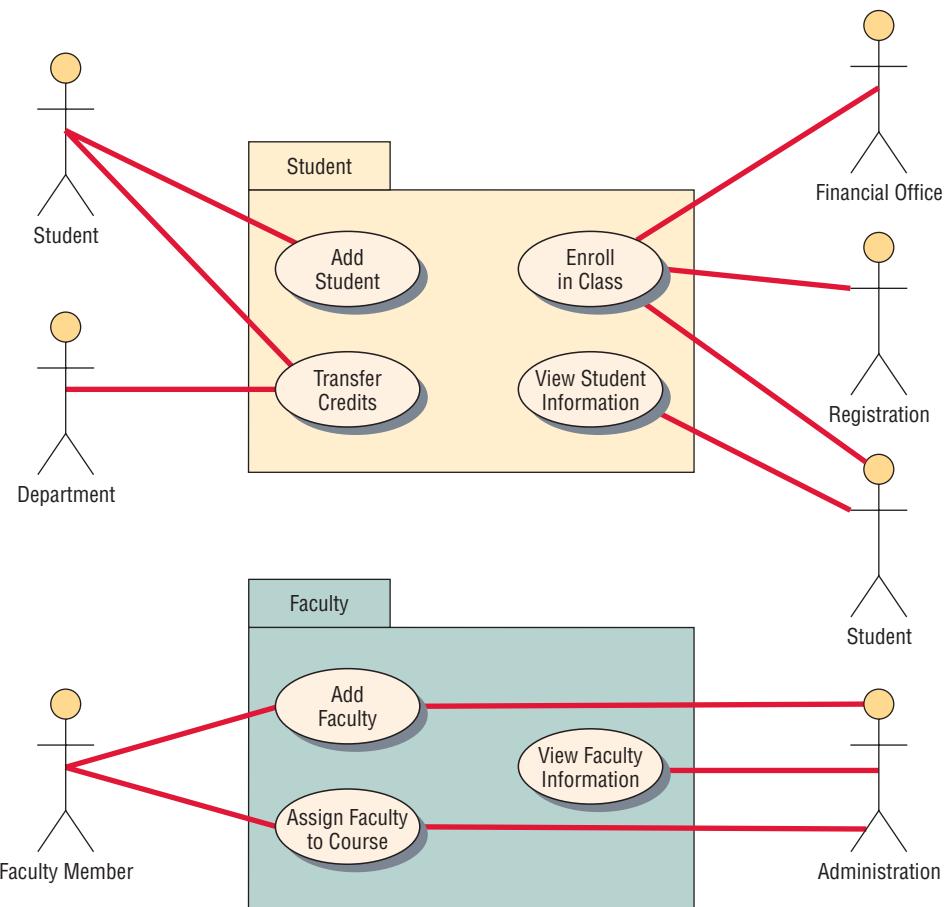
Each state should have at least one transition in and out of it. Some statechart diagrams use the same start and terminator symbols that an activity diagram uses: a filled-in circle to represent the start, and concentric circles with the center filled in to signify the end of the diagram.

## PACKAGES AND OTHER UML ARTIFACTS

Packages are containers for other UML things, such as use cases or classes. Packages can show system partitioning, indicating which classes or use cases are grouped into a subsystem, called logical packages. They may also be component packages, which contain physical system components, or

**FIGURE 10.23**

Use cases can be grouped into packages.



use case packages, containing a group of use cases. Packages use a folder symbol with the package name either in the folder tab or centered in the folder. Packaging can occur during systems analysis, or later when the system is being designed. Packages may also have relationships, similar to class diagrams, which may include associations and inheritance.

Figure 10.23 is an example of a use case package diagram. It shows that four use cases, **Add Student**, **Enroll in Class**, **Transfer Credits**, and **View Student Information**, are part of the **Student** package. There are three use cases, **Add Faculty**, **View Faculty Information**, and **Assign Faculty to Course**, that are part of the **Faculty** package.

As you continue constructing diagrams, you will want to make use of component diagrams, deployment diagrams, and annotational things. These permit different perspectives on the work being accomplished.

The component diagram is similar to a class diagram, but is more of a bird's-eye view of the system architecture. The component diagram shows the components of the system, such as a class file, a package, shared libraries, a database, and so on, and how they are related to each other. The individual components in a component diagram are considered in more detail within other UML diagrams, such as class diagrams and use case diagrams.

The deployment diagram illustrates the physical implementation of the system, including the hardware, the relationships between the hardware, and the system on which it is deployed. The deployment diagram may show servers, workstations, printers, and so on.

Annotational things give developers more information about the system. These consist of notes that can be attached to anything in UML: objects, behaviors, relationships, diagrams, or anything that requires detailed descriptions, assumptions, or any information relevant to the design and functionality of the system. The success of UML relies on the complete and accurate documentation of your system model to provide as much information as possible to the development team. Notes provide a source of common knowledge and understanding about your system to help put your developers on the same page. Notes are shown as a paper symbol with a bent corner and a line connecting them to the area that needs elaboration.



## CONSULTING OPPORTUNITY 10.3

### Developing a Fine System That Was Long Overdue: Using Object-Oriented Analysis for the Ruminski Public Library System\*

As Dewey Dezmal enters the high-ceilinged, wood-paneled reading room of the Ruminski Public Library, a young woman, seated at a long, oak table, pokes her head out from behind a monitor, sees him, and stands, saying, “Welcome. I’m Peri Otticle, the director of the library. I understand you are here to help us develop our new information system.”

Still in awe of the beauty of the old library building and the juxtaposition of so much technology amid so much history, Dewey introduces himself as a systems analyst with a small IT consulting firm, People and Objects, Inc.

“It’s the first time I’ve been assigned to this type of project, although it’s actually interesting for me, because my degree is from the Information Studies School at Upstate University. You can major in library science or IT there, so lots of my classmates went on to work in public libraries. I opted for the IT degree.”

“We should work well together, then,” Peri says. “Let’s go to my office so we don’t disturb any patrons, and I can talk you through a report I wrote.”

As they pass the beautiful, winding staircase seemingly sculpted in wood, Peri notices Dewey looking at the surroundings and says, “You may wonder about the grandeur of the building, because we are a public institution. We are fortunate. Our benefactor is Valerian Ruminski. In fact, he has donated so much money to so many libraries that the staff affectionately calls him ‘Valerian the Librarian.’”

As they pass several patrons, Peri continues, “As you can see, it’s a very busy place. And, regardless of our old surroundings, we don’t dwell in the past.”

Dewey reads the report Peri has handed him. One large section is titled “Summary of Patrons’ Main Requirements,” and the bulleted list states:

- A library patron who is registered in the system can borrow books and magazines from the system.
- The library system should periodically check (at least once per week) whether a copy of a book or journal borrowed by a patron has become overdue. If so, a notice will be sent to the patron.
- A patron can reserve a book or journal that has been lent out or is in the process of purchase. The reservation should be canceled when the patron checks out the book or journal or through a formal canceling service.

As Dewey looks up from the report, he says to Peri, “I’m beginning to understand the patron (or user) requirements. I see lots of similarities between my old university library and yours. One item I didn’t see covered, though, was how you decide what the library should collect and what it should get rid of.”

Peri chuckles and replies, “That’s an insightful question. The library staff handles the purchase of new books and journals for the library. If something is popular, more than two copies are purchased. We can create, update, and delete information about titles and copies of books and journals, patrons, loan of materials, and reservations in the system.”

Dewey looks up from his note pad and says, “I’m still a little confused. What’s the difference between the terms *title* and *copy*?”

Peri responds, “The library can have several copies of a title. Title normally refers to the name of a book or journal. Copies of a title are actually lent out from the library.”

Based on Dewey’s interview with Peri and the requirements description in her report, as well as your own experience using library services, use UML to answer the following questions. (*Note:* It is important to make sure your solutions are logical and workable. State your assumptions clearly whenever necessary.)

1. Draw a use case diagram to represent actors and use cases in the system.
2. For each use case, describe the steps (as we did to organize the use cases).
3. Describe scenarios for the steps. In other words, create a patron and write up an example of the patron as he or she goes through each step.
4. Develop a list of things.
5. Create sequence diagrams for use cases based on steps and scenarios.
6. Complete the class diagram by determining relationships between classes and defining the attributes and methods of each class. Use the grouping thing called package to simplify the class diagram.

\*Based on a problem written by Dr. Wayne Huang.

## PUTTING UML TO WORK

UML provides a useful toolset for systems analysis and design. As with any product created with the help of tools, the value of UML deliverables in a project depends on the expertise with which the systems analyst wields the tools. The analyst will initially use the UML toolset to break down the system requirements into a use case model and an object model. The use case model describes the use

cases and actors. The object model describes the objects and object associations, and the responsibilities, collaborators, and attributes of the objects.

1. Define the use case model.
  - Find the actors in the problem domain by reviewing the system requirements and interviewing some business experts.
  - Identify the major events initiated by the actors, and develop a set of primary use cases at a very high level that describe the events from the perspective of each actor.
  - Develop the use case diagrams to provide understanding of how the actors relate to the use cases that will define the system.
  - Refine the primary use cases to develop a detailed description of system functionality for each primary use case. Provide additional details by developing the use case scenarios that document the alternate flows of the primary use cases.
  - Review the use case scenarios with the business area experts to verify processes and interactions. Make modifications as necessary until the business area experts agree that the use case scenarios are complete and accurate.
2. Continue UML diagramming to model the system during the systems analysis phase.
  - Derive activity diagrams from use case diagrams.
  - Develop sequence and communication diagrams from use case scenarios.
  - Review the sequence diagrams with the business area experts to verify processes and interactions. Make modifications as necessary until the business area experts agree that the sequence diagrams are complete and accurate. This additional review of the graphical sequence diagrams often provides the business area experts an opportunity to rethink and refine processes in more atomic detail than the review of the use case scenarios.
3. Develop the class diagrams.
  - Look for nouns in use cases and list them. They are potential objects. Once you identify the objects, look for similarities and differences in the objects due to the objects' states or behavior, and then create classes.
  - Define the major relationships between the classes. Look for "has a" and "is a" relationships between classes.
  - Examine use case and sequence diagrams in order to determine classes.
  - Beginning with the use cases that are the most important to the system design, create class diagrams that show the classes and relationships that exist in the use cases. One class diagram may represent the classes and relationships described in several related use cases.
4. Draw statechart diagrams.
  - Develop statechart diagrams for certain class diagrams to provide further analysis of the system at this point. Use statechart diagrams to aid in understanding complex processes that cannot be fully derived by the sequence diagrams.
  - Determine methods by examining statechart diagrams. Derive state (data) class attributes from use cases, business area experts, and class methods. Indicate whether the methods and attributes of the class are public (accessible externally) or private (internal to the class). The statechart diagrams are extremely useful in modifying class diagrams.
5. Begin systems design by refining UML diagrams and using them to derive classes and their attributes and methods.
  - Review all existing UML diagrams for the system. Write class specifications for each class that include the class attributes, methods, and their descriptions. Review sequence diagrams to identify other class methods.
  - Develop methods specifications that detail the input and output requirements for the method, along with a detailed description of the internal processing of the method.
  - Create another set of sequence diagrams (if necessary) to reflect the actual class methods and interactions with each other and the system interfaces.
  - Create class diagrams using the specialized class symbols for boundary or interface class, entity class, and control class.
  - Analyze the class diagrams to derive the system components; that is, functionally and logically related classes that will be compiled and deployed together as a .DLL, a .COM object, a Java Bean, a package, and so forth.



## CONSULTING OPPORTUNITY 10.4

### C-Shore++

“They want the core of the customer service representative’s user interface to be radically reprogrammed again!” says Bradley Vargo, the information systems development director at C-Shore Mutual Funds. “Only eight months ago, we completed a two-year development project of the Customer Service Representative System, CSR. During that entire project, we endured a parade of moving requirements. Every month, those guys in the Marketing Department would invent some competitive new customer service feature, and within a week, the CSR group would be down here with vast changes to the CSR System specifications. I thought we’d never finish that project! Now it looks as if we will have to start a new reprogramming project on a system less than a year old. We had forecast this system for a seven-year life span! Now I think it may be going into eternal reconstruction.”

Bradley is talking with Rachael Ciupek, the senior application systems analyst responsible for the CSR system, and Bridget Ciupek, her sister and the programmer who wrote most of the user interface. “Calm down, Bradley,” says Rachael. “It is not the fault of the kids in Marketing or CSR. The nature of our business has been affected by fast-paced competition. Marketing doesn’t invent these changes out of boredom. They are often responding to new, computer-based customer services offered by our competition. We have to stay ahead or at least keep up, or we’ll all be looking for new jobs!”

“Bradley, Rachael, I think you better know that the situation may be worse than you think,” Bridget chips in. “The programmers

have actually been making small changes in the CSR user interface for the past eight months anyway. The CSR users have been calling us directly and begging for help. They usually want just a small change to one isolated part of the system, but that has created a high labor drain because we have to recertify the entire system. You know how the effects of a small change can ripple through a large program. We’ve billed the time to program maintenance on the grounds that we thought we were just fine-tuning the completed system. Although the changes have been gradual, in eight months we’ve pretty much rewritten about a quarter of the CSR user interface code already. The work has not been falling off. It’s still pretty steady.”

“So what you’re telling me,” says Bradley, “is that we have system needs in this area that have been changing constantly while we tried to write specifications, tried to write program code, and tried to make a fixed solution work against a fluid problem. How can we afford to write programs if they will only last a few months without needing expensive maintenance?”

How can Bradley manage a systems development process that no longer has fixed or constant business processes as part of its goal set? Is there a way for Rachael to manage specification and control maintenance costs when programmers are constantly asked to tinker with isolated parts of a large program? Keep in mind that an important goal is to provide good support for the users’ needs and the organization’s business strategies.

- Develop deployment diagrams to indicate how your system components will be deployed in the production environment.
- 6. Document your system design in detail. This step is critical. The more complete the information you provide the development team through documentation and UML diagrams, the faster the development and the more solid the final production system.

## THE IMPORTANCE OF USING UML FOR MODELING

UML is a powerful tool that can greatly improve the quality of your systems analysis and design, and it is hoped that the improved practices will translate into higher-quality systems.

By using UML iteratively in analysis and design, you can achieve a greater understanding between the business team and the IT team regarding the system requirements and the processes that need to occur in the system to meet those requirements.

The first iteration of analysis should be at a very high level to identify the overall system objectives and validate the requirements through use case analysis. Identifying the actors and defining the initial use case model are part of this first iteration. Subsequent iterations of analysis further refine the system requirements through the development of use case scenarios, class diagrams, sequence diagrams, statechart diagrams, and so on. Each iteration takes a successively more detailed look at the design of the system until the things and relationships in the system are clearly and precisely defined in UML documents.

When your analysis and design are complete, you should have an accurate and detailed set of specifications for the classes, scenarios, activities, and sequencing in the system. In general,

you can relate the thoroughness of the analysis and design of a system to the amount of time required to develop the system and the resultant quality of the delivered product.

Often overlooked in the development of a new system is that the further a project progresses, the costlier the changes are to the business requirements of a system. Changing the design of a system using a CASE tool, or even on paper, during the analysis and design phases of a project is easier, faster, and much less expensive than doing so during the development phase of the project.

Unfortunately, some employers are shortsighted, believing that only when a programmer or analyst is coding is that employee actually working. Some employers erroneously assume that programmer productivity can be judged solely by the amount of code produced, without recognizing that diagramming ultimately saves time and money that might otherwise be wasted if a project is prototyped without proper planning.

An analogy to building a house is very apt in this situation. Although you hire a builder to build a house, you do not want to live in a structure built without planning, one in which rooms and features are randomly added without regard to function or cost. You want a builder to build your agreed-upon design from blueprints containing specifications that have been carefully reviewed by everyone concerned. As a member of an analyst team so accurately observed, “Putting a project on paper before coding will wind up costing less in the long run. It’s much cheaper to erase a diagram than it is to change coding.”

When business requirements change during the analysis phase, you may have to redraw some UML diagrams. If the business requirements change during the development phase, however, a substantial amount of time and expense may be required to redesign, recode, and retest the system. By confirming your analysis and design on paper (especially through the use of UML diagrams) with users who are business area experts, you help to ensure that correct business requirements will be met when the system is completed.

## SUMMARY

Object-oriented systems describe entities as objects. Objects are part of a general concept called classes, the main unit of analysis in object-oriented analysis and design. When the object-oriented approach was first introduced, advocates cited reusability of the objects as the main benefit of their approach. Although reusability is the main goal, maintaining systems is also very important.

Analysts can use CRC cards to begin the process of object modeling in an informal way. Object Think can be added to the CRC cards to assist the analyst in refining responsibilities into smaller and smaller tasks. CRC sessions can be held with a group of analysts to determine classes and responsibilities interactively.

Unified modeling language (UML) provides a standardized set of tools to document the analysis and design of a software system. UML is fundamentally based on an object-oriented technique known as use case modeling. A use case model describes *what* a system does without describing *how* the system does it. A use case model partitions system functionality into behaviors (called use cases) that are significant to the users of the system (called actors). Different scenarios are created for each different set of conditions of a use case.

The main components of UML are things, relationships, and diagrams. Diagrams are related to one another. Structural things are most common; they include classes, interfaces, use cases, and many other elements that provide a way to create models. Structural things allow the user to describe relationships. Behavioral things describe how things work. Group things are used to define boundaries. Annotational things permit the analyst to add notes to the diagrams.

Relationships are the glue that holds the things together. Structural relationships are used to tie the things together in structural diagrams. Structural relationships include dependencies, aggregations, associations, and generalizations. Behavioral diagrams use the four basic types of behavioral relationships: communicates, includes, extends, and generalizes.

The toolset of UML is composed of UML diagrams. They include use case diagrams, activity diagrams, sequence diagrams, communication diagrams, class diagrams, and statechart diagrams. In addition to the diagrams, analysts can describe a use case using a use case scenario.

By using UML iteratively in analysis and design, you can achieve a greater understanding between the business team and the IT team regarding the system requirements and the processes that need to occur in the system to meet those requirements.



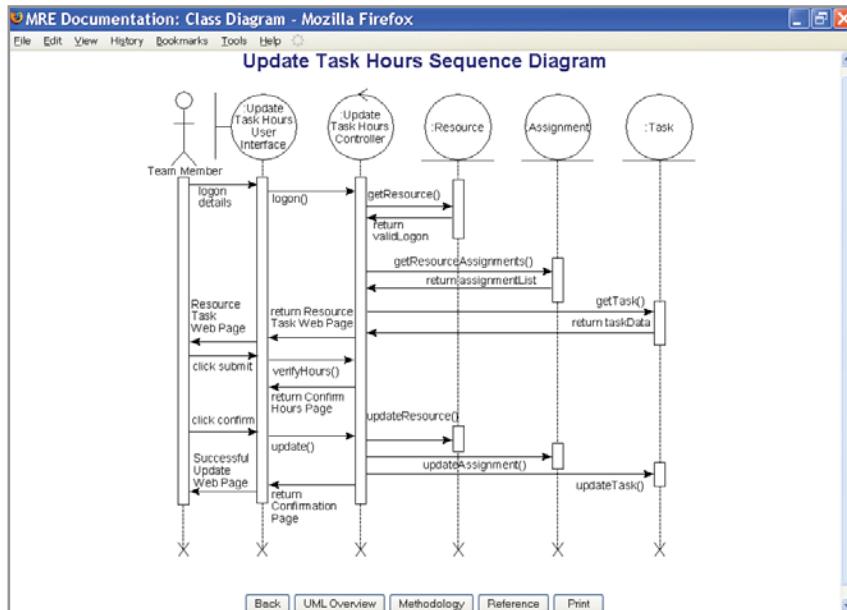
## HYPERCASE® EXPERIENCE 10

**I**hope you still feel as if you're learning new things about MRE everyday. I understand you've been talking to some of the systems people: Melissa, Todd, Roger (and even Lewis our new intern) about using some different diagramming methods to understand us better. I hope you see us as a family, not just a collection of people, though. We all certainly feel as if we've 'inherited' some great wisdom from Jimmy Hyatt and Warren's father. I'm all for using your new approach, if it helps us improve our project reporting. Of course, Snowden is eager to see your object-oriented work. Can you have something on his desk in a couple of weeks?"

### HYPERCASE Questions

1. Create an activity diagram for the Report Project Progress use case. Refer to the use case specifications in Melissa Smith's office for details and a prototype.

2. Create an activity diagram for the Add Client use case. Refer to the use case specifications in Melissa Smith's office for details and a prototype that can be found in Todd Taylor's office.
3. Create a sequence diagram for the main path of the Report Project Progress use case. Refer to the use case specifications in Melissa Smith's office for details and a prototype.
4. Create a sequence diagram for the main path of the Add Client use case. Refer to the use case specifications in Melissa Smith's office for details and a prototype that can be found in Todd Taylor's office.
5. Create a statechart diagram for the Assignment class. Assignments are created for tasks, resources are selected, hours are updated, and assignments are finished.
6. Create a statechart diagram for the Task class. Tasks are created, but not started; planned; sometimes put on hold; currently being worked on; and are completed.



**FIGURE 10.HC1**

Sequence diagrams can be found in HyperCase.

### KEYWORDS AND PHRASES

abstract class  
activity diagram  
actor  
aggregation  
Ajax  
annotational thing  
association

asynchronous message  
boundary class  
branch  
class  
class diagram  
collaboration  
communication diagram

control class	package
CRC cards	polymorphism
dependencies	primary use case
deployment diagram	relationship
entity class	sequence diagram
event	state
fork	statechart diagram
generalization/specialization (gen/spec)	swimlane
inheritance	synchronization bar
join	synchronous message
main path	temporal event
merge	unified modeling language (UML)
message	unified process
method overloading	use case diagram
method overriding	use case scenario
object	whole/part structure
object-oriented	

## REVIEW QUESTIONS

1. List two reasons for taking an object-oriented approach to systems development.
2. Describe the difference between a class and an object.
3. Explain the concept of inheritance in object-oriented systems.
4. What does CRC stand for?
5. Describe what Object Think adds to the CRC card.
6. What is UML?
7. What are the three major elements of UML?
8. List what the concept of structural things includes.
9. List what the concept of behavioral things includes.
10. What are the two main types of diagrams in UML?
11. List the diagrams included in structural diagrams.
12. List the diagrams included in behavioral diagrams.
13. What is it that a use case model describes?
14. Would you describe a use case model as a logical or physical model of the system? Defend your answer in a paragraph.
15. Define what an actor is in a use case diagram.
16. What three things must a use case always describe?
17. What does an activity diagram depict?
18. Write a paragraph that describes the use of swimlanes on activity diagrams.
19. What can be depicted on a sequence or communication diagram?
20. Why is defining classes such an important object-oriented analysis task?
21. What can be shown on a class diagram?
22. Define method overloading.
23. List the four categories into which classes fall.
24. What are the steps for creating a sequence diagram?
25. What are the two categories of relationships between classes?
26. What are gen/spec diagrams used for?
27. What is another term for polymorphism?
28. What is depicted by a statechart diagram?
29. What is a package in UML approach?
30. Why is using UML for modeling important?

## PROBLEMS

1. Create a series of CRC cards for World's Trend Catalog Division. Once an order is placed, the order fulfillment crew takes over and checks for availability, fills the order, and calculates the total amount of the order. Use five CRC cards, one for each of the following classes: order, order fulfillment, inventory, product, and customer. Complete the section on classes, responsibilities, and collaborators.
2. Finish the CRC cards in Problem 1 by creating Object Think statements and property names for each of the five classes.
3. Draw a use case diagram for World's Trend Catalog Division.

4. Draw four pictures showing examples of four types of behavioral relationships for Joel Porter's BMW automobile dealership. What type of relationship is involved when a customer must arrange financing? Are there common activities involved when a person either leases or buys an automobile? What type of relationship is between an employee that is a manager or one that is a salesperson?
5. Draw a communication diagram for a student taking a course from a teacher, who is part of the faculty.
6. Coleman County has a phone exchange that handles calls between callers and those receiving the call. Given these three actors, draw a simple sequence diagram for making a simple phone call.
7. You are ready to begin UML modeling for the Kirt Clinic. Draw a class diagram that includes a physician, a patient, an appointment, and a patient's bill. Do not get the insurance company involved.
8. Use UML to draw examples of the four structural relationships for the Kirt Clinic.
9. Write a sample use case scenario for a patient who sees a physician in the Kirt Clinic.
10. Woody's Supermarket, a small chain of grocery stores, is building a Web site to allow customers to place orders for groceries and other items they sell. The customer places a Web order, the customer master is updated, and an order record is created. The order prints at a local store, and the goods are picked from the shelves by the store employees. Customers are sent an email notification that their order is ready. When they pick up the order, frozen goods, chilled products, and other items are assembled. Draw an activity diagram showing the customer using the Web site to place an order, verification of the order, order confirmation, order details sent to the local store, and a customer email sent to the customer.
11. Sludge's Auto (refer to Chapter 12) is as an auto parts recycling center, using Ajax on Web sites for customers to browse for parts. Ajax allows the Web site to obtain data from the server while the user stays on the original Web page. The customer needs to know the make, model, and year of a car as well as the part. If the part is in stock, the description, condition of the part, price, and shipping cost are displayed, with the quantity available for each condition of the part, along with a picture of the part. Draw a sequence diagram using boundary, control, and entity classes for the Auto Part Query for Sludge's Auto.
12. Musixscore.com is an online service providing sheet music to customers. On the "browse music" Web page, customers select a genre of music from a drop-down list. The Web page uses Ajax to obtain a list of performers, musicians, or groups that match the genre, which is formatted as a drop-down list. When a selection is made from the performer's drop-down list, the Web page uses Ajax to display a third drop-down list displaying all the CDs or other works of the performer. When a CD is selected, the Web page uses Ajax to obtain all the songs on the CD in a fourth drop-down list. The viewer may make multiple selections. When the **Add to Shopping Cart** image is clicked, the songs are added to the shopping cart. The viewer may change any of the drop-down lists to select additional sheet music, and the process is repeated.
  - a. Write a use case description for the Browse Music Score use case, representing this activity.
  - b. Draw a sequence diagram using boundary, control, and entity classes for the Musixscore Web page.
  - c. Write a list of the messages, names, and the parameters, along with the data types, that would be passed to the classes and the values (with data types) that are included with the return message. Make any assumptions you need about the data.
  - d. Create a class diagram for the entity classes used in the sequence diagram.

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## EPISODE 10

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Classy Objects

"The prototypes and diagrams that we have created have really given us a feel for the project," smiles Anna, looking up from her computer. "I have a good sense about what we are doing."

"Same here," replies Chip. "But we need to work on the Web pages that will be used by a wide variety of faculty and staff."

"Where do you want to start?" asks Anna. "Do you think that we should work on the class diagram?"

Chip leans back in his chair and thinks out loud, "No, we need to do some other modeling to determine classes, attributes, and methods first. We have a preliminary E-R diagram as a starting point for entity classes. We should model the behavior of a number of prototypes. As a prototype is examined, we should be asking questions about each field. If the information is stored on a database table, we should obtain it somehow."

"Yes, typically we would include it in a drop-down list," Anna muses.

"Well, not necessarily," counters Chip. "If there are too many entries, or if one list depends on a previous action, we should use Ajax to retrieve the information and update the Web page, creating drop-down lists or links."

"The create programs that add new information will be the ones with the most keying, but the change, delete, and query programs depend on stored data," adds Anna. "Where should we start?"

"I've been giving a lot of thought to the prototype we created to use the Web to update the image of all the software that is stored on a computer lab machine," says Chip, leaning forward in his chair. "And by lab room, I mean any classroom or lab that has the same set of software on each computer. The software image is used to refresh any damaged computers or to replace software on a machine infected by a virus or other problem."

"Well, let's have a look at that UPDATE LAB IMAGE prototype," says Anna.

Chip displays the prototype (refer to the CPU case in Chapter 6). "We need to know the campus and room number to find the software image," says Chip, pointing to the first couple of fields on the Web page. "These are stored on database tables."

"Yes, but these are stored with the administrative scheduling software on the mainframe," interjects Anna. "We could copy them to the Web servers, but if the buildings or rooms change we will have inconsistent data, and an unreliable system."

"Ahh, I see what you mean," says Chip. "Good thinking! We'll have to get this data from the mainframe."

"This calls for the UPDATE LAB IMAGE activity diagram (illustrated in Figure E10.1)," remarks Anna. "Why don't I create the diagram and you check to verify that it's correct?"

"Sounds good," remarks Chip.

Anna starts to draw the diagram. "Since only certain staff members will have the authorization to update the lab image, I think that it should start with them logging onto the system. If it is a valid logon, a request will be sent to the mainframe state called GET CAMPUS BUILDING ROOMS to obtain both the campus buildings and the rooms within them. This list gets sent back to the SEND CAMPUS BUILDING LIST program on the Web server, where it gets converted to an XML document and sent to the SELECT CAMPUS BUILDING Web page."

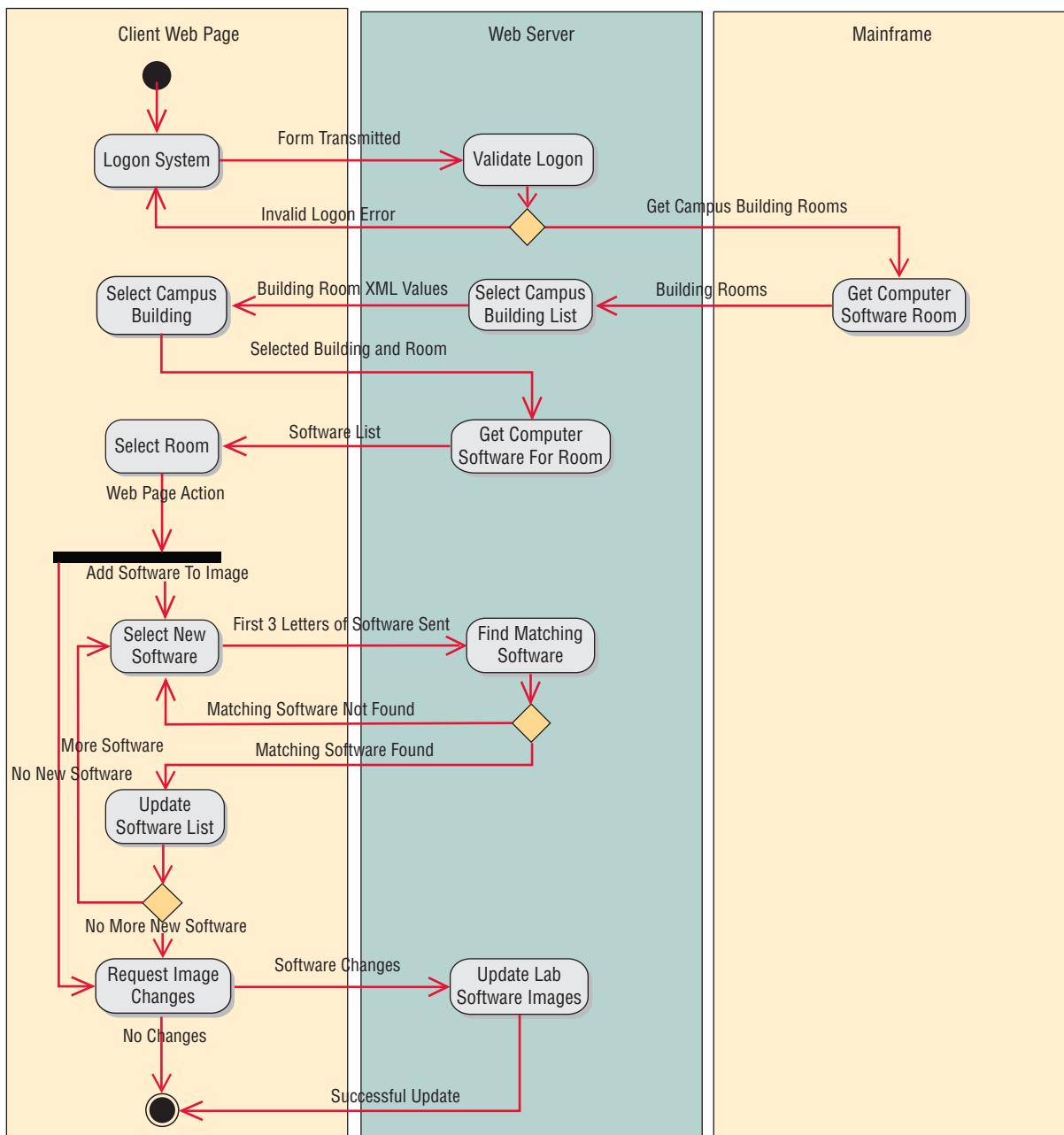
Chip asks, "Are you going to put all the rooms into the list for all the buildings? That would be a large XML document and may take a long time to load into the browser."

"The other choice is to include just the buildings and then request the rooms for a selected campus building," answers Anna thoughtfully. "That would also be acceptable, but would slow down the room selection since the browser would have to wait for the rooms to be updated in the drop-down list. If the entire XML document were sent at once, the room list would be quickly updated from the document elements at the browser level. It would be very fast. So the user would select a campus building and only the rooms for that building would display."

"I've got an idea," exclaims Chip. "When the program gets the building rooms, is there a way to select only rooms that are computer labs?"

"That's an excellent idea," says Anna. "The XML document would be smaller, and load faster in the browser. We may have to request a modification of the database table to have a code for computer labs."

"I'll check into it," replies Chip. "So what happens after we get a lab room?"

**FIGURE E10.1**

UPDATE LAB IMAGE activity diagram.

Anna thinks for a moment, “We’ll need a lab image table on the Web server containing the room number and the software included in the room. This includes standard software, such as the operating system, word processing, and virus scanning software, since they may change from room to room. I’ll add a state for the GET COMPUTER SOFTWARE FOR ROOM in the Web Server swimlane.”

Chip asks, “Do we want to include a drop-down list for the software?”

“No, that would make it difficult to remove software, or to change the version,” replies Anna thoughtfully. “I think that we should display the software in a list on the Web page and allow them to update the version number.”

“The problem is that we may have a large list of software, and we have to delete some of the software as well,” states Chip. “Why don’t we use an email model, with a check box in front of each software title and limit the number of software titles per page? We would include a next page button to display the next group of software titles.”

“How does the delete program know which software package to delete?” Anna asks.

“We need to include the software number as a hidden field that is transmitted to the Web server,” answers Chip. “What are your thoughts about adding software to the lab image?”

Anna thinks for a few minutes, “Why don’t we use Ajax again to have them enter the first few letters of the software title into an input text field? We could send the request to the Software table on the Web server and return a list of the titles that match. The Web page would create a rectangular block floating on top of the Web page with a list of the software title links and hidden fields stored with the link. The user would click a title and it would be added to the image. Then they could add another software title if needed. This is the SELECT NEW SOFTWARE activity sending the first three letters to the Web server FIND MATCHING SOFTWARE state. UPDATE SOFTWARE LIST creates the floating block of titles.”

“Great idea!” exclaims Chip.

“When they are done adding software, checking software to be removed, and changing version numbers, they click a submit button and the lab image database table is updated with the changes,” says Anna. “The REQUEST IMAGE CHANGES state sends the changes to the UPDATE LAB SOFTWARE IMAGE state.

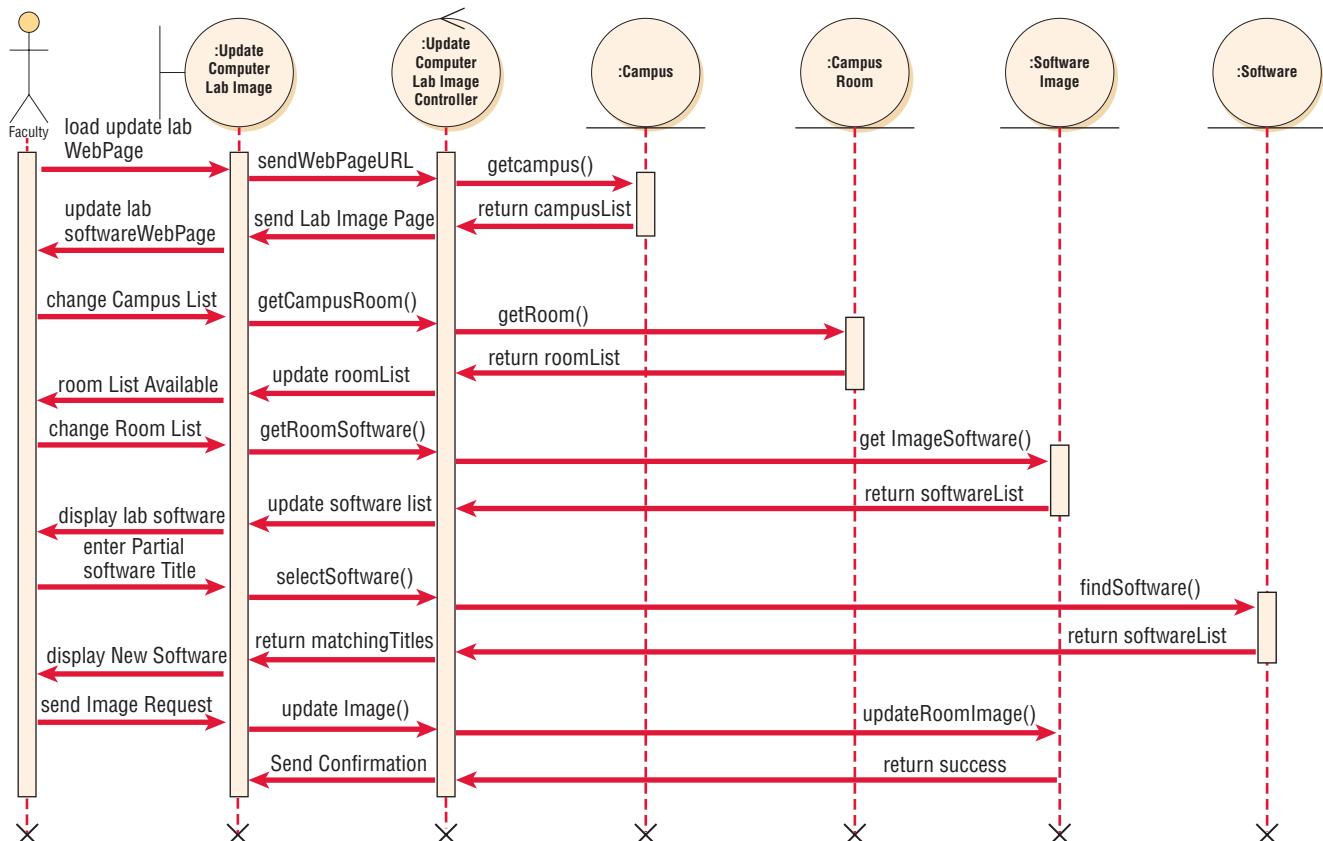
“This is fun,” grins Chip. “Let me work on a sequence diagram for the UPDATE LAB IMAGE prototype (illustrated in Figure E10.2). Chip starts by sending the request for the Update Lab Web page. The server sends the getCampus() message to the CAMPUS class, which returns the campusList, including a campusCode and a campusDescription. The controller sends a message to the CAMPUS ROOM class to obtain rooms that contain lab software, which are returned to the UPDATE COMPUTER LAB IMAGE CONTROLLER. The controller class creates the roomList XML document and sends it to the Web browser, which creates the Campus Building selection list. When the Campus Building list is changed, the Web browser uses the same XML document to change the Room Number drop-down list to include only lab rooms in the selected campus building.

When the Room Number drop-down list is changed, a getRoomSoftware() request is sent to the controller class, which sends a getImageSoftware() message to the SOFTWARE IMAGE class. Using the room number, the software is obtained and returned in the softwareList. The controller class uses the softwareList to create the XML that is sent to the UPDATE COMPUTER LAB IMAGE interface class, which updates the Web page with the software titles.

When a partial software title is entered, a selectSoftware() request is sent to the UPDATE COMPUTER LAB IMAGE CONTROLLER, which sends a findSoftware() message to the SOFTWARE entity class. The matching software is found and the softwareList containing the software number, description, and version, is sent to the controller class. This formats the XML document, which is sent to the UPDATE COMPUTER

**FIGURE E10.2**

UPDATE LAB IMAGE sequence diagram.



LAB IMAGE interface class. The Web browser formats the floating block of software titles. When a title is selected, the browser adds it to the list of software titles and the floating block is removed.

When the Send Image Request button is clicked on the Web page, the updateImage() request is sent to the controller, which sends an updateRoomImage() message to the SOFTWARE IMAGE entity class. The database table is updated and success is returned to the controller, which sends a confirmation Web page.

“The software seems to be a bit complicated, with different versions and software packages being replaced by different ones,” comments Anna. “I think that it is a good idea to draw a statechart diagram for software. This will give us a feeling for the software methods and attributes, and the interface that we will need to change the attributes.”

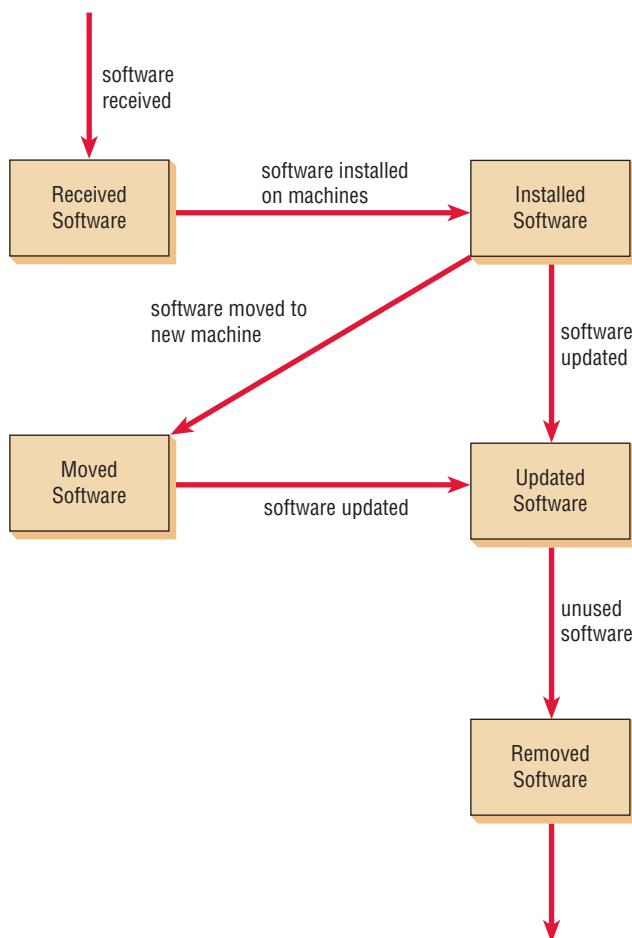
Anna starts to work on a SOFTWARE statechart diagram. When software is first received it is entered into the system using the Microsoft Access ADD SOFTWARE form and the initial attribute values are changed. All software must be added before it is permissible to install the software on machines, so the SOFTWARE INSTALLED ON MACHINES event is deferred until it has been added.

After the software has been installed on any number of machines, it exists in the INSTALLED SOFTWARE state for a long time. The HARDWARE-SOFTWARE relational table is updated to reflect the current state. From time to time a machine is replaced and the software is moved to a different machine. The HARDWARE-SOFTWARE is again updated to reflect the new location. When a new version of the software is available, the version is updated with a CHANGE SOFTWARE Microsoft Access form. Alternatively the software may be removed from the system, using a DELETE SOFTWARE Microsoft Access form. The completed SOFTWARE statechart diagram is illustrated in Figure E10.3.

Chip and Anna work on a number of activity, sequence, and statechart diagrams. After they have completed a number of diagrams Chip remarks, “I think that we have enough information to create a class diagram.”

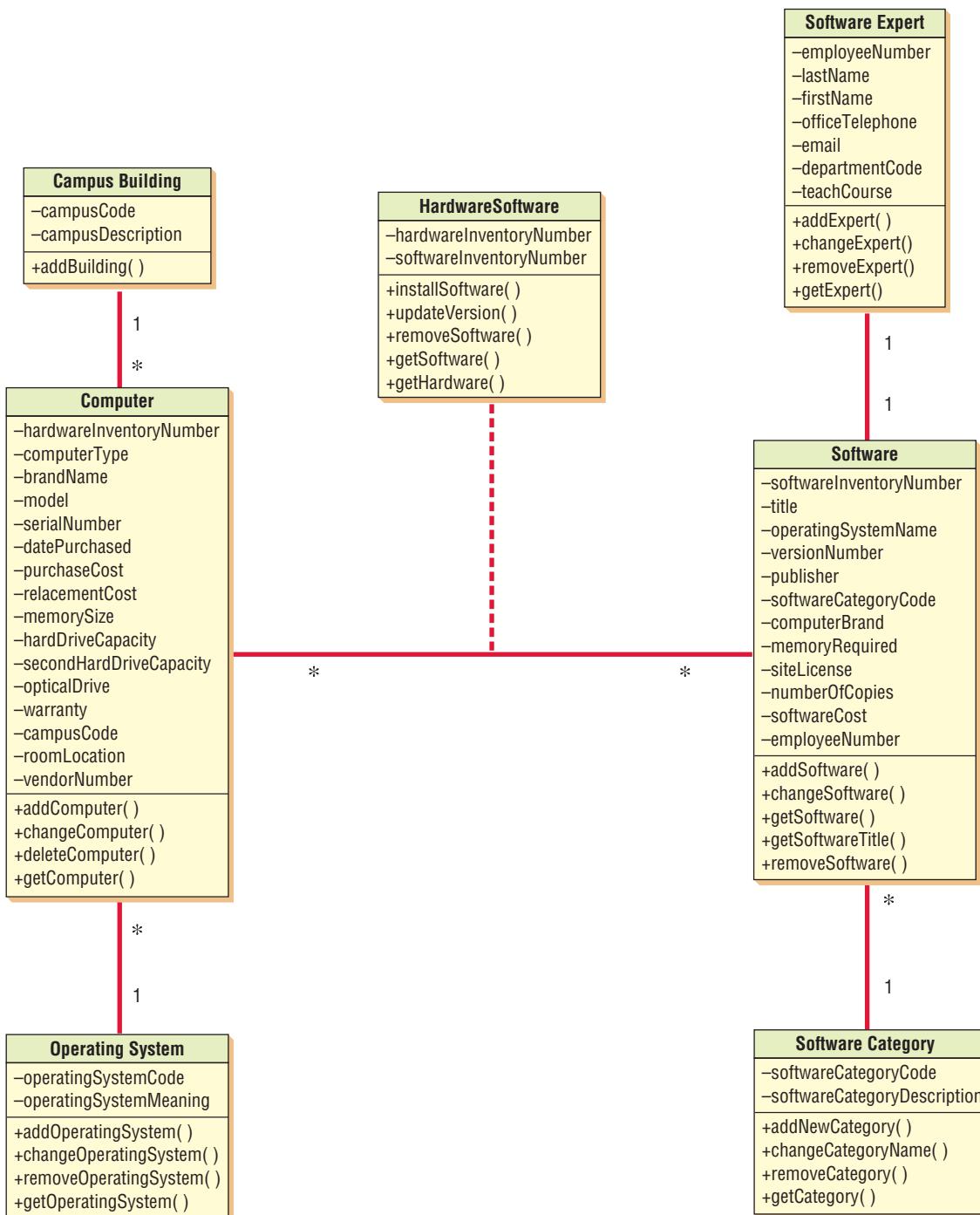
Anna agrees, “Yes, let’s map out the relationships.”

The COMPUTER SYSTEM class diagram is illustrated in Figure E10.4. Each class has private attributes and public methods in Microsoft Access to update the attributes. The major classes are Computer and Software, with a HardwareSoftware associative class connecting them. This is used to implement the many-to-many relationship between hardware and software. Each software package belongs to one Software Category and also



**FIGURE E10.3**

SOFTWARE statechart diagram.

**FIGURE E10.4**

COMPUTER SYSTEM class diagram.

has one Software Expert to call upon for support. Each computer has one or more operating systems, and is located in one campus building.

### Exercises



- E-1. Use either Microsoft Visio or Visible Analyst to view the UPDATE LAB IMAGE activity diagram.
- E-2. Use either Microsoft Visio or Visible Analyst to view the UPDATE LAB IMAGE sequence diagram.
- E-3. Use either Microsoft Visio or Visible Analyst to view the SOFTWARE statechart diagram.
- E-4. Use either Microsoft Visio or Visible Analyst to view the COMPUTER SYSTEM class diagram.

The following exercises may be done with either Microsoft Visio or Visible Analyst. A rectangle will have to be used for a class symbol when drawing sequence diagrams when using Microsoft Visio or Visible Analyst (the class stereotype symbols are not available). Place a text label above each rectangle identifying the type of class: interface, control, or entity.

- E-5. Modify and print the REGISTER FOR TRAINING activity diagram. Refer to Figure E12.3 in the CPU Case Episode in Chapter 12 to see the prototype for this Web page. Add the following state symbols and event connections:

- a. The CREATE XML EMPLOYEE DATA state in the WEB SERVER swimlane, below the GET EMPLOYEE INFORMATION state. Connect it with an event arrow coming from READ EMPLOYEE RECORD. Label the event SEND EMPLOYEE DATA.
- b. Add the EMPLOYEE INFORMATION WEB PAGE state in the CLIENT WEB PAGE swimlane, to the left of CREATE XML EMPLOYEE DATA state. Connect the two states with an event arrow into the EMPLOYEE INFORMATION WEB PAGE state labeled SEND EMPLOYEE XML DOCUMENT.
- c. Add a state below the CREATE XML EMPLOYEE DATA state called FIND SOFTWARE TRAINING CLASS. Connect it with an event arrow coming from the EMPLOYEE INFORMATION WEB PAGE state labeled SELECTED SOFTWARE AND TRAINING LEVEL.
- d. Include a decision diamond symbol below the FIND SOFTWARE TRAINING CLASS state. Connect it with an event arrow coming to it from the FIND SOFTWARE TRAINING CLASS state. An event should flow to the left into the EMPLOYEE INFORMATION WEB PAGE state labeled CLASS NOT FOUND.
- e. Add a CHOOSE SOFTWARE CLASS state below the EMPLOYEE INFORMATION WEB PAGE state, and somewhat below the decision diamond. Connect the bottom of the decision diamond with an event arrow going to the CHOOSE SOFTWARE CLASS state. Label it SOFTWARE TRAINING CLASSES.
- f. Add a state below the decision diamond and somewhat below the CHOOSE SOFTWARE CLASS state. Label it UPDATE CLASS PARTICIPANT.
- g. Connect the CHOOSE SOFTWARE CLASS state with an event arrow pointing to the UPDATE CLASS PARTICIPANT state. Label it SEND ENROLL CLASS REQUEST.
- h. Add an exit circle symbol in the bottom of the Client Web Page swimlane. Connect the CHOOSE SOFTWARE CLASS state with an event arrow pointing to the exit circle labeled CANCEL.
- i. Connect the UPDATE CLASS PARTICIPANT state with an event arrow pointing to the exit circle labeled SUCCESSFUL UPDATE.

- E-6. Create and print the TRAINING CALENDAR activity diagram. The prototype for this Web page is illustrated in Figure E11.4 which can be found in the CPU Case Episode in Chapter 11. Add a starting circle at the top left of the diagram and add the following swimlanes, state symbols, and event connections:

- a. Add a swimlane on the left labeled CLIENT WEB PAGE and one on the right called WEB SERVER.
- b. Add a starting circle at the top of the CLIENT WEB PAGE swimlane, and below it a state labeled REQUEST TRAINING CALENDAR WEB PAGE. Connect the starting circle to the state with an event arrow.
- c. Add a state in the WEB SERVER swimlane, to the right of the REQUEST TRAINING CALENDAR WEB PAGE state. Label it GET TRAINING CLASS.
- d. Connect the left state to the right one with an event arrow labeled FORM TRANSMITTED.
- e. Place a state below the GET TRAINING CLASS state. Label it GET TRAINING CLASS. Connect the two states with a downward event arrow labeled SEND COURSE NUMBER.
- f. Place a state in the CLIENT WEB PAGE swimlane to the left of the GET TRAINING CLASS state. Label it TRAINING CALENDAR COURSE DISPLAY. Connect the two states with a left pointing event arrow labeled SEND TRAINING CLASS XML VALUES.
- g. Place an exit circle at the bottom of the CLIENT WEB PAGE swimlane. Connect the TRAINING CALENDAR COURSE DISPLAY state with the exit circle. Connect the TRAINING CALENDAR COURSE DISPLAY state with an event arrow to the right and up the right side of the WEB SERVER swimlane to the GET TRAINING CLASS state. Label it DATE CHANGE OR SORT CHANGE.

- E-7. Modify and print the REGISTER FOR TRAINING sequence diagram. Add two new entity classes to the right side of the diagram and extend the lifeline down to the bottom of the diagram. The classes are Employee and Class. Add the following messages from the REGISTER FOR CLASS CONTROLLER, and add the focus of control rectangles where the messages interact with the class lifeline:
- a. getEmployee() from the controller to EMPLOYEE.
  - b. return employeeData from the EMPLOYEE class to the controller.

- c. findSoftwareClass() from the controller to the CLASS entity class.
- d. return softwareclassList from the CLASS entity class to the controller.
- e. updateClassParticipant() from the controller to the CLASS entity class.
- f. return success from the CLASS entity class to the controller.



- E-8.** Create and print the TRAINING CALENDAR sequence diagram. Add the Faculty actor in the upper left corner of the diagram and then the following classes from left to right along the top of the diagram:
- a. Display Training Classes interface class.
  - b. Display Training Classes control class.
  - c. Class entity class.
  - d. Course entity class.

Add the following messages between the classes or the actor to the class:

- a. Load Training Calendar Web page from Faculty to the Display Training Classes interface class.
- b. sendWebPageURL from Display Training Classes to Display Training Classes Controller.
- c. getClass() from the controller to the Class entity class.
- d. return classList from the Class entity class to the controller.
- e. getCourseDescription() from the controller to the Course entity class.
- f. return courseDescription from the Course entity class to the controller.
- g. update courseList from the controller class to the Display Training Classes interface class.
- h. Lab Software Web Page from the Display Training Classes interface class to the actor.
- i. Change Month/Year from the actor to the Display Training Classes interface class.
- j. A self-transition on the Display Training Classes interface class (using JavaScript to update the calendar).
- k. New Calendar from the Display Training Classes interface class to the actor.
- l. Change Date from the actor to the Display Training Classes interface class.
- m. getNewClass() from the Display Training Classes to the controller.
- n. Repeat steps c through g.
- o. Course List Available from the Display Training Classes interface class to the actor.



- E-9.** Modify and print the Training statechart diagram. Add two states after the CANCELED TRAINING CLASS on the left side of the diagram. They are ACTIVE TRAINING CLASS and, below it, COMPLETED TRAINING CLASS. Add a class below SCHEDULED TRAINING CLASS called ENROLLED TRAINING CLASS. Add the following transitions:

- a. PARTICIPANTS ENROLLED from the SCHEDULED TRAINING CLASS state to the ENROLLED TRAINING CLASS state.
- b. IN SESSION CLASS from the ENROLLED TRAINING CLASS state to the ACTIVE TRAINING CLASS state.
- c. TRAINING SESSION ENDED from the ACTIVE TRAINING CLASS state to the COMPLETED TRAINING CLASS state.
- d. An ending arrow from the COMPLETED TRAINING CLASS state to a blank area to the right.



- E-10.** Create and print the COMPUTER statechart diagram. There are two columns of states. In the left column, include the following states from the top to the bottom: NEW COMPUTER, CLEANING COMPUTER, and RECYCLED COMPUTER. In the right column, include the following states from the top to the bottom: INSTALLED COMPUTER, FUNCTIONAL COMPUTER, and REPAIR HELD COMPUTER. Add the following transitions:

- a. Start with COMPUTER RECEIVED going from a point in space above the state rectangle into the NEW COMPUTER state.
- b. COMPUTER INSTALLED from the NEW COMPUTER state to the INSTALLED COMPUTER state.
- c. SOFTWARE INSTALLED from the INSTALLED COMPUTER state to the FUNCTIONAL COMPUTER state.
- d. MAINTENANCE SCHEDULED from the FUNCTIONAL COMPUTER state to the CLEANING COMPUTER state.
- e. MAINTENANCE COMPLETE from the CLEANING COMPUTER state to the FUNCTIONAL COMPUTER state.
- f. PROBLEM REPORTED from the FUNCTIONAL COMPUTER state to the REPAIR HELD COMPUTER state.
- g. REPAIR COMPLETED from the REPAIR HELD COMPUTER state to the FUNCTIONAL COMPUTER state.
- h. REFRESH IDENTIFIED COMPUTER from the FUNCTIONAL COMPUTER state to the RECYCLED COMPUTER state.

- i. UNFEASIBLE REPAIR IDENTIFIED from the REPAIR HELD COMPUTER state to the RECYCLED COMPUTER state.
- J. An ending arrow from the RECYCLED COMPUTER state to a blank area below the state.

- E-11.** Modify and print the COMPUTER class diagram. Each computer may have one or more operating systems installed. Move the Operating System class to the right of its current location and add a new class called Computer Operating System below the Computer class. Change the connecting line from Computer to Operating System to connect the Operating System class to the Computer Operating System class. Add a new relationship between the Computer class (the one end) to the Computer Operating System class (the many end). Add the following attributes to the Computer Operating System class:

HardwareInventoryNumber  
operatingSystemCode

Add the following methods to the Computer Operating System class:

addComputerOperatingSystem()  
removeComputerOperatingSystem()

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.



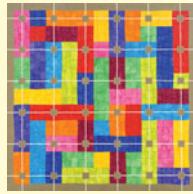
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# Designing Effective Output

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand the objectives for effective output design.
2. Relate output content to output methods inside and outside the organization.
3. Realize how output bias affects users.
4. Design display output.
5. Design dashboards, widgets, and gadgets.
6. Design a Web site for ecommerce.



Output is information delivered to users through the information system by way of intranets, extranets, or the World Wide Web. Some data require extensive processing before they become suitable output; other data are stored, and when they are retrieved, they are considered output with little or no processing. Output can take many forms: the traditional hard copy of printed reports and soft copy such as display screens, microforms, and video and audio output. Users rely on output to accomplish their tasks, and they often judge the merit of the system solely by its output. To create the most useful output possible, the systems analyst works closely with the user through an interactive process until the result is considered to be satisfactory.

## OUTPUT DESIGN OBJECTIVES

Because useful output is essential to ensuring the use and acceptance of the information system, there are six objectives that the systems analyst tries to attain when designing output:

1. Designing output to serve the intended purpose.
2. Designing output to fit the user.
3. Delivering the appropriate quantity of output.
4. Making sure the output is where it is needed.
5. Providing the output on time.
6. Choosing the right output method.

### Designing Output to Serve the Intended Purpose

All output should have a purpose. During the information requirements determination phase of analysis, the systems analyst finds out what user and organizational purposes exist. Output is then designed based on those purposes.

You will have numerous opportunities to supply output simply because the application permits you to do so. Remember the rule of purposiveness, however. If the output is not functional,

it should not be created, because there are costs of time and materials associated with all output from the system.

### Designing Output to Fit the User

With a large information system serving many users for many different purposes, it is often difficult to personalize output. On the basis of interviews, observations, cost considerations, and perhaps prototypes, it will be possible to design output that addresses what many, if not all, users need and prefer.

Generally speaking, it is more practical to create user-specific or user-customizable output when designing for a decision support system or other highly interactive applications such as those using the Web as a platform. It is still possible, however, to design output to fit a user's tasks and function in the organization, which leads us to the next objective.

### Delivering the Appropriate Quantity of Output

Part of the task of designing output is deciding what quantity of output is correct for users. A useful heuristic is that the system must provide what each person needs to complete his or her work. This answer is still far from a total solution, because it may be appropriate to display a subset of that information at first and then provide a way for the user to access additional information easily.

The problem of information overload is so prevalent that it is a cliché, but it remains a valid concern. No one is served if excess information is given only to flaunt the capabilities of the system. Always keep the decision makers in mind. Often they will not need great amounts of output, especially if there is an easy way to access more via a hyperlink or drill-down capability.

### Making Sure the Output Is Where It Is Needed

Output is often produced at one location and then distributed to the user. The increase in online, screen-displayed output that is personally accessible has cut down somewhat on the problem of distribution, but appropriate distribution is still an important objective for the systems analyst. To be used and useful, output must be presented to the right user. No matter how well designed reports are, if they are not seen by the pertinent decision makers, they have no value.

### Providing the Output on Time

One of the most common complaints of users is that they do not receive information in time to make necessary decisions. Although timing isn't everything, it does play a large part in how useful output will be. Many reports are required on a daily basis, some only monthly, others annually, and others only by exception. Using well-publicized, Web-based output can alleviate some problems with the timing of output distribution as well. Accurate timing of output can be critical to business operations.

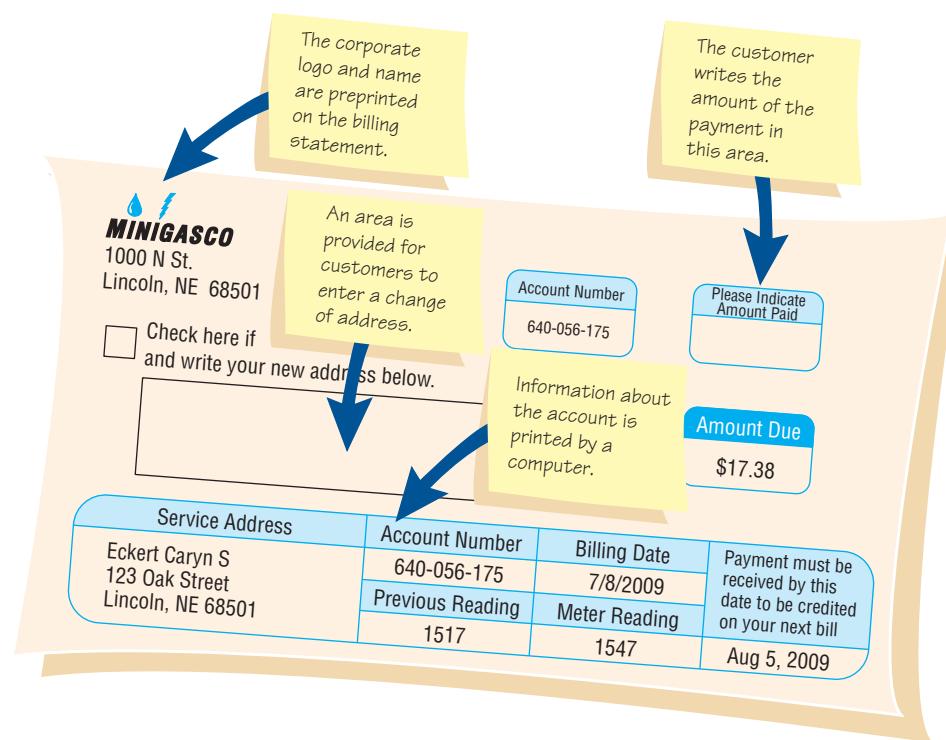
### Choosing the Right Output Method

Choosing the right output method for each user is another objective in designing output. Much output now appears on display screens, and users have the option of printing it out with their own printer. The analyst needs to recognize the trade-offs involved in choosing an output method. Costs differ; for the user, there are also differences in the accessibility, flexibility, durability, distribution, storage and retrieval possibilities, transportability, and overall impact of the data. The choice of output methods is not trivial, nor is it usually a foregone conclusion.

## RELATING OUTPUT CONTENT TO OUTPUT METHOD

The content of output from information systems must be considered as interrelated to the output method. Whenever you design output, you need to think of how function influences form and how the intended purpose will influence the output method that you choose.

Output should be thought of in a general way so that any information put out by the computer system that is useful to people in some way can be considered output. It is possible to conceptualize output as either external (going outside the business), such as information that appears to the public on the Web, or internal (staying within the business), such as material available on an intranet.

**FIGURE 11.1**

A turnaround document for Minigasco's data processing.

External output is familiar to you through utility bills, advertisements, paychecks, annual reports, and myriad other communications that organizations have with their customers, vendors, suppliers, industry, and competitors. Some of this output, such as utility bills, is designed by the systems analyst to serve double duty as a turnaround document. Figure 11.1 is a gas bill that is a turnaround document for a gas company's data processing. The output for one stage of processing becomes the input for the next. When the customer returns the designated portion of the document, it is optically scanned and used as computer input.

External output differs from internal output in its distribution, design, and appearance. Many external documents must include instructions to the recipient if they are to be used correctly. Many external outputs are placed on preprinted forms or Web sites bearing the company logo and corporate colors.

Internal outputs include various reports to decision makers. They range from short summary reports to lengthy, detailed reports. An example of a summary report is a report summarizing monthly sales totals. A detailed report might give weekly sales by salesperson.

Other kinds of internal reports include historical reports and exception reports that are output only at the time an exception occurs. Examples of exception reports are a listing of all employees with no absences for the year, a listing of all salespeople who did *not* meet their monthly sales quota, or a report on consumer complaints made in the last six months.

## Output Technologies

Producing different types of output requires different technologies. For printed output, the options include a variety of printers. For screen output, the options include attached or stand-alone displays. Audio output can be amplified over a loudspeaker or listened to on a variety of speakers, ranging from small to surround sound-capable on a PC. Audio output may also be designed for mobile phones. Electronic output is created with special software tools. As you can see, the choices are numerous. Figure 11.2 is a comparison of output methods.

**PRINTERS.** Because printed reports are such a common kind of output, it is logical to assume that in any large organization printers are ubiquitous. Although other types of output are gaining popularity, it is likely that businesses will still desire printed output, or will want to design output that will look good if customers, suppliers, or vendors print it out using their own software and hardware.

Output Method	Advantages	Disadvantages
Printer	<ul style="list-style-type: none"> <li>Affordable for most organizations</li> <li>Flexible in types of output, location, and capabilities</li> <li>Handles large volumes of output</li> <li>Highly reliable with little down time</li> </ul>	<ul style="list-style-type: none"> <li>Still requires some operator intervention</li> <li>Compatibility problems with computer software</li> <li>May require special, expensive supplies</li> <li>Depending on model, may be slow</li> <li>Environmentally unfriendly</li> </ul>
Display screen	<ul style="list-style-type: none"> <li>Interactive</li> <li>Online, real-time transmission</li> <li>Quiet</li> <li>Takes advantage of computer capabilities for movement within databases and files</li> <li>Good for frequently accessed, ephemeral messages</li> </ul>	<ul style="list-style-type: none"> <li>May require cabling and setup space</li> <li>Still may require printed documentation</li> </ul>
Audio output and podcasts	<ul style="list-style-type: none"> <li>Good for individual user</li> <li>Good for transient messages</li> <li>Good where worker needs hands free</li> <li>Good if output needs to be widely distributed</li> </ul>	<ul style="list-style-type: none"> <li>Needs earbuds where output will not interfere with other tasks</li> <li>Has limited application</li> </ul>
DVD, CD-ROM, and CD-RW	<ul style="list-style-type: none"> <li>Has large capacity</li> <li>Allows multimedia output</li> </ul>	<ul style="list-style-type: none"> <li>Requires a computer and display for reading data</li> </ul>
Electronic output (email, Web sites, blogs, and RSS feeds)	<ul style="list-style-type: none"> <li>Reduces paper</li> <li>Can be updated very easily</li> <li>Can be “broadcast”</li> <li>Can be made interactive</li> </ul>	<ul style="list-style-type: none"> <li>Is not conducive to formatting (email)</li> <li>Is difficult to convey context of messages (email)</li> <li>Web sites need diligent maintenance</li> </ul>

**FIGURE 11.2**

A comparison of output methods.

The trend in printers is toward increased flexibility. This trend translates into expanding the options for the location of the printing site itself, accommodating different numbers of characters per page, including numerous type styles and type fonts, changing the position of print on the page, including more graphics capability and color, producing quieter printing, protecting the environment, reducing the number of preprinted forms in inventory, simplifying operator tasks, and reducing the amount of overall operator intervention.

Together with users, the systems analyst must determine the purpose for the printer. Once that is established, three key factors of printers to keep in mind are:

1. Reliability.
2. Compatibility with software and hardware.
3. Manufacturer support.

**DISPLAYS AS OUTPUT.** Display screens are an increasingly popular output technology. Once used mostly for data entry, screens are also becoming a feasible technology for many other uses as their size and price decrease and as their compatibility with other system components increases.

Screens have distinct advantages over printers because of their quietness and potential for interactive user participation. Screen output can afford flexibility in allowing the user to change output information in real time either through deletion, addition, or modification. Screens also permit review of stored output through access to and the display of items from a relevant database, permitting individual decision makers to stop storing redundant printouts.

Display screens as output result in cost savings. If users can complete their tasks by interacting with a screen, they may not need paper, thereby eliminating the cost of printing, filing, and physical storage. If a report was previously sent out by post, convincing users to view the documents on screen can save mailing, as well as printing, costs. Stockbrokers, phone companies, utilities, and banks are all offering electronic delivery of output to their customers.

Electronic display may also be desirable from the user's standpoint. A user may want just to glance briefly at a monthly statement to verify its accuracy. The user needs, however, to file the statement away for tax reasons. If the statement is delivered via email, the electronic copy may be all that the user wants. This will help record keeping and consequently encourage the user to

prefer the electronic statement to the paper statement. Another reason for preferring display output to paper output is that it is easier to keep the electronic version up-to-date.

One potential drawback is showing output on a variety of display screens using different screen resolutions. If the screen displayed is from a Web page, the Web page programmer needs a plan for checking images at each resolution (for example, 800 × 600, 1600 × 1200, and so on), using different browsers, to make sure that the pages look similar. If users need access to smartphones or mobile phones to complete their work, special Web pages may need to be developed as well.

If the output is a report other than a Web page, the analyst is faced with solving other problems. Users may not have the necessary fonts on their computers, and their Microsoft Word documents may be customized with unusual margins. If a Word document is sent by email, a beautifully formatted document on a sender's computer may end up looking poorly formatted on a receiver's display. One solution is to convert output to PDF files using Adobe Acrobat. This allows unusual fonts to be embedded and all the margins to be set properly no matter what computer or screen resolution the receiving party has.

**VIDEO, AUDIO, AND ANIMATION.** Many of the tools and application packages you will be working with facilitate the inclusion of video in the output options. Video is a complex form of output, as it combines the strength and potential emotional impact of audio (including sound effects, voice, and music) with a visual channel. Some familiar applications are those that are Web-based. Examine Figure 11.3 to see a Web page that provides a series of six brief video clips of an actual event, the Decision Sciences Institute (DSI) Knowledge Bowl. Video output is useful here, because the event was held to commemorate an important anniversary in the organization's history.

There are many uses for including video output in your users' displays. Video clips make useful output for:

1. Supplementing static, printed output.
2. Enabling distance collaboration that connects people who do not often get to see each other. For example, this can be helpful for virtual project team members who must work together, but who do not typically meet face to face.
3. Showing how to perform an action, such as demonstrating how a form should be filled out, how software should be installed, or how a product should be assembled.
4. Providing brief training episodes that are job specific or task specific in order to emphasize a new or unfamiliar skill.
5. Shifting the time of an actual event by recording it for later output.
6. Preserving an important occasion for addition to an organization's archives.



**FIGURE 11.3**

Streaming video can be used effectively for telling a story or sharing an event. This Web page chronicles an event called the DSI Knowledge Bowl.

In a way, audio output can be thought of as the opposite of printed output. Audio output is transient, whereas the printed word is permanent. Audio output is usually output for the benefit of one user, whereas printed output is often widely distributed. Audio output is interpreted by the human ear as speech, although it is actually produced by discrete digital sounds that are then put together in such a way as to be perceived as continuous words. Telephone companies were among the first businesses to produce systems using audio output for customers.

Sound can also enhance a presentation. Public domain music and sound effects are readily available. Presentation packages such as Microsoft PowerPoint allow users to insert sound, music, and even videos. Sound files come in various formats, but some of the most common for PCs are MP3, .WMP (Windows Media Player), .aac (iTunes and iPhones), and .WAV files.

Audio output is being used to “staff” catalog toll-free phone numbers 24 hours a day, seven days a week. By using a digital phone, consumers can call the number and, in response to instructions via audio output, enter the item number, quantity, price, and their credit card number. Stores are capturing sales that would otherwise be missed, because hiring actual employees might be too expensive to justify offering a 24-hour phone number.

When using audio and telephone systems to enter data, be sure to provide proper user feedback, such as, “You have entered thirty three dollars. Press one if this is correct. Press two to change.” Audio input must be scripted into a well-designed and clear sequence. Keep audio instructions brief so that people remember the beginning segments.

Podcasting is the technique of putting downloadable voice files on the Web. These voice files may be used to inform customers about new products or the product of the week, to provide a walking tour of a city or other tourist destination, to deliver a newscast, and many other applications. Capability to download audio and video files has been available for some time on the Web, but podcasting uses a small RSS file (an XML file) to store the latest version of a podcast (if they are updated frequently).

Animation is another form of output that can be used to enhance a Web site or presentation. Animation is the presentation of different images in a series, one at a time. Animation images are composed of several basic elements. Elemental symbols can be abstract objects or real photos, and they can take on different colors, forms, and textures. Spatial orientation helps the user grasp whether symbols are closely related to one another. Transition effects are either gradual or abrupt, just as with PowerPoint slide transitions. Alteration effects include changing the color, size, or texture, and can also include transforming the image through morphing.

If animation is used to support decision making, experiments have shown that the use of realistic, rather than abstract, images results in better quality of decisions. Experimental subjects who viewed gradual, rather than abrupt, animated transitions made better decisions. When using animation on Web pages, use caution to keep sequences streamlined, and not busy.

**CD-ROMS AND DVDS.** With the demand for multimedia output growing, the display of material on CD-ROMs has become widespread. CD-ROMs are less vulnerable to damage from human handling than other output. CD-ROMs can include full-color text and graphics, as well as music and full-motion video, so as an output medium they provide a designer maximum creativity. The DVD (digital versatile disc) is also a useful output technology. Not only are DVDs used for output, but they also are used for backup storage.

**ELECTRONIC OUTPUT.** Many of the new Web-based systems you design will have the capability of sending electronic output in the form of email, faxes, and bulletin board messages that can be sent from one computer to another without the need for hard copy.

Email can be set up and run internally in the organization through an intranet, or set up through communication companies or online service providers. By designing email systems, you can support communication throughout the organization. A useful and flexible email system can form the basis of support for work groups.

Two newer groups of technologies that allow users to pull information from the Web and also allow organizations to send information to them periodically are being designed for organizations. These output technologies are called pull and push technologies, reflecting the way users and organizations look for information on the Web and either “pull” it in downloads or have it sent, or “pushed,” to them.

RSS (really simple syndication) feeds are XML documents that users can obtain from links on Web pages or to which they can subscribe. They contain a title, usually the same name as the Web



## CONSULTING OPPORTUNITY 11.1

### Your Cage or Mine?

“Why can’t they get this right? It’s driving me to distraction. The zoo in Colombia is writing to me about a tiger that has been on loan from our place since 2002. They should be writing to Tulsa,” trumpets Ella Fant, waving a letter in the air. Ella is general curator in charge of the animal breeding program at the Gotham Zoo.

She is talking with members of the zoo’s five-person committee about the proposals before them. The committee meets every month to decide which animals to loan to other zoos and which animals to get on loan so as to breed them. The committee is composed of Ella Fant, the general curator; Ty Garr, the zoo’s director; two zoo employees, Annie Malle and Mona Key; and a layperson, Rex Lyon, who is in business in the community.

Ty paces in front of the group and continues the meeting, saying, “We have the possibility of loaning out two of our golden tamarins, and we have the opportunity to play matchmaker for two lesser pandas. Because three of you are new to the committee, I’ll briefly discuss your responsibilities. As you know, Ella and I would pounce on any chance to lure animals in for the breeding program. Your duties are to assess the zoo’s financial resources and to look at our zoo’s immediate demands. You also must consider the season and our shipping capability, as well as that of the zoos we’re considering. The other zoos charge us nothing for the loan of their animals for the breeding program. We pay the shipping for any animal being loaned to us and then maintain them, and that gets expensive.”

“We are linked, via the Internet, to a database of selected species with 164 other zoos,” says Ella as she picks up the story from Ty. “My office has a computer equipped with a display. I can access the records of all captive animals in the system, including those from the two zoos we are negotiating with right now.”

As the committee members work, they begin asking questions. “I need to read some information, get some meat to sink my teeth into, before I’m ready to decide whether the loan of the lesser pan-

das is a good idea. Where are the data on the animals we’re considering?” growls Rex.

Annie replies, “We have to go to Ella’s office to get to it. Mostly, the other employees who need to know just use her computer.”

Mona gets into the swing of the discussion and says, “Some information on the current state of the budget would be divine, too. I’ll go bananas with new expenditures until we at least have a summary of what we’re spending. I bet it’s a bunch.”

Ty answers, “We don’t mean to monkey around, but frankly we feel trapped. Costs of reproducing all the financial data seem high to us. We’d rather put our money into reproducing rare and endangered species! Paperwork multiplies on its own.”

The group laughs nervously together, but there is an air of expectancy in the room. The consensus is that the committee members need more internal information about the zoo’s financial status and the prospective loan animals.

Ella, aware that the group cannot be tamed in the way the previous one was, says, “The old committee preferred to get their information informally, through chatting with us. Let’s spend this first meeting discovering what kinds of documents you think you need to do your work as a committee. Financial data are on a stand-alone PC that our financial director uses. It’s his baby, of course.”

What are some of the problems related to output that the committee is experiencing? What suggestions do you have for improving output to the committee? How can the budget constraints of the zoo be met while still allowing the committee to receive the output it needs to function? Comment on the adequacy of the output technology that is currently in use at the zoo. Suggest alternatives or modifications to output and output technology that would enhance what is being done. (*Hint:* Consider ways in which the committee can leverage its use of the Internet—say, more use of the Web—to get the output that it needs and that it needs to share.) Analyze both internal and external output requirements.

site of the RSS feed; a link, often the same link as the Web page; a short description; copyright; the language the text is written in, using a standard code such as en-us (for English—United States); pubDate (the published date); lastBuildDate (the date that the RSS feed was last modified); images; text; and other information. RSS feeds are usually marked on a Web page by white XML or RSS text on an orange button. Recently an orange square with three white lines depicting radio waves was introduced in Firefox as a secondary button symbol, and it is gaining in popularity.

RSS is supposed to be really simple. It is made up of a feed (also known as a channel), which has a title, link, and description, followed by a number of news items, each with its own title, link, and description. Although it is supposed to be simple, you should realize that there are over a half a dozen different versions of RSS and a similar syndication format called Atom. Developers can provide RSS feeds on their company’s Web site or develop them for clients.

The RSS feed is read using RSS reader software, often a free program. These readers, sometimes called news aggregators, are programs that track updates, download, categorize, and display RSS feeds. RSS is a way of gathering and distributing news and other content from multiple sources. RSS news readers can either stand alone or be integrated with your browser as plug-ins. At the time this book is being written, popular news readers are Bloglines, BottomFeeder, FeedDEMON, MY

MSN, My Yahoo!, NewsIsFree, NEWSMONSTER, Pluck, RSSBANDIT, SHARPREADER, and Wizz RSS (for Firefox browsers). Soon the market for RSS readers will shake out and only a few RSS readers will survive.

RSS has the advantage of efficiently organizing news and other information from a variety of sources chosen by the user. It is also timely, with the latest news displayed first. RSS is not limited to news but can be used to keep track of the latest revision of a book or manuscript, check new movie or theatre reviews, or gain early knowledge of new software for your mobile phone.

**PULL TECHNOLOGY.** An important output technology made possible by the Web is pull technology. If you have tried to pull information from the Web by clicking on links, you have used the most basic type of pull technology.

In the future, evolutionary agents (programmed using intelligent agent software) may be used to help organizational members find what they need on the Web. These agents will relieve some of the users' typical burden of searching the Web, because the agents will observe and understand users' behavior as they interact with a variety of material on the Web, and then can be programmed to seek out the information users want. In this way, Web searches will be more efficient and more effective for users.

**PUSH TECHNOLOGY.** Another type of output analysts design is Web and wireless content delivered via push technology. Push technology can be used for external communication to push (electronically send) solicited or unsolicited information to a customer or client. It can also be used within the organization to focus the immediate attention of an employee or a decision maker who is facing a critical deadline to critical items. The term *push technology* can be described as any content sent to users at specified times, from basic Webcasting to selective content delivery using sophisticated evolutionary filtering agents.

Many traditional as well as Internet-based businesses are experimenting with push technology. Push technology can get the information to the person who needs it. Broadcasting information to all employees is less expensive than printing out information and then distributing it to a select few. However, the analyst needs to guard against flooding employees with meaningless pushed information.

Push technologies are highly flexible. For example, when output is delivered over an intranet to a PC, the user is able to take it and customize it in many ways. An employee may decide to look at a single product or may want to generate a graph of sales over time.

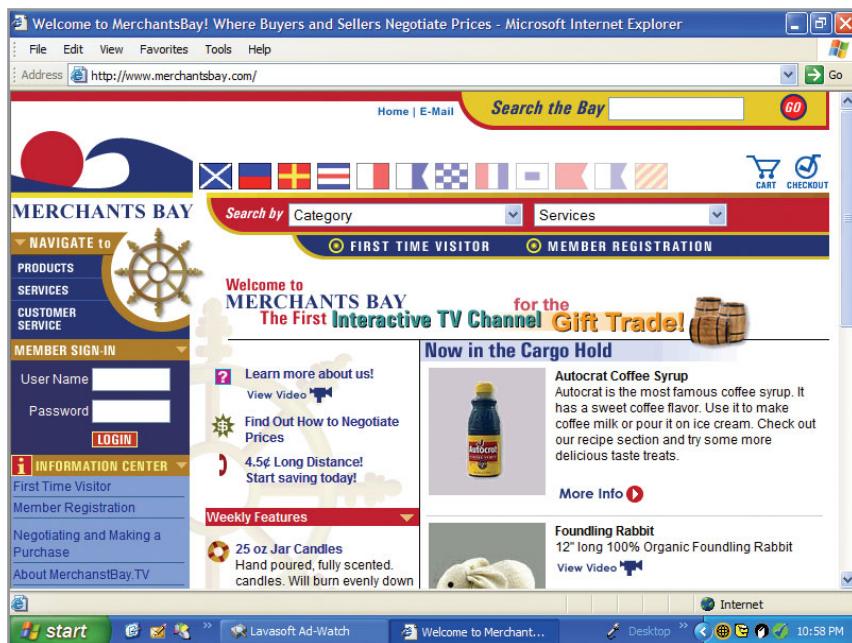
### Factors to Consider When Choosing Output Technology

There are several factors to consider when choosing output technology. Although the technology changes rapidly, certain usage factors remain fairly constant in relation to technological breakthroughs. These factors, some of which present trade-offs, must be considered. They include the following:

1. Who will use (see) the output (requisite quality)?
2. How many people need the output?
3. Where is the output needed (distribution, logistics)?
4. What is the purpose of the output? What user and organizational tasks are supported?
5. What is the speed with which output is needed?
6. How frequently will the output be accessed?
7. How long will (or must) the output be stored?
8. Under what special regulations is the output produced, stored, and distributed?
9. What are the initial and ongoing costs of maintenance and supplies?
10. What are the human and environmental requirements (accessibility, noise absorption, controlled temperature, space for equipment, cabling, and proximity to Wi-Fi transmitters or access points—i.e., hot spots) for output technologies?

Examining each factor separately will allow you to see the interrelationships and how they may be traded off for one another in a particular system.

**WHO WILL USE (SEE) THE OUTPUT?** Discovering who will use the output is important because job requirements help dictate what output method is appropriate. For example, when district managers must be away from their desks for extended periods, they need printed output that can



travel with them or technology that can access appropriate Web sites and databases as they visit the managers in their region. Screen output or interactive Web documents are excellent for people such as truck dispatchers who are deskbound for long periods.

External recipients of output (clients and customers, vendors and suppliers, shareholders, and regulatory agencies) and users within the business will require different output. Clients, vendors, and suppliers can be part of several extranets, which are networks of computers built by the organization, providing applications, processing, and information to users on the network.

Examine the Web site shown in Figure 11.4 for an ecommerce company called Merchants Bay. The Web designer is attuned to the intended users of the wholesale gift site. The ecommerce company's Web site is powered by a patented negotiating algorithm in which users submit bids (for 1 item or 400) on an array of merchandise. The company's strategy is based on the president's personal experience with flea markets and the observation that people are powerfully attracted to bargaining for a deal.

The Web site intentionally invokes a cluttered feel, similar to what one gets walking through a flea market. The site is intended for customers who would frequent flea markets in person: They are known to be collectors, gregarious and curious by nature. The Web site is a profusion of colors, includes a variety of sale signs in a mixture of lettering, and even incorporates a video that provides new layers of color and action. Colloquial language is used throughout the site.

Notice that the company's catchphrase is "purveyor of good stuff." The Web designer has carried out a nautical metaphor throughout the site. The user is invited to "search the Bay" for merchandise. In addition, the company's logo includes a wave and a sun on the horizon, and an icon of a ship's steering wheel is placed above a column that invites the user to "navigate" for products, services, and customer service.

To complete a transaction on the site, a customer has an opportunity to accept the "Captain's price" as posted or to submit a bid. If the bid submitted is too low according to the stored negotiation algorithm, a natural language response is returned in a pop-up window stating: "Thanks for your offer, mate. You don't like to part with your money if you don't have to, heh? Yet hey, I like ya, mate. Please try again by offering a better price or by ordering a larger quantity." In this way, the bid is rejected in a friendly, humorous way, and bidders are even given two hints on how to improve the chances that their next bids will be successful. The Web designer clearly had a solid profile of the intended customer in mind when designing the site.

**HOW MANY PEOPLE NEED THE OUTPUT?** Choice of output technology is also influenced by how many users need the output. If many people need output, Web-based documents with a print option or printed copies are probably justified. Some external customers may want a printed copy

## FIGURE 11.4

When designing a Web site, it is important to choose a metaphor that can be used throughout the site. This example from Merchants Bay ([www.merchantsbay.com](http://www.merchantsbay.com)) employs a nautical theme.

of specific documents, such as a stockholder report or a monthly billing statement, but others may prefer Web-based documents with an email notification. If only one user needs the output, a screen or audio may be more suitable.

If many users in the business need different output at different times for short periods and they need it quickly, Web documents or screens connected to online terminals that are able to access database contents are a viable option.

**WHERE IS THE OUTPUT NEEDED (DISTRIBUTION, LOGISTICS)?** The choice of output technology is also influenced by the physical destination of the output. Information that will remain close to its point of origin, that will be used by only a few users in the business, and that may be stored or referred to frequently can safely be printed or mounted on an intranet. An abundance of information that must be transmitted to users at great distances in branch operations may be better distributed electronically, via the Web or extranets, with the recipient customizing it.

Sometimes federal or state regulations dictate that a printed form remain on file at a particular location for a specified period of time. In those instances, it is the responsibility of the systems analyst to see that the regulation is observed for any output that is designed.

**WHAT IS THE PURPOSE OF THE OUTPUT?** What user and organizational tasks are supported? Consider the purpose of the output when choosing output technology. If it is intended to be a report created to attract shareholders to the business by allowing them to peruse corporate finances at their leisure, well-designed, printed output such as an annual report is desirable. A variety of media may also be used so that the annual report is available on the Web as well as in printed form.

If the purpose of the output is to provide instant updates on stock market quotes, and if the material is highly encoded and changeable, screen crawls, Web pages, or audio presentations are preferable. Output must support user tasks, such as performing analysis, or determining ratios, so software tools, including calculators and embedded formulae, could be part of output. It must also support organizational tasks such as tracking, scheduling, and monitoring.

**WHAT IS THE SPEED WITH WHICH OUTPUT IS NEEDED?** As we go through the three levels of strategic, middle, and operations management in the organization, we find that decision makers at the lowest level of operations management need output rapidly so that they can quickly adjust to events, such as a stopped assembly line, raw materials that have not arrived on time, or a worker who is absent unexpectedly. Online screen output may be useful here.

As we ascend the management levels, we observe that strategic managers are more in need of output for a specific time period, which helps in forecasting business cycles and trends.

**HOW FREQUENTLY WILL THE OUTPUT BE ACCESSED?** The more frequently output is accessed, the more important is the capability to view it on a display connected to local area networks or the Web. Infrequently accessed output that is needed by only a few users is well suited to a CD-ROM archive.

Output that is accessed frequently is a good candidate for incorporation into Web-based or other online systems or networks with displays. Adopting this type of technology allows users easy access and alleviates physical wear and tear that cause frequently handled printed output to deteriorate.

**HOW LONG WILL (OR MUST) THE OUTPUT BE STORED?** Output printed on paper deteriorates rapidly with age. Output preserved on microforms or digitized in archives is not as prone to succumb to environmental disturbances such as light, humidity, and human handling. However, if hardware to access the archived material becomes hard to acquire or obsolete, this output method can become problematic.

A business may be subject to governmental regulations on local, state, or federal levels that dictate how long output must be kept. As long as the corporation is willing to maintain it and it is nonproprietary, archival information, it can be maintained in Web documents as part of the organization's Web site. Organizations can enact their own internal policies about how long output must be retained.

**UNDER WHAT SPECIAL REGULATIONS IS THE OUTPUT PRODUCED, STORED, AND DISTRIBUTED?** The appropriate format for some output is actually regulated by the government. For example, in the United States, the statement of an employee's wages and tax withholding, called a W-2 form, must be printed; its final form cannot be a screen or microform output. Each business in each country exists within a different complex of regulations under which it produces output. To that extent, appropriate technology for some functions may be dictated by law.



## CONSULTING OPPORTUNITY 11.2

### A Right Way, a Wrong Way, and a Subway

**S**o far so good. Sure, there have been some complaints, but any new subway will have those. The ‘free ride’ gimmick has helped attract some people who never would have ridden otherwise. I think there are more people than ever before interested in riding the subway,” says Bart Rayl. “What we need is an accurate fix on what ridership has been so far so we can make some adjustments on our fare decisions and scheduling of trains.”

Rayl is an operations manager for S.W.I.F.T., the newly built subway for Western Ipswich and Fremont Transport that serves a major northeastern city in the United States. He is speaking with Benton Turnstile, who reports to him as operations supervisor of S.W.I.F.T. The subway system is in its first month of operation, offering limited lines. Marketing people have been giving away free rides on the subway to increase public awareness of S.W.I.F.T.

“I think that’s a good idea,” says Turnstile. “It’s not just a token effort. We’ll show them we’re really on the right track. I’ll get back to you with ridership information soon,” he says.

A month later, Rayl and Turnstile meet to compare the projected ridership with the new data. Turnstile proudly presents a two-inch-high stack of computer printouts to Rayl. Rayl looks a little surprised but proceeds to go through it with Turnstile. “What all is in here?” Rayl asks, fingering the top page of the stack hesitantly.

“Well,” says Turnstile, training his eyes on the printout, “it’s a list of all the tickets that were sold from the computerized machines. It tells us how many tickets were bought and what kinds of tickets were bought. The guys from Systems That Think, Inc., told me this report would be the most helpful for us, just like it was for the operations people in Buffalo and Pittsburgh,” says Turnstile, turning quickly to the next page.

“Maybe, but remember those subway systems began with really limited service. We’re bigger. And what about the sales from the three manned ticket booths in the Main Street Terminal?” asks Rayl.

“The clerks in the booth can get information summarizing ticket sales onscreen any time they want it, but it’s not included here. Remember that we projected that only 10 percent of our sales would be from the booths anyway. Let’s go with our original idea and add that to the printout,” suggests Turnstile.

Rayl replies, “But I’ve been observing riders. Half of them seem to be afraid of the automated ticket machines. Others start using them, get frustrated reading the directions, or don’t know what to do with the ticket that comes out, and they wind up at the ticket booth blowing off steam. Furthermore, they can’t understand the routine information posted on the kiosks, which is all in graphics. They wind up asking clerks what train goes where.” Rayl pushes the printout holding the ticket sales to one side of the conference table and says, “I don’t have much confidence in this report. I feel as if we’re sitting here trying to operate the most sophisticated subway system in the United States by peering down a tunnel instead of at the information, like we should be. I think we need to think seriously about capturing journey information on magnetically stripped cards like the New York Transit Authority is doing. Every time you insert the card to take a ride, the information is stored.”

What are some of the specific problems with the output that the systems consultants and Benton Turnstile gave to Bart Rayl? Evaluate the media that are being used for output as well as the timing of its distribution. Comment on the external output that users of the automated ticket machines are apparently receiving. Suggest some changes in output to help Rayl get the information he needs to make decisions on fares and scheduling of trains, and to help users of the subway system get the information they need. What are some decisions facing organizations like the New York Transit Authority if they collect and store input concerning an individual’s destinations each time a trip is taken? What changes would S.W.I.F.T. have to make to its output and its tickets if it adopted this technology?

Much of this regulation, however, is industry-dependent. For example, in the United States a regional blood system is required by federal law to keep a medical history of a blood donor—as well as his or her name—on file. The exact output form is not specified, but the content is strictly spelled out.

**WHAT ARE THE INITIAL AND ONGOING COSTS OF MAINTENANCE AND SUPPLIES?** The initial costs of purchasing or leasing equipment must be considered as yet another factor that enters into the choice of output technology. Most vendors will help you estimate the initial purchase or lease costs of computer hardware, including the cost of printers and displays, the cost of access to online service providers (Internet access), or the costs of building intranets and extranets. Many vendors, however, do not provide information about how much it costs to keep a printer or other technologies working. Therefore, it falls to the analyst to research the costs of operating different output technologies or of maintaining a corporate Web site over time.

**WHAT ARE THE HUMAN ENVIRONMENTAL REQUIREMENTS FOR OUTPUT TECHNOLOGIES?** Analysts need to factor into their output decisions accessibility, noise absorption, controlled temperature, space for equipment, cabling, and proximity to Wi-Fi transmitters or access points called “hot spots.” When humans interact with technologies, specific environments help systems run more effectively and efficiently. Users need accessibility and support in accessing Web pages as well as other output.

Printers require a dry, cool environment to operate properly. Displays require space for setup and viewing. Audio and video output require a quiet environment if they are to be heard, and they should be audible only to employees (or customers) who are using them. Thus, the analyst should not specify audio output for a work situation in which many employees or customers are engaged in a variety of tasks unrelated to the output.

In order to set up wireless local area networks so users can access the Web wirelessly, Wi-Fi access points need to be made available. These work when PCs are within a few hundred feet of transmitters, but can be subject to interference by other devices.

Some output technologies are prized for their unobtrusiveness. Libraries, which emphasize silence in the workplace, make extensive use of displays for Web documents and other networked database information, but printers might be scarce.

## REALIZING HOW OUTPUT BIAS AFFECTS USERS

Output is not just a neutral product that is subsequently analyzed and acted on by decision makers. Output affects users in many different ways. Systems analysts must put great thought and care into designing the output so as to avoid biasing it.

### Recognizing Bias in the Way Output Is Used

It is a common error to assume that once the systems analyst has signed off on a system project, his or her impact is ended. Actually, the analyst's influence is long-lasting. Much of the information on which organizational members base their decisions is determined by what analysts perceive is important to the business.

Bias is present in everything that humans create. This statement is not to judge bias as bad, but to make the point that it is inseparable from what we (and consequently our systems) produce. The concerns of systems analysts are to avoid unnecessarily biasing output and to make users aware of the possible biases in the output they receive.

Presentations of output are unintentionally biased in three main ways:

1. How information is sorted.
2. Setting of acceptable limits.
3. Choice of graphics.

**INTRODUCING BIAS WHEN INFORMATION IS SORTED.** Bias is introduced to output when the analyst and users make choices about how information is sorted for a report. Common sorts include alphabetical, chronological, and cost.

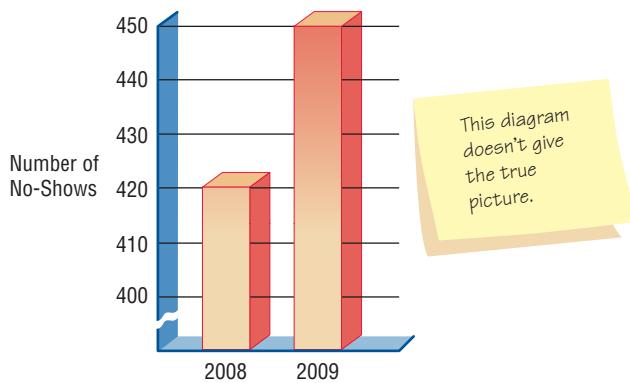
Information presented alphabetically may overemphasize the items that begin with the letters A and B, because users tend to pay more attention to information presented first. For example, if past suppliers are listed alphabetically, companies such as Aardvark Printers, Advent Supplies, and Barkley Office Equipment are shown to the purchasing manager first. When certain airlines created the SABRE and APOLLO reservations systems, they listed their own flights first, until the other airlines complained that this type of sorting was biased.

**INTRODUCING BIAS BY SETTING LIMITS.** A second major source of bias in output is the predefinition of limits for particular values being reported. Many reports are generated on an exception basis only, which means that when limits on values are set beforehand, only exceptions to those values will be output. Exception reports make the decision maker aware of deviations from satisfactory values.

For example, limits that are set too low for exception reports can bias the user's perception. An insurance company that generates exception reports on all accounts one week overdue has set too low a limit on overdue payments. The decision maker receiving the output will be overwhelmed with "exceptions" that are not really cause for concern. The one-week overdue exception report leads to the user's misperception that there are a great many overdue accounts. A more appropriate limit for generating an exception report would be accounts 30 days or more overdue.

**INTRODUCING BIAS THROUGH GRAPHICS.** Output is subject to a third type of presentation bias, which is brought about by the analyst's (or users') choice of graphics for output display. Bias can occur in the selection of the graph size, its color, the scale used, and even the type of graphic.

Graph size must be proportional so that the user is not biased as to the importance of the variables that are presented. For example, Figure 11.5 shows a column chart comparing the number

**FIGURE 11.5**

A misleading graph will most likely bias the user.

of no-shows for hotel bookings in 2008 with no-shows for hotel bookings in 2009. Notice that the vertical axis is broken, and it appears that the number of no-shows for 2008 is twice as much as the number of no-shows in 2009, although the number of no-shows has actually gone up only slightly.

### Avoiding Bias in the Design of Output

Systems analysts can use specific strategies to avoid biasing the output they and others design:

1. Be aware of the sources of bias.
2. Create an interactive design of output during prototyping that includes users and a variety of differently configured systems when testing the appearance of Web documents.
3. Work with users so that they are informed of the output's biases and can recognize the implications of customizing their displays.
4. Create output that is flexible and that allows users to modify limits and ranges.
5. Train users to rely on multiple outputs for conducting "reality tests" on system output.

All these strategies (except the first) focus on the relationship between the systems analyst and the user as it involves output. Systems analysts first need to recognize the potential impact of output and be aware of the possible ways in which output is unintentionally biased. They then need to be proactive in helping users design output with minimal, but identifiable, biases.

### Designing Printed Output

The source of information to be included in reports is the data dictionary, the compilation of which was covered in Chapter 8. Recall that the data dictionary includes names of data elements as well as the required field length of each entry.

Reports fall into three categories: detailed, exception, and summary. Detailed reports print a report line for every record on the master file. They are used for mailing to customers, sending student grade reports, printing catalogs, and so on. Inquiry screens have replaced many detailed reports.

Exception reports print a line for all records that match a set of conditions, such as which holiday decorations will be discounted the day after the holiday or which students are on the dean's list. They are usually used to help operational managers and clerical staff run a business. Summary reports print one line for a group of records and are used to make decisions, such as which items are not selling and which are hot selling.

### Guidelines for Printed Report Design

Figure 11.6 is an output report that is intended for divisional managers of a food wholesaler that supplies a number of franchise grocery stores. We will focus on different aspects of the report as we cover the tools, conventions, and functional and stylistic design attributes of printed output reports.

**REPORT DESIGN CONVENTIONS.** Conventions to follow when designing a form include the type of data (alphabetic, special, or numeric) that will appear in each position, showing the size of the form being prepared, and showing the way to indicate a continuation of data on consecutive layout forms. Most form design software that analysts now use features standard conventions for designing forms onscreen. In addition, it features familiar drag-and-drop interfaces that allow you to select attributes such as an address block with a mouse click and then drop it on the screen



## CONSULTING OPPORTUNITY 11.3

### Should This Chart Be Barred?

**G**ee, I'm glad they hired you guys. I know the Redwings will be better next season because of you. My job'll be a lot easier, too," says Andy Skors, ticket manager for the Kitchener, Ontario, hockey team, the Kitchener Redwings. Andy has been working with your systems analysis team on analyzing the systems requirements for computerizing ticket sales.

Recall that when we last heard from the systems analysis team, consisting of Hy Sticking (your leader), Rip Shinpadd, Fiona Wrink, and you, you were wrestling with whether to expedite the project and set team productivity goals (in "Goal Tending," Consulting Opportunity 3.5).

Andy is talking with the team about what to include in the systems proposal to make it as persuasive as possible to the Redwings' management. "I know they're going to like this chart," Andy continues. "It's a little something I drew up after you asked me all those questions on past ticket sales, Rip."

Andy hands the bar chart to Rip, who looks at it and suppresses a slight smile. "As long as we have you here, Andy, why don't you explain it to us?"

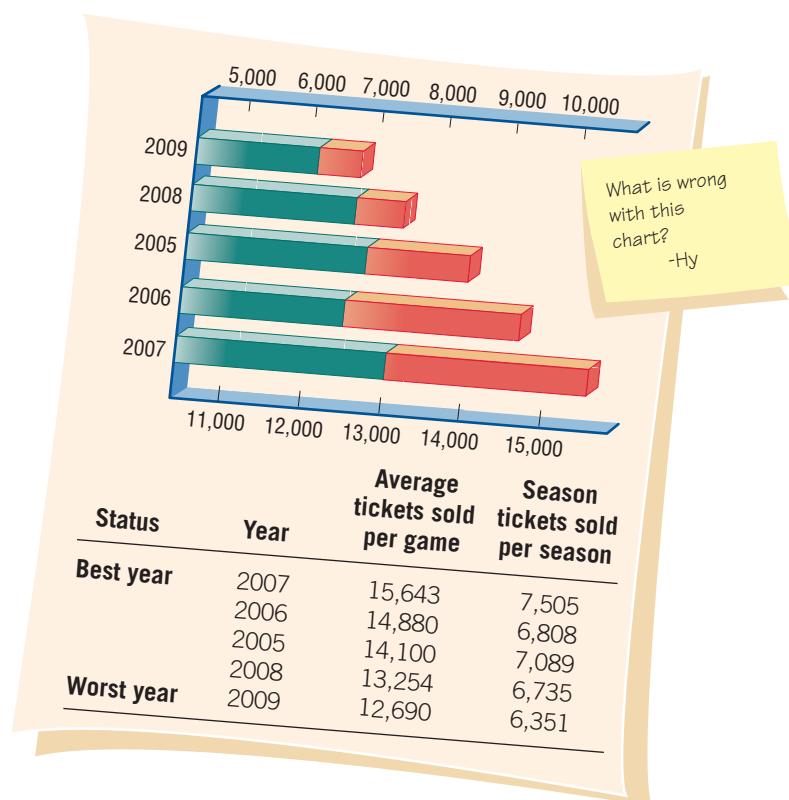
Like a player fresh out of the penalty box, Andy skates smoothly into his narrative of the graph. "Well, our ticket sales

reached an all-time high in 2007. We were real crowd pleasers that year. Could've sold seats on the scoreboard if they let me. Unfortunately, ticket sales were at an all-time low in 2009. I mean, we're talking about a disaster. Tickets moved slower than a glacier. I had to convince the players to give tickets away when they made appearances at the shopping mall. Why, just look at this table, it's terrible.

"I think computerizing the ticket sales will help us pick out who our season supporters are. We've got to figure out who they are and get them back. Get them to stick with us. That would be a good goal to shoot for," Andy concludes.

As Andy's presentation finally winds down, Hy looks as if he thought the 20-minute period would never end. Picking up on his signal, Fiona says, "Thanks for the data, Andy. We'll work on getting them into the report somehow."

As Fiona and Rip head out of the room with Andy, Hy realizes the bench has emptied, so he asks you, the fourth team member, to coach Andy on his bar chart by making a list of the problems you see in it. Hy would also like you to sketch some alternative ways to graph the data on ticket sales so that a correct and persuasive graph of ticket sales can be included in the systems proposal. Draw two alternatives.



**FIGURE 11.C1**

An incorrectly drawn graph.

## FIGURE 11.6

A printed output report for divisional managers of a food wholesaler.

where you want to position it on your form. You will be using WYSIWYG (what you see is what you get) so it makes the design of forms a very visual exercise.

*Constant information* is information that remains the same whenever the report is printed. The title of the report and all the column headings are written as constant information. *Variable information* is information that can vary each time the report is printed out. In our example, the sales figures in thousands of dollars will change; hence, they are indicated as variable information.

**PAPER QUALITY, TYPE, AND SIZE.** Output can be printed on innumerable kinds of paper. The overriding constraint is usually cost. One example is the use of security paper for checks and check envelopes, as well as for documents that must bear official, inalterable seals or holograms, such as passports.

Preprinted forms can easily convey a distinctive corporate image through the use of corporate colors, logos, and other design elements. Using innovative shapes, colors, and layouts is also a dramatic way of drawing users' attention to the report contained on the preprinted form.

**DESIGN CONSIDERATIONS.** In designing the printed report, the systems analyst works with users to incorporate both functional and stylistic or aesthetic considerations so that the report supplies the user with necessary information in a readable and pleasing format. Because function and form reinforce each other, one should not be emphasized at the expense of the other.

**Functional Attributes** The functional attributes of a printed report include (1) the heading or title of the report, (2) the page number, (3) the date of preparation, (4) the column headings, (5) the grouping of related data items together, and (6) the use of control breaks. Each of these serves a distinctive purpose for the user.

There are several stylistic or aesthetic considerations for the systems analyst to observe when designing a printed report. If printed output is unappealing and difficult to read, it will not be used effectively or may not be used at all. The upshot is uninformed decision makers and a waste of organizational resources.

Printed reports should be well organized, reflecting the way that the eye sees. In this culture, that means that the report should read from top to bottom and left to right. Related data items should be grouped together. The aesthetics of Web site and Web page design are covered in an upcoming section of this chapter.

## DESIGNING OUTPUT FOR DISPLAYS

Chapter 12 covers designing displays for human or computer input, and the same guidelines also apply here for designing output, although the contents will change. Notice that output for displays differs from printed output in a number of ways. It is ephemeral (that is, a display is not permanent in the same way that printouts are), it can be more specifically targeted to the user, it is available on a more flexible schedule, it is *not* portable in the same way, and sometimes it can be changed through direct interaction.

In addition, users must be instructed on which keys to press, links to click, or how to scroll when they want to continue reading additional displays, when they want to know how to end the display, and when they want to know how to interact with the display (if possible). User access to displays may be controlled through a password, whereas distribution of printed output is controlled by other means.

### Guidelines for Display Design

Four guidelines facilitate the design of displays:

1. Keep the display simple.
2. Keep the presentation consistent.
3. Facilitate user movement among displayed output.
4. Create an attractive and pleasing display.

Just as with printed output, good displays are not created in isolation. Systems analysts need the feedback of users to design worthwhile displays. Once approved by users after successive prototypes and refinements, the display layout can be finalized.

The output produced from the design display is pictured in Figure 11.7. Notice that it is uncluttered, but it still gives a basic summary of the shipping status. The display orients users as to what they are looking at with the use of a heading. Instructions at the bottom of the display pro-

**FIGURE 11.7**

The New Zoo output display screen is uncluttered and orients users well.

New Zoo Order Status			
Retailer	Order #	Order Date	Order Status
Animals Unlimited	933401	09/05/2009	Shipped On 09/29
	934567	09/11/2009	Shipped On 09/21
	934613	09/13/2009	Shipped On 09/21
	934691	09/14/2009	Shipped On 09/21
Bear Bizarre	933603	09/02/2009	Partially Shipped
	933668	09/08/2009	Scheduled For 10/03
	934552	09/18/2009	Scheduled For 10/03
	934683	09/18/2009	Shipped On 09/28
Cuddles Co.	933414	09/12/2009	Shipped On 09/18
	933422	09/14/2009	Shipped On 09/21
	934339	09/16/2009	Shipped On 09/26
	934387	09/18/2009	Shipped On 09/21
Stuffed Stuff	934476	09/25/2009	Backordered
	934341	09/14/2009	Shipped On 09/26
	934591	09/18/2009	Partially Shipped
	934633	09/26/2009	Backordered
	934664	09/29/2009	Partially Shipped

Press any key to see the rest of the list; ESC to end; ? for help  
For more detail place cursor over the order number and hit the Enter key.

vide users with several options, including continuing the present display, ending the display, getting help, or getting more detail. This display provides context for users attempting to complete a task such as checking on the status of an order.

Output displays in an application should show information consistently from page to page. Figure 11.8 shows the display that results when the user positions the cursor over the order number for a particular retailer. The new display presents more details on Bear Bizarre. In the body of the display, the user can see the retailer's order number, complete address, the order date, and the status. In addition, a detailed breakdown of the shipment and a detailed status of each part of the shipment are given. A contact name and phone number are supplied, along with the account balance, credit rating, and shipment history. Notice that the bottom portion of the display advises the user of options, including more details, ending the display, or getting help. Users are provided control over what they might do next while viewing the display.

Rather than crowding all retailer information onto one page, the analyst has made it possible for the user to bring up a particular retailer if a problem or question arises. If, for example, the summary indicates that an order was only partially shipped, the user can check further on the order by calling up a detailed retailer display and then following up with appropriate action.

### Using Graphical Output in Screen Design

Graphical output can be powerful. It is much easier to identify a trend or notice a pattern when the right graph is displayed. Most people notice differences in graphs more easily than they notice differences in tables. It is important to collaborate with users in choosing the correct style of graph to communicate your meaning.

As with the presentation of tabular output, graphical output needs to be accurate and easy to understand and use if it is to be effective in communicating information to users. Decision makers using the graphs need to know the assumptions (biases) under which the graphs are being constructed so that they can adjust to or compensate for them.

In designing graphical output, the systems analyst and any users involved in design prototyping must determine (1) the purpose of the graph, (2) the kind of data that need to be displayed, (3) its audience, and (4) the effects on the audience of different kinds of graphical output. In the instance of a decision support system, the purposes of graphical displays are to support any of the three phases of problem solving a user experiences: intelligence, design, or choice. An example from the Nebraska State Patrol workforce planning DSS is shown in Figure 11.9. Here, current response times, forecasted response times, and minimum requirements are graphed as differently shaded bars.

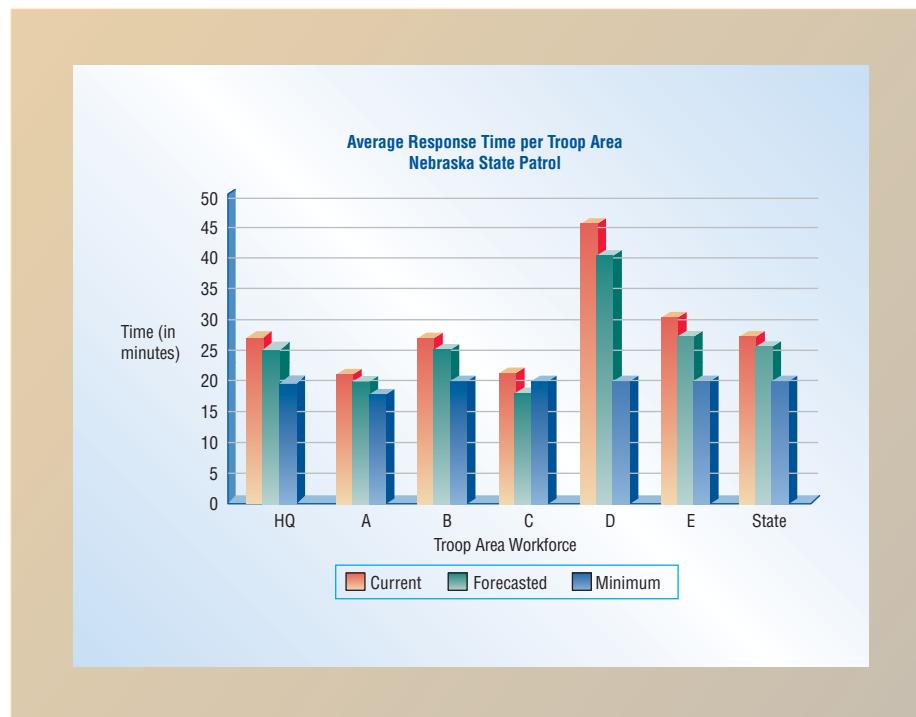


**FIGURE 11.8**

If users want more details regarding the shipping status, they can call up a separate screen.

**FIGURE 11.9**

A bar chart display for onscreen inspection of troop time response.



## Dashboards

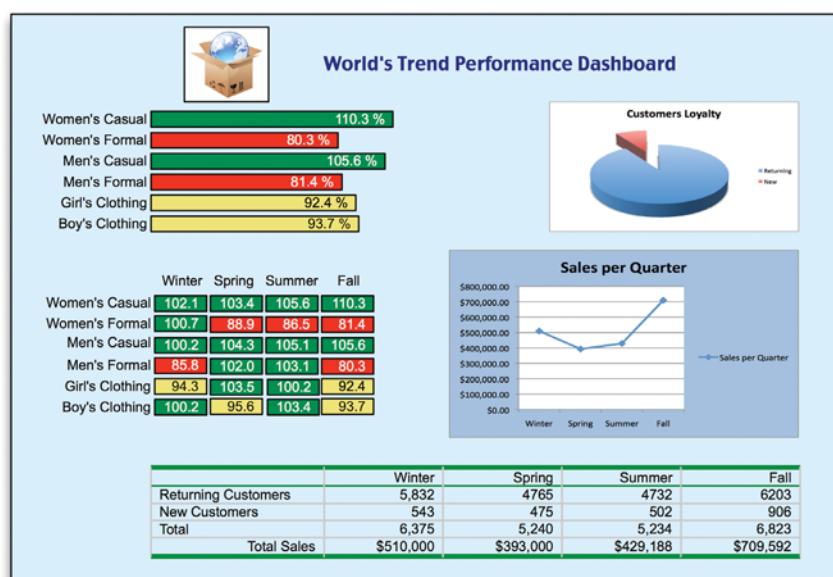
Decision makers need output that helps them make decisions effectively and quickly. It helps executives and other decision makers if all the information they need to make decisions is displayed in front of them. When given a written report, a decision maker would prefer all the information to be contained in that one report rather than searching for information in other places. The same principle applies to screen design.

A dashboard, similar to the dashboard in a car, has many different gauges. Each gauge can display a graph (similar to the speed in miles or kilometers per hour), a problem light (similar to a light showing that the automatic braking system is not functioning), or even text (like an odometer that simply counts the miles traveled).

An executive can find a dashboard to be extremely useful in making decisions, but only if the dashboard is designed properly. The dashboard in Figure 11.10 shows that a considerable amount of information can be included on a single screen.

**FIGURE 11.10**

This dashboard has a variety of displays depicting performance measurements to help make decisions.



Dashboards are all about communicating measurements to the user. An executive uses a dashboard to review performance measures and to take action if the information on the screen calls for it. Here are some rules of thumb that can be used to make the dashboard you design more attractive and more effective:

1. Make sure the data have context. If you design a screen stating that sales last month were \$851,235, what does that mean? Are sales above or below average?
2. Display the proper amount of summarization and precision. It will clutter the screen if you display last month's sales as \$851,235.32 instead of \$851,235 or even \$851K.
3. Choose appropriate performance measures for display. For example, plotting the difference in actual versus expected sales in a deviation chart is much more meaningful than using a line chart to plot actual and expected sales.
4. Present data fairly. If you introduce bias into the dashboard, it will hinder rather than support good decisions.
5. Choose the correct style of graph or chart for display. Using the correct chart is important. While a pie chart may be an excellent graph to persuade someone, it may not be a good way for an executive to monitor the performance of regional offices, for example.
6. Use well-designed display media. Even if you choose the very best type of graph, you still need to draw, size, color, and label the graph in a meaningful and pleasing way.
7. Limit the variety of item types. Keep the number of graph, chart, and table styles to a minimum so that the information can be communicated quickly and accurately.
8. Highlight important data. Use bright colors and bold fonts only for important data. You can highlight key performance measures or important exceptions that are occurring but not both. Choose what to emphasize.
9. Arrange the data in meaningful groups. Performance measures are almost always associated with other performance measures because of the data displayed or the type of graph. Learn how to group associated items together.
10. Keep the screen uncluttered. Avoid photographs, ornate logos, or themes that can distract users from the data.
11. Keep the entire dashboard on a single screen. All the performance measures are meant to be on the same screen. If forced to switch screens, a user will not see two relevant measures at the same time.
12. Allow flexibility. If an executive wants a different graph or chart, consider replacing it. Prototyping the dashboard and refining it based on the user's feedback makes sense. Decision makers often know best when it comes to getting the right information in the most appropriate form for their decision style.

### Widgets and Gadgets—Changing the Desktop Metaphor

Related to dashboards are new, user-designed desktops. Systems designers who develop software for personal computers should be aware of a trend to encourage users to personalize their desktops with widgets and gadgets. These items are small programs, usually written in JavaScript and VBScript, that reside either in a sidebar attached to a browser or program or even reside in a special layer on the desktop itself.

Widgets (as they are called by Yahoo!), Dashboard Widgets (as they are called by Apple), and Gadgets (as they are called by Google and Microsoft) can be any type of program that may be useful to anyone interacting with a computer. Clocks, calculators, bookmark helpers, translators, search engines, easy access to utilities, quick launch panels, and sticky notes are popular productivity widgets.

Stock tickers, weather reports, and RSS feeds are also useful widgets. Gadgets allow users to track packages and check schedules. The user can put amusements like games, music podcasts, and hobbies on their desktop as well. Widgets and gadgets possess dual, almost paradoxical natures. They can empower users to take part in the design of their own desktop, and designers who are observant can learn a lot about what users prefer when they study user-designed desktops. But widgets and gadgets can also distract people from system-supported tasks. Designers need to work with users to support them in achieving a balance. One possibility is to add user-specific performance measures as widgets and gadgets that are helpful to decision makers.



## CONSULTING OPPORTUNITY 11.4

### Is Your Work a Grind?

**I**want everything I can get my hands on, and the tighter the information is packed, the better. Forget that stuff you hear about information overload. It's not in my vocabulary. I want it all, and not in a bunch of pretty-looking, half-page reports either. I want it all together, packed on one sheet that I can take into a meeting in case I need to look something up. And I need it every week," proclaims Stephen Links, vice president of a large, family-owned sausage company.

During an interview, Links has been grilling Paul Plishka, who is part of the systems analysis team that is busy designing an information system for Links Meats. Although Paul is hesitant about what Links has told him, he proceeds to design a printed report that includes all the important items the team has settled on during the analysis phase.

When a prototype of the new report, designed to his specifications, is handed to Stephen, however, there appears to be a change of heart. Links says in no uncertain terms that he can't find what he needs.

"This stuff looks terrible. It looks like scraps. My kindergarten makes better reports in crayon. Look at it. It's all ground up together. I can't find anything. Where's the summary of the number of beef items sold in each outlet? Where is the total volume of items sold for *all* outlets? How about the information on our own shop downtown?" says Links, slicing at the report.

The report clearly needs to be redesigned. Design a report (or reports) that better suits Stephen Links. What approach can the analyst take in suggesting more reports with a less-crowded format? Comment on the difficulty of implementing user suggestions that go against your design training. What are the trade-offs involved (as far as information overload goes) in generating numerous reports as opposed to generating one large report containing all the information Stephen wants? Devise a heuristic concerning the display of report information on one report in contrast to the generation of numerous reports. Consider advocating a Web-based or dashboard solution that would permit hyperlinks to all the information Stephen desires. How feasible is that?

## DESIGNING A WEB SITE

You can borrow some of the design principles from designing displays when you design a Web site. Remember, though, that the key word here is *site*. The first documents displayed on the Internet using the http protocol were called home pages, but it became apparent very quickly that companies, universities, governments, and people were not going to be displaying just one page. The term *Web site* replaced *home page*, indicating that the array of pages would have to be organized, coordinated, designed, developed, and maintained in an orderly process.

Printing is a highly controlled medium, and the analyst has a very good idea of what the output will look like. GUI and character-based (CHUI, character-based user interface) screens are also highly controlled. The Web, however, is a very uncontrolled environment for output.

Different browsers display images differently, and screen resolution has a large impact on the look and feel of a Web site. The standard resolutions are  $1024 \times 768$  pixels or  $1600 \times 1200$  pixels. The issue is further complicated by the use of handheld devices, such as mobile phones, that are used to browse the Web. The complexity deepens when you realize that each person may set a browser to use different fonts and may disable the use of JavaScript, cookies, and other Web programming elements. Analysts and users face many decisions when designing a Web site.

In addition to the general design elements discussed earlier in this chapter, there are specific guidelines appropriate for the design of professional-quality Web sites. Web terms are defined in Figure 11.11.

### General Guidelines for Designing Web Sites

There are many tools as well as examples that can guide you in designing Web sites.

**USE PROFESSIONAL TOOLS.** Use software called a Web editor such as Adobe Dreamweaver or Microsoft Expression Web. These tools are definitely worth the price. You will be more creative and you'll get the Web site finished much faster than working directly with HTML (hypertext markup language).

Web Term	Meaning
Ajax	A method using JavaScript and XML to dynamically change Web pages without displaying a new page by obtaining small amounts of data from the server.
CSS	Cascading style sheets, a set of styles that control the formatting of a Web page. CSS may be stored in a file and used to format a number of Web pages, or may be defined within a Web page.
DHTML	Dynamic HTML, a way of combining JavaScript and perhaps cascading style sheets to have the Web page change with user actions.
FAQ	Frequently Asked Questions. Web sites often have a page devoted to these so that the company sales force or tech support is not inundated with the same questions over and over again and users can have 24-hour access to answers.
FTP	File transfer protocol, currently the most common way to move files between computer systems.
GIF	Graphic interchange format, a popular compressed image format best suited for artwork.
Java	An object-oriented language that allows dynamic applications to be run on the Internet. Nonprogrammers can use software packages such as Symantec's Visual Café for Java.
JPEG	Joint Photographic Expert Group, the acronym for a popular compressed image format best suited for photographs, whose quality can be adjusted by the designer.
HTML	Hypertext markup language, the language behind the appearance of documents on the Web. It is actually a set of conventions that mark the portions of a document, telling a browser what distinctive format should appear on each portion of a page.
http://	Hypertext transfer protocol, used to move Web pages between computers, such as from a Web site on a computer in another country to your personal computer.
PHP	An open source programming language, often used with MySQL, a database management system.
plug-ins	Additional software (often developed by a third party) that can be used with another program; for example, RealNetworks' Real Player or Macromedia Flash are used as plug-ins in Web browsers to play streaming audio or video and view vector-based animation.
URL	Uniform resource locator, the address of a document or program on the Internet. Familiar extensions are .com for commercial, .edu for educational institution, .gov for government, .org for organization, and so on.
VB .NET	Visual Basic .NET, a Microsoft programming environment.
Webmaster	The person responsible for maintaining the Web site.
WMP	Windows media photo, a Microsoft-developed alternative to JPEG.

**FIGURE 11.11**

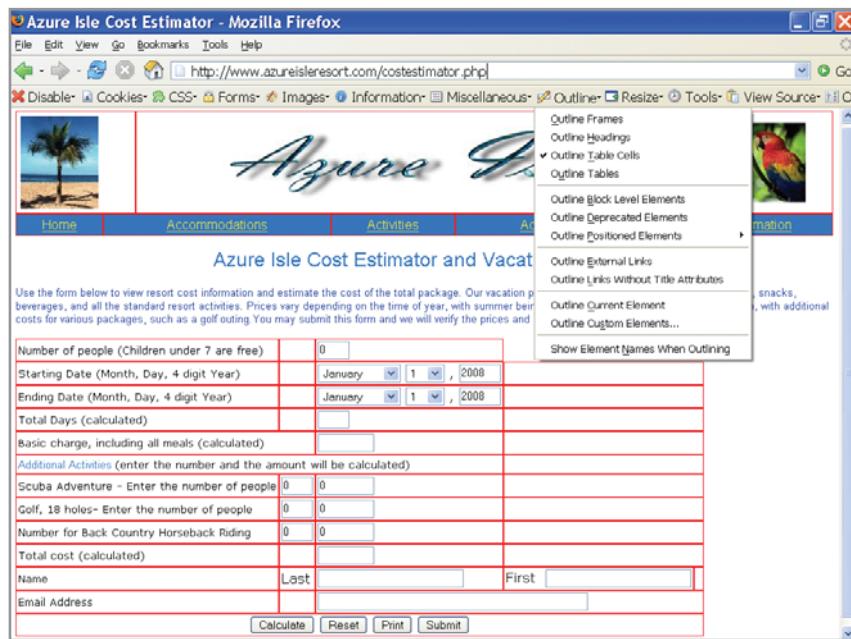
Web vocabulary terms.

**STUDY OTHER WEB SITES.** Look at Web sites you and other users think are engaging. Analyze what design elements are being used and see how they are functioning, then try to emulate what you see by creating prototype pages. (It is not ethical or legal to cut and paste pictures or code, but you still can learn from the other sites.)

Firefox, which is part of the open source software movement, is a useful browser for studying other Web sites. It has a number of extensions created by third-party developers that are available as free downloads. Run Firefox and click “Tools/Extensions” and “Get More Extensions.” There are pages of extensions, but one called Web Developer is very useful to designers and Webmasters. It allows the analyst to outline tables and styles and to view JavaScript and cookies; it provides form information as well as a wealth of other useful items from which to choose. Palette Grabber is another extension that allows Web developers to see a display of color codes just by picking any color on a Web site. There are also tools for working with XML. Figure 11.12 is an example of the Web Developer toolbar used to highlight table cells. Notice the red border around each individual cell.

**FIGURE 11.12**

A Web developer can outline table cells when designing a Web page, as shown in this example.



**USE THE RESOURCES THAT THE WEB HAS TO OFFER.** Look at Web sites that give hints on design. One such site is [useit.com](http://useit.com).

**EXAMINE THE WEB SITES OF PROFESSIONAL DESIGNERS.** As you look at professionally designed pages, ask yourself, "What works? What doesn't work? In what ways can users interact with the site?" For example, does the site have hot links to email addresses, interactive forms to fill in, consumer surveys, games, quizzes, chat rooms, and so on? What about color schemes and pervasive metaphors?

**USE THE TOOLS YOU'VE LEARNED.** Figure 11.13 provides a form that has been used successfully by Web designers to evaluate Web pages systematically. You might want to use copies of the form

**FIGURE 11.13**

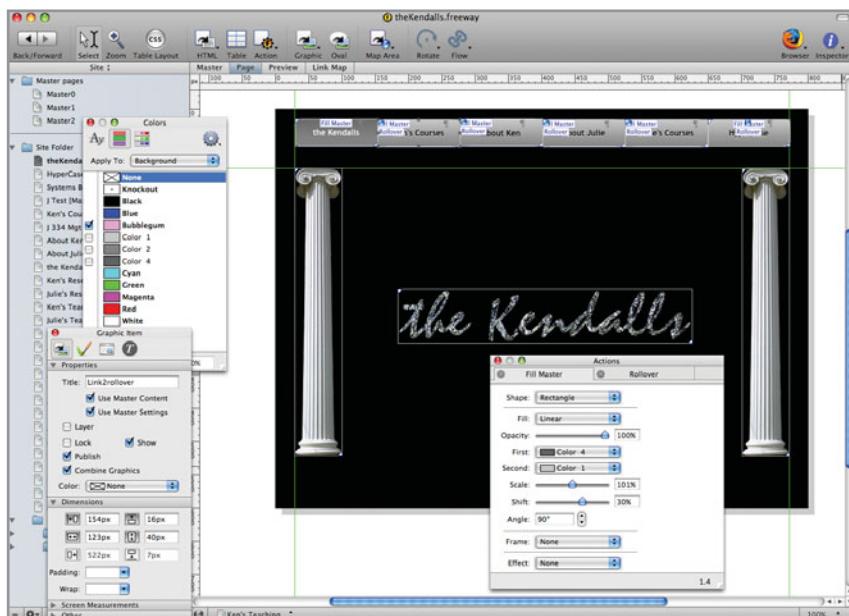
A Web site evaluation form.

Web Site Critique					
Date Visited:	/	/	Analyst's Name		
Time Visited:					
<b>DESIGN</b>					
Overall Appearance	1	2	3	4	Excellent
Use of Graphics	1	2	3	4	5
Use of Color	1	2	3	4	5
Use of Sound/Video (Multimedia)	1	2	3	4	5
Use of New Technology and Products	1	2	3	4	5
<b>CONTENT &amp; INTERACTIVITY</b>					
Content	1	2	3	4	5
Navigability	1	2	3	4	5
Site Management and Communications	1	2	3	4	5
<b>SCORE</b>			/40		
COMMENTS:					



There are many different approaches to creating Web sites. Coders want as much control over the HTML code as possible, but many designers aren't really that interested in tweaking the code. Good designers want to be able to include many different items in both graphics and text, rotate and enhance images, format them in carefully thought-out designs, and make them appear just right in any browser and in any resolution. There are many WYSIWYG packages available that allow designers to do this, both on a Mac and a PC. Some of these packages work well, but others don't.

Softpress Systems, the developers of Freeway Pro, have created Web design software that has a different approach. Unlike other software, Freeway Pro does not create code while a designer works. Once a designer is pleased with their design, then Freeway Pro generates the code. In this way, the code is extremely efficient. This is also a highly useful tool for prototyping. Freeway Pro assumes that when standards change, updates to the software will allow Web designers to simply republish the entire site using the updated standard.



**FIGURE 11.MAC**

Freeway Pro, from Softpress Systems, uses a unique approach for Web site designers.

to help you compare and contrast the many Web sites you will visit as you go about learning Web page design.

**CONSULT THE BOOKS.** Something that can add to your expertise in this new field is to read about Web design. Some books on Web site design are:

Eckerson, W. W. *Performance Dashboards: Measuring, Monitoring, and Managing Your Business*. New York: John Wiley & Sons, Inc., 2005.

Few, S. *Information Dashboard Design: The Effective Visual Communication of Data*. Sebastopol, CA: O'Reilly Media, Incorporated, 2006.

Flanders, V., and D. Peters. *Son of Web Pages That Suck: Learn Good Design by Looking at Bad Design*. Alameda, CA: Sybex, 2002.

McNeil, P. *The Web Designer's Idea Book: The Ultimate Guide to Themes, Trends & Styles in Website Design*. New York: F+W Media, 2008.

**LOOK AT SOME POOR EXAMPLES OF WEB PAGES, TOO.** Critique poor Web pages and remember to avoid those mistakes. Examine the Web site found at [www.webpagesthatsuck.com](http://www.webpagesthatsuck.com). Despite its “counterculture” name, this is a wonderful site that provides links to many poorly designed sites, and points out the errors that designers have made on them.

**CREATE TEMPLATES OF YOUR OWN.** If you adopt a standard-looking page for most of the pages you create, you'll get the Web site up and running quickly and it will consistently look good. Web sites may be made using cascading style sheets (CSS) that allow the designer to specify the color, font size, font type, and many other attributes only once. These attributes are stored in a style sheet file and then are applied to many Web pages. If a designer changes a specification in the style sheet file, all the Web pages using that style sheet will be updated to reflect the new style.

**USE PLUG-INS, AUDIO, AND VIDEO VERY SPARINGLY.** It is wonderful to have features that the professional pages have, but remember that everyone looking at your site doesn't have every new plug-in. Don't discourage visitors to your page.

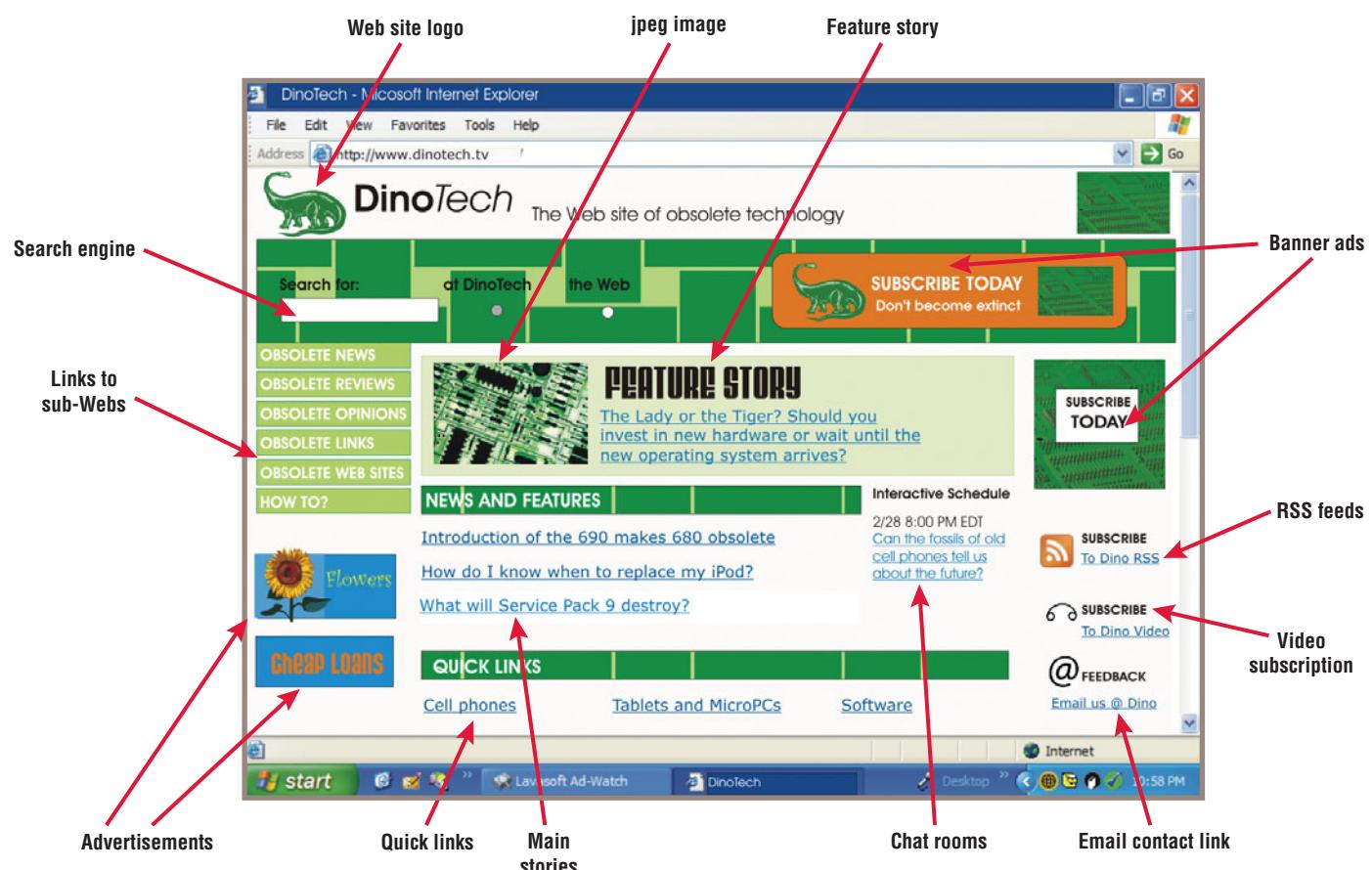
**PLAN AHEAD.** Good Web sites are well thought out. Pay attention to the following:

1. Structure.
2. Content.
3. Text.
4. Graphics.
5. Presentation style.
6. Navigation.
7. Promotion.

**FIGURE 11.14**

The DinoTech Web site makes the most of links, RSS feeds, video subscriptions, and banner ads.

**Structure** Planning the structure of a Web site is one of the most important steps in developing a professional Web site. Think about your goals and objectives. Each page in the overall Web structure should have a distinct message or other related information. Sometimes it is useful to examine professional sites to analyze them for content and features. Figure 11.14 is a screen



capture from the DinoTech Web site. The purpose for the site and the Web medium work well together. Notice that there is great attention to supporting users on the site. There are words, graphics, JPEG images, and icons. In addition, there are many kinds of links: to RSS feeds, video, sub-Webs, chat rooms, a search engine, and many other features.

To help plan and maintain a solid structure, a Webmaster can benefit from using one of the many Web site diagramming and mapping tools available. Many software packages, including Microsoft Visio, have Web charting options built into the software. Although helpful for development, these tools become even more important when maintaining a Web site. Given the dynamic nature of the Web, sites that are linked to your site may move at any time, requiring you or your Webmaster to update the links.

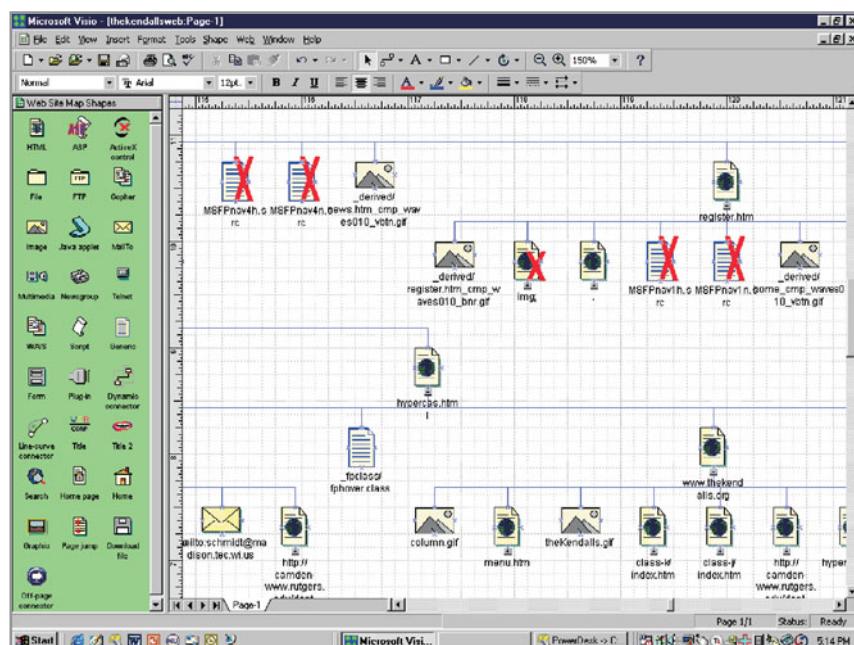
In Figure 11.15, a map of a section of the authors' Web site is shown in the Microsoft Visio window. In this example, we explore the Web site down to all the existing levels. Notice the links to HTML pages, documents, images (GIF or JPEG files), and mail-to's (a way to send email to a designated person). The links can be either internal or external. If a link is broken, a red X appears and the analyst can investigate further. This Visio file can be printed out in sections and posted on the wall to get an overall picture of the Web site.

**Content** Provide something important to Web site users. Exciting animation, movies, and sounds are fun, but you have to include appropriate content to keep the user interested. Supply some timely advice, important information, a free offer, or any activity that you can provide that is interactive and moves users away from a browsing mode and into an interactive one.

“Stickiness” is a quality a Web site can possess. If a user stays at your site for a long period of time, your site has a high degree of stickiness. That is why a merchant includes many items of interest on a site. A wine merchant, for example, may put lessons on how to uncork a bottle, taste the wine, or choose a proper glass.

Use a metaphor or images that provide a metaphor for your site. You can use a theme, such as a storefront, with additional pages having various metaphors related to the storefront, such as a deli. Avoid the overuse of cartoons, and don't be repetitive.

Every Web site should include an FAQ (Frequently Asked Questions) page. Often these are created based on the experiences of users and technical support people who identify the topics of continuing concern. Eighty percent of the questions will fall into the FAQ category. By having answers readily available, 24 hours a day, you will save valuable employee time and also save user time. FAQ pages also demonstrate to users of your site that you are in concert with them and have a good idea of what they would like to know.



**FIGURE 11.15**

A Web site can be evaluated for broken links by using a package such as Microsoft Visio.

On the Web, COTS software takes on another meaning. A Web site may take advantage of prewritten software. Examples include search engines (such as Google), mapping software (such as MapQuest), weather information, and news and stock tickers. Web site designers value these packages because they can increase the functionality of the site, and the additional features encourage users to bookmark their clients' Web sites because they provide valuable bonus content.

**Text** Remember that text is important, too. Each Web page should have a title. Place meaningful words in the first sentence appearing on your Web page. Let people know that they have indeed navigated to the right Web site. Clear writing is especially important.

**Graphics** The following list provides details about creating effective graphics for Web sites:

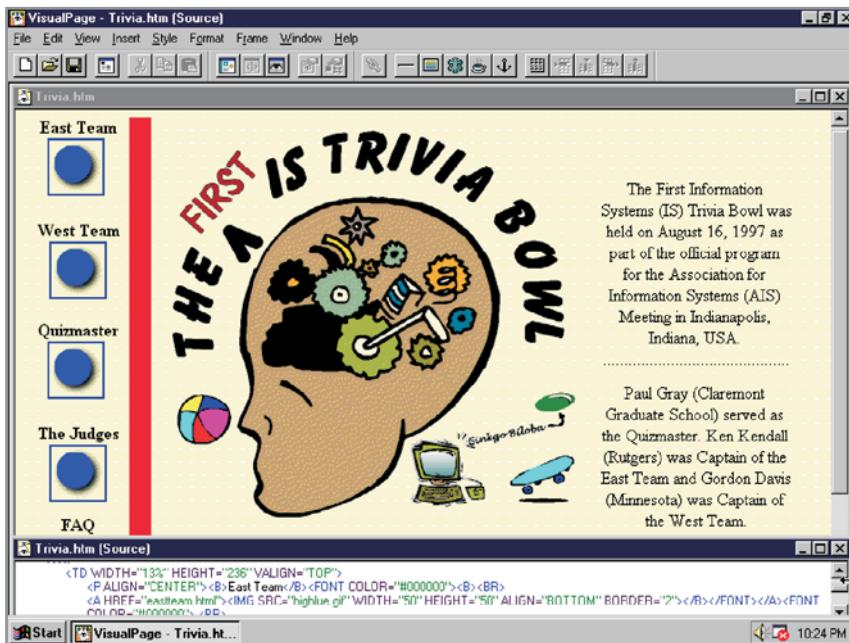
1. Use one of the most commonly used image formats, JPEG or GIF. JPEGs are best for photographs, and GIFs are best for artwork images. GIFs are limited to 256 colors but may include a transparent background, pixels that allow the background to show through the GIF image. GIF images may also be interlaced, meaning that the Web browser will show the image in successive stages, presenting a clearer image with each stage.
2. Keep the background simple and make sure users can read the text clearly. When using a background pattern, make sure that you can see the text clearly on top of it.
3. Create a few professional-looking graphics for use on your pages.
4. Keep graphic images small, and reuse bullet or navigational buttons such as BACK, TOP, EMAIL, and NEXT. These images are stored in a cache, an area on the browsing computer's hard drive. Once an image has been received, it will be taken from the cache whenever it is used again. Using cached images improves the speed with which a browser can load a Web page.
5. Include text in what is called a title attribute for images and image hot spots. The text displays when the user moves the mouse over the image. An alt attribute provides text for screen readers and is essential to support Web accessibility for visually impaired site visitors.
6. Examine your Web site on a variety of displays and screen resolutions. Scenes and text that look great on a high-end video display may not look good to others with poorer-quality equipment.

**Presentation Style** The following list gives added details about how to design engaging entry displays for Web sites:

1. Provide an entry display (also called a home page) that introduces the visitor to the Web site. The page must be designed to load quickly. A useful rule of thumb is to design a page that will load in 14 seconds. (Although you may be designing the page on a workstation at the university, a visitor to your Web site may be accessing it from home.) This entry display should be 100 kilobytes or less, including all graphics.

The entry page should contain a number of choices, much like a menu. An easy way to accomplish that is to design a set of links or buttons and position them on the left side or the top of the screen. These links can be linked to other pages on the same Web site or linked to different Web sites. A specialized text menu may be included in a smaller font at the top or bottom of the page. An example of this is shown in Figure 11.16, an entry page that contains a large image and some content but that directs the visitor to journey elsewhere in the site. This page was constructed with software that allows designers to see HTML code (at the bottom of the screen) at the same time they see what the page would look like in a browser.

2. Keep the number of graphics to a reasonable minimum. It takes additional download time to transfer a graphics-intensive site.
3. Use large and colorful fonts for headings.
4. Use interesting images and buttons for links. A group of images combined into a single image is called an image map, which contains various hot spots that act as links to other pages.
5. Use cascading style sheets (CSS) to control the formatting and layout of the Web page. CSS separates the content (the text and images) from how they look (the presentation). Cascading style sheets are commonly stored in a file external to the Web page, and one

**FIGURE 11.16**

Using a visual HTML editor (in this example, Visual Page), a Web site designer can see what a page looks like in a browser and the HTML Code (see bottom of screen) at the same time.

style sheet may control the formatting of many pages. An advantage of using external style sheets is making a change in the style sheet; for example, changing the color of bold text will change the formatting of all the Web pages that use the style sheet. Cascading style sheets may also be used in a single Web page, and any duplicate styles will override an external style sheet if one is used. This allows the designer to vary from the standard look and feel of a Web site, perhaps for a “special sale” Web page or some other exception.

Styles may be added to individual items on a Web page, overriding any other style sheets.

6. Use divisions and cascading styles or tables to enhance a layout. Tables are easy to use and provide adequate layout. However, tables are not well suited for visually impaired visitors. Screen reading software reads across the page, not necessarily in a table column. Divisions control the layout by providing blocks of text on the Web page. Each block may be defined with a position from the top and left of the screen or a larger block, and it may have a width and height, as well as border style and background color. Divisions eliminate the need for tables within tables and simplify design; screen reading software will read all the text in the division, making the site accessible for visually impaired viewers.
7. Use the same graphics image on several Web pages. Consistency will be improved, and the pages will load more quickly because the computer stores the image in a cache and doesn't have to load it again.
8. Use JavaScript to enhance the Web page layout by having images that change when a mouse is moved over them, having menus expand, and so on. JavaScript may be used to reformat the Web page based on the height and width of the screen. If the Web site is multinational, JavaScript can detect the language being used (a browser setting) and redirect the viewer to a different Web page in a different language.
9. Avoid overusing animation, sound, and other elements.

**Navigation** Is it fun for you to follow links on the Web? The answer most likely is that it depends. When you discover a Web site that loads easily, has meaningful links, and allows you to easily return to the places you want to go back to, then chances are you think it is fun. Fun is not just play; it can be an important part of work too. Recent research shows that fun can have a powerful effect on making computer training effective.

If, on the other hand, you can't decide which button or hot spot to push, and you are afraid to choose the wrong one because you might get into the wrong page that takes a long time to load, navigation is more painful than fun. An example is visiting a software company's page to find information about the features of the latest version of a product. You have choices such as products, download, FAQ, and tech support. Which button will lead to the answers you're looking for?



## CONSULTING OPPORTUNITY 11.5

### A Field Day

“**T**he thing of it is, I get impatient,” says Seymour Fields, owner of a chain of 15 highly successful florist shops/indoor floral markets called Fields that are located in three Midwestern cities. “See this thing here?” He taps his PC display irritatedly. “We do all the payroll and all the accounting with these things, but I don’t use it like I should. I actually feel a little guilty about it. See?” he says, as he makes a streak on the display with his finger. “It’s even got dust on it. I’m a practical person, though. If it’s sitting here, taking up space, I want to use it. Or smell it, or at least enjoy looking at it, like flowers, right? Or weed it out, that’s what I say. The one time I tried something with it, it was a real disaster. Well, look, I can show you if I still remember how.” Seymour proceeds to try to run a program, but can’t seem to get it working.

Clay Potts, a systems analyst, has been working on a systems project for the entire Fields chain. Part of the original proposal was to provide Seymour and his vice presidents with a group decision support system that would help them devise a strategy to determine which European markets to visit to set up purchase agreements for fresh flowers, which outlets to ship particular kinds of flowers to, and how much general merchandise,

such as planters, vases, note cards, and knickknacks, to stock in each outlet.

Seymour continues, “I can tell you what we disliked about the program I worked with. There were too many darn layers, too much foliage, or whatever you call it, to go through. Even with a screen in front of me, it was like paging through a thick report. What do you call that?”

“Menus?” Potts suggests helpfully. “The main point is that you didn’t like having to go through lots of information to get to the display you needed.”

Seymour Fields looks happily at Potts and says, “You’ve got it. I want to see more fields on each screen.”

How should Potts design screen output so that Fields and his group can get what they want on each screen while observing the guidelines for good display design? Remember that the group members are busy and that they are infrequent computer users. Design a hyperlinked page that would work well in a DSS for the vice presidents. What should be included in the first display, and what should be stored in hyperlinks? List elements for each and explain in a paragraph why you have decided on this strategy.

Most importantly, observe the three-clicks rule. Users should be able to move from the page they are currently on to the page containing the information they want in three clicks of the mouse button.

**Promotion** Promote your site. Don’t assume that search engines will find you right away. Submit your site every few months to various search engines. Include keywords, called metatags, that search engines will use to link search requests to your site. General information about metatags, may be found at [searchenginewatch.com/showPage.html?page=2167931](http://searchenginewatch.com/showPage.html?page=2167931). Free metatag generating software may be downloaded at [www.siteup.com/meta.html](http://www.siteup.com/meta.html), and a metatag builder may be found at [vancouver-webpages.com/META/mk-metas.html](http://vancouver-webpages.com/META/mk-metas.html). You can also purchase software to make this process easier. If you try to use email to promote your site, others will consider it junk email or spam.

Encourage your readers to bookmark your Web site. If you link to and suggest that they go to affiliated Web sites that feature the “best movie review page in the world” or to the “get music for free” Web site, don’t assume they’ll be coming back to your site in the near future. You will encourage them to revisit if they bookmark your site (bookmarks are called “favorites” on Microsoft Internet Explorer). You may add a **Click here to bookmark this page** link to your Web page to automate the process. You may also want to design a “favicon,” or favorite icon, so that users can identify your site in their lists of favorites.

### Maintaining Web Sites

As a Web developer, you may also be asked to maintain and update Web sites on an ongoing basis. This is a service you can provide, and the payment can be agreed upon during initial project contract negotiations and project budgeting. By now you recognize that there are many features on corporate Web sites that are stable, and thus require infrequent updating. However, the picture is different on ecommerce sites, where content needs to be refreshed seasonally. Featured items change, as do trends, discounts, and interactive features. Content management systems (CMS) are powerful software tools that can enable the analyst to develop and maintain Web sites and other

online applications. An increasingly popular CMS is Joomla! which can be found at [www.joomla.org/about-joomla.html](http://www.joomla.org/about-joomla.html). It is based on PHP and MySQL. Unlike many proprietary CMS, which are expensive and not widely available, Joomla! is an open source solution that is made freely available to any developer.

### **Creating Blogs (Web Logs)**

Blogs, also called Web logs, are being written by corporate users for both internal and external communication. Blogs are informal and personal, and they often invite comments and feedback. They are easy to create and update and are designed to change daily. Companies are using blogs for advertising and to build social networks for consumers, clients, and vendors around their products, building trust and customer relationships.

Corporate blogs are monitored out of a sense of responsibility for the participants. Guidelines, policies, and laws that shape monitoring practices include shared cultural, ethical, and legal values such as respecting other employees and customers; not publishing any sensitive or secret corporate information or anything protected by copyright (without permission); and excluding anything that is hateful or profane or that violates anyone's privacy.

Even with all of the preceding guidelines, you still need to ensure that blog posts are written in a human voice, not immersed in legal language. The latest entry should be at the start of the blog. It should contain the following elements:

1. The permalink, or permanent link, specific for the blog post. The permalink should never change.
2. The headline or title of the post.
3. The primary link, which connects the reader to the subject under discussion.
4. An optional summary, often appearing after the link.
5. The blog text or commentary.
6. An optional image.
7. A block quote containing quotations or other material from other sources that contributes to the discussion (often indented or in a different font to set it apart from the main text).
8. Links for comments by other people.
9. Other blog software features, such as a calendar, search form, and other universal features.

## **OUTPUT PRODUCTION AND XML**

Output production varies depending on the platform used to produce it. There are many different ways to create output, ranging from simple database software, such as Microsoft Access, to programs such as SAS, Crystal Reports, and Adobe Acrobat's PDF files.

We discussed XML in Chapter 8. One of the advantages of using XML is that the XML document may be transformed into different output media types. This is done using cascading style sheets (CSSs) or extensible style language transformations (XSLTs). These methods reinforce the idea that data should be defined once and used many times in different formats.

Cascading style sheets are an easy way to transform an XML document. The style sheet provides a series of styles, such as font family, size, color, border, and so on, that are linked to the elements of the XML document. These styles may vary for different media, such as a screen, printed output, or a handheld device. The transforming software detects the type of device and applies the correct styles to control the output.

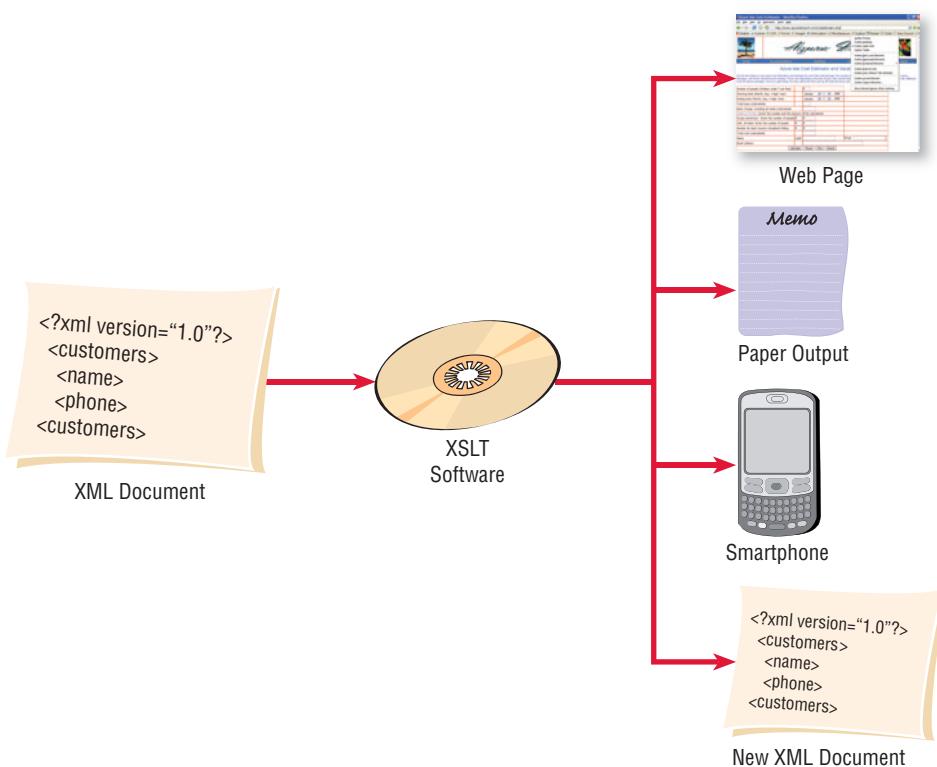
For example, a style used for a flat-panel display might use a rich palette of colors and a sans serif font, which is easier to read on a screen. A different style using a serif font and black or gray color may be used to define a printed report for the same data. A smaller font size might be used for a handheld device or mobile phone.

The drawback of using cascading style sheets is that they do not allow the analyst to manipulate the data, such as rearranging the order of the elements or sorting, and only a limited amount of identifying text, such as captions, may be added. They are basically used for formatting.

Extensible style language transformations (XSLT) are a more powerful means of transforming an XML document. They allow the analyst to select the elements and insert them into a Web page or another output medium. Figure 11.17 illustrates the transformation process. XSLT is not a programming language, but uses a series of statements to define which elements should be output,

**FIGURE 11.17**

Extensible style language transformation (XSLT) software can be used to make XML documents and transform them into many different formats for a variety of platforms.



the sort sequence, the selection of data, and so on. An example of an XML transformation is illustrated in Figure 11.18. The XML is shown on the left, and the result of the transformation is shown on the right. Notice that only the data between the tags (the tags are the less than [<>] and greater than [>] symbols) are included in the output.

### Ajax

Another technique, called Ajax, uses both JavaScript and XML to obtain small amounts of data, either plain text or XML, from a server without leaving the Web page. This is a big advantage because it means that the entire Web page does not need to be reloaded. It works by allowing the Web page to reformat itself based on choices that a user inputs. Since Ajax is also related to user input, see additional details in Chapter 12.

Ajax is discussed here because the output implications are important as well. It is up to the analyst and designer to determine when data should be added or changed on a Web page and to identify the conditions that cause the change. The order in which the questions are asked plays into this design as well.

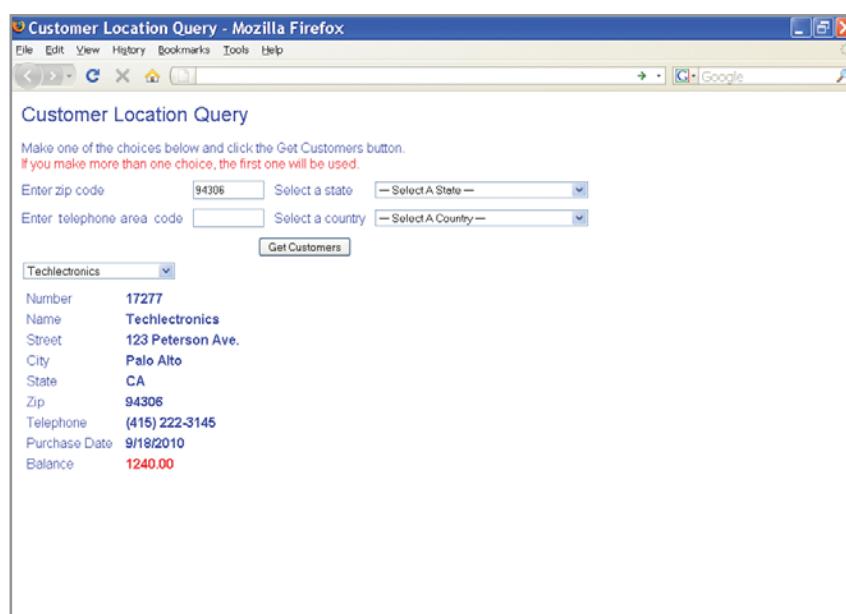
An example of a Web page using Ajax is shown in Figure 11.19, which demonstrates that Ajax makes it possible to display much less data on a page, thereby making the output less cluttered and less confusing. In this example, the user entered one of four ways to narrow down the search to view a list of current customers. The options the user had available were (1) enter the first three digits of a zip code (postal code), (2) enter a telephone area code, (3) select the state, or (4) select a country. The user may not know the postal code or area code and may therefore need to search by state or country, so the options are very useful.

After entering one of the location choices, in this case the first three digits of the postal code, the user clicked on the **Get Customers** button. The value of the postal code is sent to the server along with data indicating it was a postal code. The server then finds all customer records for the selected location, creates an XML document, and sends it to the same Web page.

When designing output, the systems analyst has many different options regarding how to display this data on the Web page. In this case, the analyst specified that the XML document would be used to create a drop-down list containing all current customers for the desired location. Once a user selects a customer from the drop-down list, more information about the particular customer is displayed, as shown in the example.

**FIGURE 11.18**

An XML transformation, with XML on the left and the result of the transformation on the right. Only data between the tags are included in the output on the right.

**FIGURE 11.19**

A Web page using Ajax makes it possible to display much less data on a page, allowing an uncluttered display.

## HYPERCASE® EXPERIENCE 11



**I**'d say the reception you received, or should I say your team received, for your proposal presentation was quite warm. How did you like meeting Mr. Hyatt? What? He didn't come? Oh [laughing], he's his own man. Anyway, don't worry about that too much. The reports I got from Snowden were encouraging. In fact, now he wants to see some preliminary designs from all of you. Can you have something on his desk or send it as an attachment to his email in two weeks? He'll be in Singapore on business next week, but then when he recovers from the jet lag, he'll be looking for those designs. Thanks."

### HYPERCASE Questions

1. Consider the reports from the Training Unit. What are Snowden's complaints about these reports? Explain in a paragraph.

2. Using either a layout paper form, Microsoft Visio, or a CASE tool, design a prototype output display based on the Training Unit's reports that will summarize the following information for Snowden:
  - Number of accepted projects in the Training Unit.
  - Number of projects currently being reevaluated.
  - Training subject areas for which a consultant is being requested.
3. Design an additional output display that you think will support Snowden in the kind of decision making he does frequently.
4. Show your designs to three classmates. Get written feedback from them about how to improve the output displays you have designed.
5. Redesign the displays to capture the improvements suggested by your classmates. In a paragraph, explain how you have addressed each of their concerns.

**FIGURE 11.HC1**

You have the ability to view and critique output screens in HyperCase.

The screenshot shows a Mozilla Firefox window displaying a budget report from the Global Engineering Management System (GEMS) for Maple Ridge Engineering. The report is titled "Budget Report" and is dated 4/28/2009, page 1. It includes a logo of a maple leaf and the company name "MAPLE RIDGE ENGINEERING". The report details a project for St. Ignatius Clinic Patient Tracking with a projected budget of \$115,000.00 and expended amount of 0.0%. Milestones listed are Analysis Complete (2/03/09) and Form Management Team (3/21/09). Tasks include the creation of the Patient Tracking System by Taylor for \$75.00.

Project Description: St. Ignatius Clinic Patient Tracking	
Projected Budget:	\$115,000.00
Expended:	0.0%
Milestone:	Analysis Complete
Milestone Date:	2/03/09
Projected Budget:	\$13,000.00
Expended:	0.0%
Task Description:	St. Ignatius Clinic Patient Tracking System
Task Date:	3/21/09
Task Description:	Form Management Team
Assignment Scheduled Duration:	2
Resource Name:	Taylor
Resource Fee:	\$75.00

The advantage of using Ajax for displaying data is that the user does not have to wait for a new Web page to display after making a selection. The Ajax philosophy is to display limited questions for the user to answer on an incremental basis. This eliminates screen clutter. Once the user responds to an answer by making a choice, a new question may be generated.

## SUMMARY

Output is any useful information or data delivered by the information system or decision support system to the user. Output can take virtually any form, including print, display, audio, microforms, CD-ROMs or DVDs, and Web-based documents.

The systems analyst has six main objectives in designing output. They are to design output to serve the intended human and organizational purpose, to fit the user, to deliver the right quantity of output, to deliver it to the right place, to provide output on time, and to choose the right output method.

It is important that the analyst realize that output content is related to output method. Output of different technologies affects users in different ways. Output technologies also differ in their speed, cost, portability, flexibility, accessibility, and storage and retrieval possibilities. All these factors must be considered when deciding among print, display, audio, electronic, or Web-based output, or a combination of these.

The presentation of output can bias users in their interpretation of it. Analysts and users must be aware of the sources of bias. Analysts should interact with users to design and customize output; inform users of the possibilities of bias in output; create flexible and modifiable output; and train users to use multiple outputs to help verify the accuracy of any particular report.

Printed reports are designed with the use of computer-aided software design tools that feature form design templates and drag-and-drop interfaces. The data dictionary serves as the source for necessary data on each report.

Designing output for user displays is important, especially for DSS and the Web. Aesthetics and usefulness are critical when creating well-designed output for displays. It is important to produce prototypes of screens and Web documents that encourage users to interact with them and make changes where desired.

## KEYWORDS AND PHRASES

Ajax	hyperlink
audio output	hypertext
bookmark	internal output
browser	Java
cascading style sheet (CSS)	output bias
CD-ROM	output design
constant information	plug-in
content management system (CMS)	podcasting
dashboard	RSS feeds
display screen	stickiness
DVD	uniform resource locator (URL)
electronic bulletin board	variable information
electronic output	Web logs (blogs)
email	Webmaster
extensible style language transformation (XSLT)	Web page
external output	Web site
FAQ	

## REVIEW QUESTIONS

1. List six objectives the analyst pursues in designing system output.
2. Contrast external outputs with internal outputs produced by the system. Remember to consider differences in external and internal users.
3. What are three situations that point to printers as the best choice for output technology?
4. Give two instances that indicate that display output is the best solution for the choice of output technology.
5. List potential electronic output methods for users.
6. What are the drawbacks of electronic and Web-based output?
7. List 10 factors that must be considered when choosing output technology.
8. What output type is best if frequent updates are a necessity?
9. What kind of output is desirable if many readers will be reading, storing, and reviewing output over a period of years?
10. What are two of the drawbacks to audio output?
11. List three main ways in which presentations of output are unintentionally biased.
12. What are five ways the analyst can avoid biasing output?
13. What is the difference between constant and variable information presented on a report?
14. Why is it important to show users a prototype output report or display?
15. List six functional elements of printed reports.
16. List five stylistic or aesthetic elements of printed reports.

17. In what ways do displays, printed output, and Web-based documents differ?
18. List four guidelines to facilitate the design of good display output.
19. What differentiates output for a DSS from that of a more traditional MIS?
20. What are the four primary considerations the analyst has when designing graphical output for decision support systems?
21. Define stickiness.
22. List seven guidelines for creating good Web sites.
23. List five guidelines for using graphics in designing Web sites.
24. List seven ideas for improving the presentation of corporate Web sites that you design.
25. What is the “three-clicks” rule?
26. In what ways can you encourage companies to promote their Web sites that you have developed?
27. How does a cascading style sheet allow the analyst to produce output?
28. What are the advantages of using XSLT instead of a cascading style sheet?
29. What are RSS feeds?
30. How can the Web administrator use RSS feeds?
31. What are dashboards mainly used for?
32. What are widgets (or gadgets)?
33. Why should a systems designer be aware of the popularity of widgets (or gadgets)?
34. How does a cascading style sheet allow the analyst to produce output?
35. What are the advantages of using an extensible style language transformation instead of a cascading style sheet?
36. How does Ajax help to build effective Web pages?

## PROBLEMS

1. “I’m sure they won’t mind if we start sending them the report on these oversized computer sheets. All this time we’ve been condensing it, retyping it, and sending it to our biggest accounts, but we just can’t now. We’re so understaffed, we don’t have the time,” says Otto Breth. “I’ll just write a comment here telling them how to respond to this report, and then we can send it out.”
  - a. What potential problems do you see in casually changing external output? List them.
  - b. Discuss in a paragraph how internal and external output can differ in appearance and function.
2. “I don’t need to see it very often, but when I do, I have to be able to get at it quickly. I think we lost the last contract because the information I needed was buried in a stack of paper on someone’s desk somewhere,” says Luke Alover, an architect describing the company’s problems to one of the analysts assigned to the new systems project. “What I need is instant information about how much a building of that square footage cost the last time we bid it; what the basic materials such as steel, glass, and concrete now cost from our three top suppliers; who our likely competition on this type of building might be; and who comprises the committee that will be making the final decision on who gets the bid. Right now, though, it’s in a hundred reports somewhere. I have to look all over for it.”
  - a. Given the limited details you have here, write a paragraph to suggest an output method for Luke’s use that will solve some of his current problems. In a second paragraph, explain your reasons for choosing the output method you did. (*Hint:* Be sure to relate output method to output content in your answer.)
  - b. Luke’s current thinking is that no paper record of the output discussed need be kept. In a paragraph, discuss what factors should be weighed before displayed output is used to the exclusion of printed reports.
  - c. Make a list of five to seven questions concerning the output’s function in the organization that you would ask Luke and others before deciding to do away with any printed reports currently being used.
3. Here are several situations calling for decisions about output content, output methodology, distribution, and so on. For each situation, note the appropriate output decision.
  - a. A large, well-regarded supplier of key raw materials to your company’s production process requires a year-end summary report of totals purchased from it.
  - b. Internal brainstorming memos are circulated through the staff regarding plans for a company picnic and fund-raiser.
  - c. A summary report of the company’s financial situation is needed by a key decision maker, who will use it when presenting a proposal to potential external backers.
  - d. A listing of the current night’s hotel room reservations is needed for front desk personnel.
  - e. A listing of the current night’s hotel room reservations is needed by the local police.
  - f. A real-time count of people passing through the gates of Wallaby World (an Australian theme park) will be used by parking lot patrols.

- g. An inventory system must register an item each time it has been scanned by a wand.
  - h. A summary report of merit pay increases allotted to each of 120 employees will be used by 22 supervisors during a joint supervisors' meeting, and subsequently when explaining merit pay increases to the supervisors' own departmental employees.
  - i. Competitive information is needed by three strategic planners in the organization, but it is industrially sensitive if widely distributed.
  - j. A casual style of conversation is needed to inform customers about powerful but seldom used features of a product.
  - k. A historic district of a city wants to let visitors know about historical buildings and events.
  - l. Storm warnings must be delivered to subscribers in a large geographical area.
4. "I think I see now where that guy was coming from, but he had me going for a minute there," says Miss deLimit. She is discussing a prototype of display output, one designed by the systems analyst, that she has just seen. "I mean, I never considered it a problem before if even as much as 20 percent of the total class size couldn't be fit into a class," she says. "We know our classes are in demand, and because we can't hire more faculty to cover the areas we need, the adjustment has to come in the student demand. He's got it highlighted as a problem if only 5 percent of the students who want a class can't get in, but that's okay. Now that I know what he means, I'll just ignore it when the computer beeps."
- a. In a sentence or two, describe the problem Miss deLimit is experiencing with the display output.
  - b. Is her solution to "ignore the beeps" a reasonable one given that output is in the prototype stage?
  - c. In a paragraph, explain how the display output for this particular problem can be changed so that it better reflects the rules of the system Miss deLimit is using.
5. Following is a log sheet for a patient information system used by nurses at a convalescent home to record patient visitors and activities during their shifts. Design a printed report using form design software that provides a summary for the charge nurse of each shift and a report for the activities coordinator at the end of a week. Be sure to use proper conventions to indicate constant data, variable data, and so on. These reports will be used to determine staffing patterns and future activities offerings.

<i>Date</i>	<i>Patient</i>	<i>Visitors</i>	<i>Relationship</i>	<i>Activities</i>
2/14	Clarke	2	Mother, father	Walked about halls, attended chapel, meals in cafeteria
	Coffey	6	Coworkers	Played games, party in room
	Martine	0	—	Meals in room
	Laury	4	Husband and friends	Games in sunroom, watched TV
	Finney	2	Parents	Conversation, meals in cafeteria
	Cartwright	1	Sister	Conversation, crafts room
	Goldstein	2	Sister, brother	Conversation, games out of room, whirlpool

6. Design display output for Problem 5 using form design software. Make any assumptions about system capability necessary and follow display design conventions for onscreen instructions. (*Hint:* You can use more than one display screen if you wish.)
- a. In a paragraph, discuss why you designed each report as you did in Problems 5 and 6. What are the major differences in your approach to each one? Can the printed reports be successfully transplanted to displays without changes? Why or why not?
  - b. Some of the nurses are interested in a Web-based system that patients' families can access from home with a password. Design an output screen for the Web. In a paragraph, describe how your report had to be altered so that it could be viewed by one patient's family.
7. Clancy Corporation manufactures uniforms for police departments worldwide. Its uniforms are chosen by many groups because of their low cost and simple but dignified design. You are helping to design a DSS for Clancy Corporation, and it has asked for tabular output that will help it in making various decisions about what designers to use, where to market its uniforms, and what changes to make to uniforms to keep them looking up-to-date. The following table lists some of the data the company would like to see in tables, including uniform style names, an example of a buyer group for each style, and which designers design which uniform styles. Prepare an example of tabular output for display that incorporates these data about Clancy's. Follow proper conventions for tabular output displays. Use codes and a key where appropriate.

<i>Style Name</i>	<i>Example Buyer</i>	<i>Designers</i>
Full military	NYPD	Claudio, Rialto, Melvin Mine
Half military	LAPD	Rialto, Calvetti, Duran, Melvin Mine
Formal dress	Australian Armed Forces	Claudio, Dundee, Melvin Mine
Casual dress	"Miami Vice"	Johnson, Melvin Mine

8. Clancy's is interested in graphical output for its DSS. It wants to see a graphical comparison of how many of each style of uniform are being sold each year.
- Choose an appropriate graph style and design a graph for display that incorporates the following data:

	<i>Full Military (percent of total)</i>	<i>Half Military</i>	<i>Formal Dress</i>	<i>Casual Dress</i>
2005	50	20	20	10
2006	55	15	20	10
2007	60	15	15	10
2008	62	15	15	8
2009	65	10	15	10

Be sure to follow proper design conventions for displays. Use codes and a key if necessary.

- Choose a second method of graphing that might allow the decision makers at Clancy's to see a trend in the purchase of particular uniform styles over time. Draw a graph for display as part of the output for Clancy's DSS. Be sure to follow proper design conventions for displays. Use codes and a key if necessary.
  - In a paragraph, discuss the differences in the two onscreen graphs you have chosen. Defend your choices.
9. Michael Cerveris owns a number of cars used for racing. What performance measures does he need to develop to keep track of the performance of his driver, pit crews, and support staff (not to mention any bald tires his cars experience)?
10. Design a DSS dashboard for Michael (Problem 9). Use appropriate types of charts and graphs to illustrate performance.
11. Design a dashboard for keeping track of a person's stock and portfolio. Think about how the dashboard could be used to make decisions about buying and selling stock. Remember that a client can have more than one stockbroker.
12. Gabriel Shanks runs a nonprofit theatre that produces seven plays per year in three theatres. Each play lasts eight weeks but can be extended four weeks if the show is a success. Design a dashboard for Gabriel, taking into consideration the different phases of putting on a performance as well as the need to sell as many tickets as possible. Don't forget that Gabriel is involved in theatre and is very visual. He doesn't like tables, however.
13. While Gabriel (from the previous problem) is taking care of various details during an ordinary day, he would like to keep up on theatre news in Manhattan, at the same time having some simple tools around to help him with his computer-related activities. What sort of widgets and gadgets would Gabriel need to do his job while having some simple computer-based tools always available?
14. Browse the Web to view well-designed and poorly designed Web sites. Choose three examples of each. Comment on what makes the sites excellent or poor, using the critique form presented earlier in the chapter to compare and contrast them.
15. Propose a Web site for Clancy's, the uniform company described in Problems 7 and 8. Sketch by hand or use form design software to create a prototype of Clancy's home page. Indicate hyperlinks, and include a sketch of one hyperlink document. Remember to include graphics, icons, and even sound or other media if appropriate. In a paragraph, describe who the intended users of the Web site are and state why it makes sense for Clancy's to have a Web presence.
16. Elonzo's Department Stores is a chain of about 50 retail stores, specializing in kitchen, bath, and other household items, including many decorative and fashionable items. Recently Elonzo's decided to automate its gift registry to allow wedding and other event guests to be able to browse for items that were selected by the wedding couple or others.
- Design a Web page that would allow customers to enter a zip code and find the nearest store.
  - Design a Web page for customers to browse gifts and order them online. Do not include the actual ordering forms, simply the products. What sort of options should be available for customers? Include buttons or links to change the sort sequence in your design.
  - Design a printed list that customers could request when they go to one of the stores. What sequences would be optimal for a customer trying to find items? Would all items requested by the wedding couple be included on the list? (*Hint:* Some may have been purchased already.)

17. Design an outline of a podcast for someone touring your university, college, or business. What sequence would you place the topics in? How much time would you allow for each campus or building location? Assume the party will arrive in the morning and sequence lunch into the podcast.
18. Design an airline flight reminder screen for a smartphone or other handheld device.
19. Design an Ajax style of Web page that would allow a dean at a community college to select part-time instructors. The dean should be able to select a discipline or a course and have the server send an XML document containing all the potential part-time instructors for the selection. The XML document should be used to populate a drop-down list of the instructor names. Clicking an instructor's name would display information about the potential instructor. Decide what information to include that would help the dean make a decision on whom to hire. (*Hint:* Part-time instructors may be able to teach only on certain days or only in the morning, afternoon, or evening.)

## GROUP PROJECTS

1. Brainstorm with your team members about what types of output are most appropriate for a variety of executives and high-level managers of Dizzyland, a large theme park in Florida. Include a list of environments or decision-making situations and types of output. In a paragraph, discuss why the group suggested particular options for output.
2. Have each group member design an output display or form for the output situations you listed in Group Project 1. (Use either Microsoft Visio, a CASE tool, or paper layout form to complete each display or form.)
3. Create a dashboard for Dizzyland managers in Group Project 1.
4. Design a Web site, either on paper or using software with which you are familiar, for Dizzyland in Group Project 1. Although you may sketch documents or graphics for three levels of pages and required hyperlinks on paper, create a prototype home page for Dizzyland, indicating hyperlinks where appropriate. Obtain feedback from other groups in your class and modify your design accordingly. In a paragraph, discuss how designing a Web site is different from designing displays for other online systems.
5. Explore the Joomla! Web site at [www.joomla.org](http://www.joomla.org). How could this open source application be helpful in implementing your designs from Problem 4? Summarize your findings in a paragraph. Use the Web to find another CMS and use a paragraph to compare it to Joomla! Be sure to address cost, ease of use, support, and availability in your comparison.
6. Use brainstorming to develop a new set of widgets (gadgets) to be more productive. Come up with a list of your top five bright ideas for new widgets.

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## EPISODE 11

### CPU Case

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Reporting on Outputs

"Let's create output specifications and then work backward through the UML diagrams and data flow to determine the corresponding input data," says Anna during her next meeting with Chip.

"Of course," Chip agrees.

Output was separated into two categories: reports and displays. Reports were further defined as external reports such as the USER SOFTWARE NOTIFICATION or internal reports such as the HARDWARE INVENTORY LISTING. Each report was further classified as a detailed, exception, or summary report.

Based on conversations with Paige Prynter, the analysts think the HARDWARE INVESTMENT REPORT has the highest priority. It is needed as soon as possible because the budget process will soon reach a critical phase and there are many requests for new hardware as well as upgrades for existing equipment.

The process used for creating the HARDWARE INVESTMENT REPORT is similar to the process for creating all reports. Chip examines the data flow diagrams for the new system and locates the data flow labeled HARDWARE INVESTMENT REPORT. Double clicking on the data flow line brings up the repository entry for this report.

"I'm really glad we took the time to document the prototype reports and displays when creating the data flow diagrams," remarks Chip. "I can easily identify the elements required to produce the report."

Chip examines the repository for the details for each element.

"This is great," exclaims Chip. "It was a good idea to define all the elements as we learned about them."

Chip then proceeds to create a sample report using Microsoft Access. After the first draft, Chip uses the **Print Preview** feature to preview the report.

"Hmmm," murmurs Chip. "Some of the fields need rearranging, and the horizontal spacing needs some work."

The report design is modified and reviewed again. By the third try, the report is in its final form. The next step is crucial: Chip asks Paige to review the report and make any changes she likes. Chip asks, "Are there any additional columns or other data missing that would make for a more useful report? Are all the data on the report necessary?"

Paige studies the output for a few minutes and remarks, "Subtotals for each BRAND, including the NUMBER OF MACHINES and grand totals, are necessary. We receive requests for different types of machines, and knowing how many of each machine may help determine what is purchased."

Chip returns to his computer and makes the necessary changes. The final HARDWARE INVESTMENT REPORT sample is shown in Figure E11.1. This version is again reviewed by Paige, and she signs off on the layout as complete.

**FIGURE E11.1**

HARDWARE INVESTMENT REPORT sample output.

1/04/2010		Hardware Investment Report		Page 1 of 1
Brand Name	Model	Number of Machines	Total Invested	
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx	Brand Subtotal	3	\$29,997.00
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx		3	\$29,997.00
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx	Brand Subtotal	4	\$39,996.00
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx		2	\$19,998.00
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx	Brand Subtotal	6	\$59,994.00
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx		3	\$29,997.00
Xxxxxxxxxxxxxx	Xxxxxxxxxxxxxxxxxx	Brand Subtotal	11	\$82,992.00
			14	\$112,989.00
		Grand Total	23	\$202,980.00

The logic for this summary report is outlined in a process specification. The COMPUTER table is sorted by MODEL within BRAND. Totals are accumulated for each BRAND and MODEL. When either BRAND or MODEL changes, a report line is printed. When a change in BRAND occurs, BRAND SUBTOTALS are printed after all records are processed.

Anna spends some time speaking with Cher Ware about her report needs. Several printed reports are outlined when Cher asks the question, “Will I get online reports that I can quickly view, containing the latest information?”

The discussion that follows results in the creation of several queries.

“How would you like to view the software categories?” asks Anna. “Would you like to see all the software on one large scrolling display?”

“Well, I would like to have some way of finding one category and then displaying all the software available for that category,” replies Cher. “It would also be useful to be able to move to subsequent and previous categories.”

Anna creates the SOFTWARE BY CATEGORY display by creating a Microsoft Access form, shown in Figure E11.2. There is a button for finding records as well as buttons to move to the previous and next categories. In the lower area of the screen is an area to display multiple software packages for the category. The OPERATING SYSTEM field is stored as a code on the corresponding database table and is converted to the code description on the display.

Anna shows both Chip and Cher the completed display. “I’m impressed,” exclaims Cher. “That’s exactly what I need!”

At that moment, Hy Perteks saunters in. “What’s going on?” he asks. After viewing the query, he remarks, “I would like some Web pages developed for the training classes.”

“What do you have in mind?” inquires Chip.

“Well, I have been giving it some thought,” replies Hy. “I envision that it would be useful for the faculty and staff to be able to look up information about the software courses we are planning to offer. Later we could add a Web form for them to enroll in the courses.”

“That would be fun to work on,” remarks Chip. “We could link to the page from our Technology Support menus.”

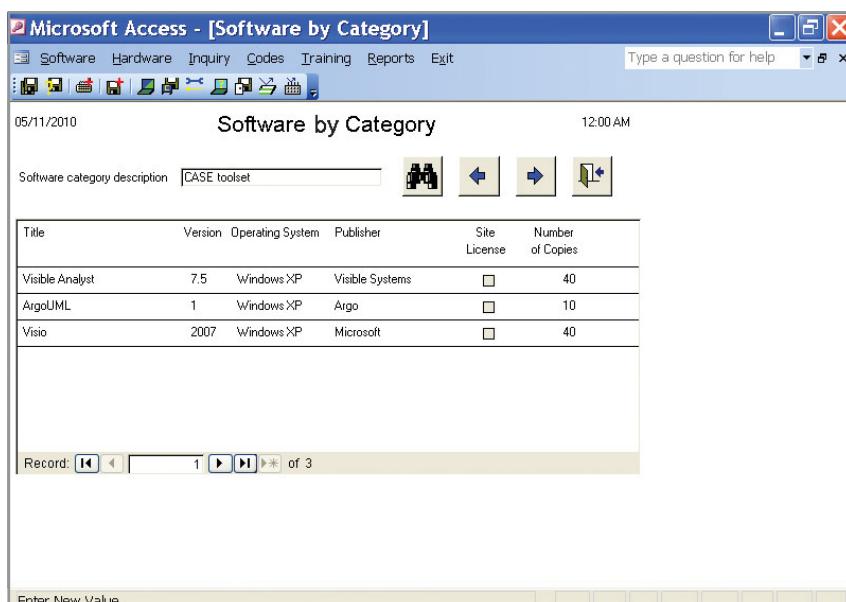
“Count me in on it,” replies Anna. “What would you like on the page?”

“I would like to create a Web page that lists the courses, including the level, such as beginning or intermediate, and the dates that the courses start,” replies Hy.

Chip and Anna set to work on the Web page. The fields are identified and grouped onto the TRAINING CLASSES OFFERED data flow, illustrated in the Visible Analyst screen in Figure E11.3. Note that the Web address is included as an alias. Anna creates the final intranet Web page, illustrated in Figure E11.4. Chip and Hy review the page.

“I like the menus on the top of the page and the submenu that drops down below it when the mouse hovers over it, listing further menu choices,” remarks Chip.

“The calendar makes it very useful for the staff to view the currently scheduled courses by date, with buttons to change the month and year,” comments Hy. “It’s a nice feature to change the courses dynamically when the month, day, or year changes. That makes for a smooth user experience.”

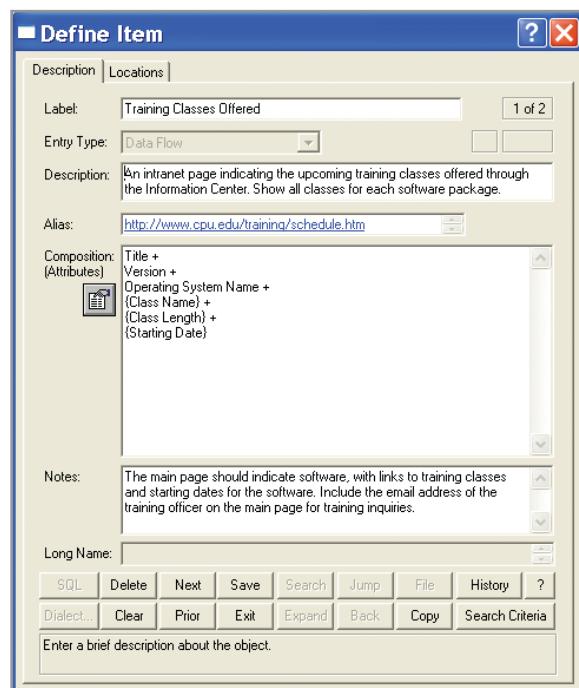


**FIGURE E11.2**

SOFTWARE BY CATEGORY  
Microsoft Access display screen.

**FIGURE E11.3**

TRAINING CLASSES  
OFFERED data flow display screen.



"Yes, and I think allowing the staff to change how the data are displayed is also very good. Many staff members like to view courses offered at their campus," remarks Chip.

"It would add some pizzazz if we include an image for the mascot," adds Hy, "and the university motto."

"I'll get right on it," replies Anna. "These are really good suggestions."

The final Web page is finished and approved by Hy.

"I'll put out an email to all the faculty and staff and a link on our 'New and Improved' Web page," remarks Hy. "Thanks for including my email address. It should help to facilitate registering for courses and answering any questions. I think we are really making progress!"

The following exercises may be done by designing the report or display using layout forms, or they may be created using any word processor with which you are familiar. The fields and other related information for the reports are contained in Visible Analyst data flow repository entries or in a Web page containing a copy of the repository. The Web page contains links to the other elements in the repository, making it easy to view one repository entry and jump to another one and back. The names for the data flow are listed for each exercise.

**FIGURE E11.4**

An Ajax enabled Web page for Central Pacific University.

Course Title	Level	Campus	Maximum Enrollment	Currently Enrolled
Beginning Photoshop	Elementary	Central	20	12
PowerPoint, Advanced	Advanced	Waterford	20	15

Corresponding reports and Microsoft Access forms have been created. All the information is present in the Microsoft Access database; you only have to modify the existing reports and screens to produce the final versions. Modifications are made by clicking on the desired report or screen and then clicking the **Design** button. The following modifications may be made. The **Page Header** contains column headings. The **Detail** area contains the print fields for the report.

Click in a field to select it. Click on several fields while holding the shift key to select them.

Drag a selected field (or fields) to move them.

Click on one of the small boxes surrounding the field to change the field size.

Select several fields and click **Format** and one of the following:

**Align**, to align all fields with the top, left, and so forth field.

**Size**, to make fields equal to the widest, tallest, and so forth field.

**Horizontal Spacing**, to make horizontal spacing equal or to increase or decrease the spacing.

**Vertical Spacing**, to make vertical spacing equal or to increase or decrease the spacing.

## EXERCISES

E-1. Use Microsoft Access to view the HARDWARE INVESTMENT REPORT. If you are familiar with Microsoft Access, use the **File/Export... menu option to save the report as a Web page. When the Export dialogue box opens, click in the Save As Type drop-down list and select HTML Documents.**



E-2. Chip, Dot, and Mike participated in several brainstorming sessions resulting in the outlining of several reports. Design (or modify using Access) the HARDWARE MASTER REPORT. This report is large, and you will have to be careful to include all the data in the report area. You may want to have several detail lines for each record. Print the completed report.



E-3. After meeting with Cher Ware and Hy Perteks to discuss reporting needs, Anna has identified the fields for the partially completed NEW SOFTWARE INSTALLED REPORT. Design (or modify) the report to include the elements found in the data flow repository entry. Is the report a summary or detailed report? In a paragraph, outline the logic that you think the report-producing program must use.



E-4. Both Dot and Mike need to know when new computers have been received. Create the NEW COMPUTER RECEIVED REPORT. The COMPUTER RECEIVED REPORT data flow contains the necessary elements.



E-5. Design the SOFTWARE MASTER REPORT containing pertinent information that helps Cher and Hy to locate the various copies of any software package easily. The elements necessary to produce the report are located on the SOFTWARE MASTER REPORT data flow.



The TITLE, VERSION, OPERATING SYSTEM NAME, PUBLISHER, CATEGORY, and FIRST and LAST NAME of the software expert should be group printed. Totals are to be included for each TITLE/OPERATING SYSTEM/VERSION combination. Print the completed report design.

E-6. Design the HARDWARE INVENTORY LISTING, showing the computers available in each room at each campus. The CAMPUS field should be the CAMPUS DESCRIPTION, not the code representing the campus.



E-7. Design the INSTALLED COMPUTER REPORT, showing personal computers that have been installed in each room. Use the CAMPUS DESCRIPTION and group print by CAMPUS DESCRIPTION and ROOM LOCATION.



E-8. Use Microsoft Access to view the SOFTWARE BY CATEGORY screen report. Click the **Find** button and locate **CASE toolset**. Click the **Next** and **Previous** buttons to view next and previous **Software Categories**.



E-9. Design the SOFTWARE BY MACHINE screen report. Refer to the data flow repository entry for elements.



E-10. Design the COMPUTER PROBLEM REPORT. This report shows all computers that have a large number of repairs or a large repair cost. Refer to the repository description for the data flow for the elements or modify the Microsoft Access report.



E-11. Design or modify the INSTALLATION REPORT. Refer to the repository entry for the data flow for the elements. This report shows which computers have been recently received and are available for installation.



E-12. Design the NEW COMPUTER RECEIVED REPORT. Refer to the repository description for the data flow for the elements or modify the Microsoft Access report. This summary report shows the number of computers of each brand and model. These computers need to be unpacked before they may be installed in rooms.





**E-13.** Design or modify the PREVENTIVE MAINTENANCE REPORT. Refer to the repository entry for the data flow for the elements. This report shows which computers need to have preventive maintenance performed on them.



**E-14.** Design the SOFTWARE CROSS REFERENCE REPORT. Refer to the repository description for the data flow for the elements or modify the Microsoft Access report. This report shows the computer on which each software package is installed. The TITLE, VERSION, OPERATING SYSTEM MEANING, and PUBLISHER are group printed. The detail lines under the group contain data showing the machine, installation campus, and room.



**E-15.** Design or modify the OUTSTANDING COMPUTER PURCHASE ORDERS REPORT. Refer to the repository entry for the data flow for the elements. This report would be produced for all PURCHASE ORDER records that have a purchase order code of M101, representing computers, with the additional condition that the QUANTITY ORDERED on the record must be greater than the QUANTITY RECEIVED. In a paragraph, state whether this report is a summary, exception, or detailed report. Explain.



**E-16.** Design the SOFTWARE INVESTMENT REPORT. Refer to the repository description for the data flow for the elements or modify the Microsoft Access report.



**E-17.** Design the SOFTWARE CROSS REFERENCE Web page. Refer to the repository description for the SOFTWARE CROSS REFERENCE REPORT data flow for the elements on the Web page. This Web page shows the computers on which each software package is installed. Include a drop-down list of software that allows the user to select a software package. The design uses Ajax to refresh the Web page list of computers containing the software and their locations.



**E-18.** Design the HARDWARE INVENTORY LISTING Web page, showing the computers available in each room at each campus. The CAMPUS is selected from a drop-down list displaying the CAMPUS DESCRIPTION. When the user selects a campus name from the drop-down list, the Web page uses Ajax techniques to fill the campus room drop-down list. When a room is selected, the Web page uses Ajax to display the machines located in the room. Use the repository for the HARDWARE INVENTORY LISTING without total number of machines at campus or the total number of machines.

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download sample Microsoft Visio files or a Visible Analyst Project, and a Microsoft Access database that can be used to complete the exercises.

# CHAPTER 12

## Designing Effective Input

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Design functional input forms for users of business systems.
2. Design engaging input displays for users of information systems.
3. Design useful input forms for people interacting on the Web.
4. Design useful input pages for users of intranets and the Internet.



Users deserve quality output. The quality of system input determines the quality of system output. It is vital that input forms, displays, and interactive Web documents be designed with this critical relationship in mind.

Well-designed input forms, displays, and interactive Web fill-in forms should meet the objectives of effectiveness, accuracy, ease of use, consistency, simplicity, and attractiveness. All these objectives are attainable through the use of basic design principles, the knowledge of what is needed as input for the system, and an understanding of how users respond to different elements of forms and displays.

Effectiveness means that input forms, input displays, and fill-in forms on the Web all serve specific purposes for users of the information system, whereas accuracy refers to design that ensures proper completion. Ease of use means that forms and displays are straightforward and require no extra time for users to decipher. Consistency means that all input forms, whether they are input displays or fill-in forms on the Web, group data similarly from one application to the next, whereas simplicity refers to keeping those same designs uncluttered in a manner that focuses the user's attention. Attractiveness implies that users will enjoy using input forms because of their appealing design.

### GOOD FORM DESIGN

The systems analyst should be capable of designing a complete and useful form. Unnecessary forms that waste an organization's resources should be eliminated.

Forms are important instruments for steering the course of work. They are preprinted papers that require people to fill in responses in a standardized way. Forms elicit and capture information required by organizational members that will often be input to the computer. Through this process, forms often serve as source documents for users or for input to ecommerce applications that humans must enter.

To design forms that people find useful, four guidelines for form design should be observed:

1. Make forms easy to fill in.
2. Ensure that forms meet the purpose for which they are designed.
3. Design forms to ensure accurate completion.
4. Keep forms attractive.

Each of the four guidelines is considered separately in the following sections.

## Making Forms Easy to Fill In

To reduce error, speed completion, and facilitate the entry of data, it is essential that forms be easy to fill in. The cost of the forms is minimal compared with the cost of the time employees spend filling them in and then entering data into the information system. It is often possible to eliminate the process of transcribing data that are entered on a form into the system by using electronic submission. That method often features data keyed in by users themselves, who visit Web sites set up for informational or ecommerce transactions.

**FORM FLOW.** Designing a form with proper flow can minimize the time and effort expended by employees in form completion. Forms should flow from left to right and top to bottom. Illogical flow takes extra time and is frustrating. A form that requires people to go directly to the bottom of the form and then skip back up to the top for completion exhibits poor flow.

**SEVEN SECTIONS OF A FORM.** A second method that makes it easy for people to fill out forms correctly is logical grouping of information. The seven main sections of a form are the following:

1. Heading.
2. Identification and access.
3. Instructions.
4. Body.
5. Signature and verification.
6. Totals.
7. Comments.

Ideally, these sections should appear on a page grouped as they are on the Bakerloo Brothers Employee Expense Voucher in Figure 12.1. Notice that the seven sections cover the basic information required on most forms. The top quarter of the form is devoted to three sections: the heading, the identification and access section, and the instructions section.

The heading section usually includes the name and address of the business originating the form. The identification and access section includes codes that may be used to file the report and gain access to it at a later date. (In Chapter 13, we discuss in detail how to access specially keyed information in a database.) This information is very important when an organization is required to keep the document for a specified number of years. The instructions section tells how the form should be filled out and where it should be routed when complete.

The middle of the form is its body, which composes approximately half of the form. This part of the form requires the most detail and development from the person completing it. The body is the part of the form most likely to contain explicit, variable data.

The bottom quarter of the form is composed of three sections: signature and verification, totals, and comments. Requiring ending totals and a summary of comments is a logical way to provide closure for the person filling out the form.

There is one more feature to notice about the Bakerloo Brothers form. The form design provides an internal double check, with column totals and row totals expected to add up to the same number. If the row and column totals don't add up to the same number, the employee filling out the form knows there is a problem and can correct it on the spot. An error is prevented, and the employee can be reimbursed the amount due; both outcomes are attributable to a suitable form design.

**CAPTIONING.** Clear captioning is another technique that can make easy work of filling out a form. Captions tell the person completing the form what to put in a blank line, space, or box. Several options for captioning are shown in Figure 12.2. Two types of line captions, two types of check-off captions, and examples of a boxed caption and table caption are shown.

The advantage of putting the caption below the line is that there is more room on the line itself for data. The disadvantage is that it is sometimes unclear which line is associated with the caption: the line above or below the caption.

Line captions can be to the left of blanks and on the same line, or they can be printed below the line on which data will be entered.

Another way to caption is to provide a box for data instead of a line. Captions can be placed inside, above, or below the box. Boxes on forms help people enter data in the correct place, and they also make reading the form easier for the form's recipient. The caption should use a small

**FIGURE 12.1**

Seven sections found in a well-designed form that help to encourage completion.

**Bakerloo Brothers**  
EMPLOYEE EXPENSE VOUCHER  
Claimant: Make No Entries  
in Shaded Areas

Full Name of Employee _____	Employee ID Number								
Department _____	Voucher Number								
Room Number _____	Action Taken On:								
LIST EXPENSES FOR EACH DAY SEPARATELY. ATTACH RECEIPTS FOR ALL EXPENSES EXCEPT MEALS, TAXIS, AND MISCELLANEOUS ITEMS LESS THAN \$3.00. ITEMIZE ALL MISCELLANEOUS EXPENSES.									
Date / /	Place City, State	Meal Expenses	Lodging Expenses	Automobile		Miscellaneous		Taxi Cost	Total Cost
<b>Totals</b>									
I certify that all the above information is correct									
Signature of Claimant				Date					
Approved by				Date					
Form BB-104 01/2009									

type size so that it does not dominate the entry area. Small vertical tick marks may be included in the box if the data is intended for entry into a computer system. If there is not enough room on a record for the data, the person filling out the form, rather than the data entry operator, has the freedom to determine how the data should be abbreviated. Captions may also include small clarification notes to help the user correctly enter the information, such as Date (MM/DD/YYYY) or Name (Last, First, Middle Initial).

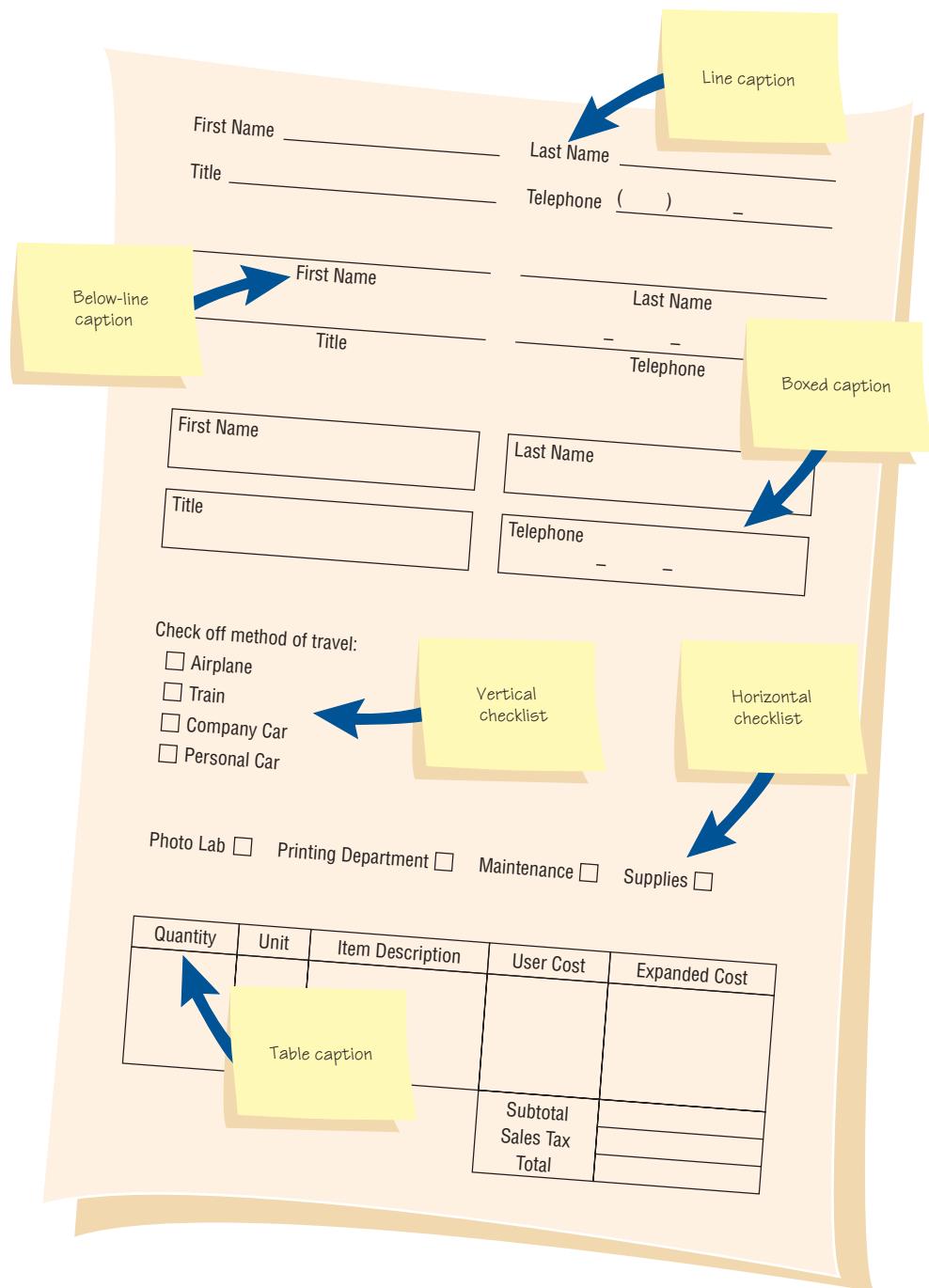
Whatever styles of line caption are chosen, it is important to employ them consistently. For instance, it is confusing to fill out a form that has both above- and below-line captions.

Check-off captions are superior when response options are necessarily restricted. Notice the list of travel methods shown for the vertical check-off example in the previous figure. If employee expenses for business travel are reimbursed only for those travel methods listed, a check-off system is more expedient than a blank line. This method has the added advantage of reminding the person who is verifying the data to look for an airline ticket stub or other receipt.

A horizontal check-off caption is also superior to a line caption when information required is routine and constant. An example is a form that would request services from one of the following

**FIGURE 12.2**

Major captioning alternatives.



departments: Photo Lab, Printing Department, Maintenance, or Supplies. The departments routinely provide services to others in the organization and are not likely to change quickly.

Table captions work well in the body of a form on which details are required. When an employee properly fills out a form with table captions, he or she is creating a table for the next person receiving the form, thereby helping to organize data coherently.

A combination of captions can also be used effectively. For example, table captions can be used to specify categories such as quantity, and line captions can be used to indicate where the subtotal, sales tax, and total should be. Because different captions serve different purposes, it is generally necessary to employ several caption styles in each form.

### Meeting the Intended Purpose

Forms are created to serve one or more purposes in the recording, processing, storing, and retrieving of information for businesses. Sometimes it is desirable to provide different information to

different departments or users but still share some basic information. This situation is where specialty forms are useful.

The term *specialty form* can also refer solely to the way forms are prepared by the stationer. Examples of stationers' specialty forms are multiple-part forms that are used to create instant triplicates of data, continuous-feed forms that run through the printer without intervention, and perforated forms that leave a stub behind as a record when they are separated.

## Ensuring Accurate Completion

Error rates typically associated with collecting data will drop sharply when forms are designed to ensure accurate completion. Design is important for ensuring that people do the right thing with the form whenever they use it. When service employees such as meter readers or inventory takers use handheld devices to scan or otherwise key in data at the appropriate site, the extra step of transcription during data entry is avoided. Handheld devices use wireless transmission, or are plugged back into larger computer systems so they can upload the data that the service worker has stored. No further transcription of what has occurred in the field is necessary.

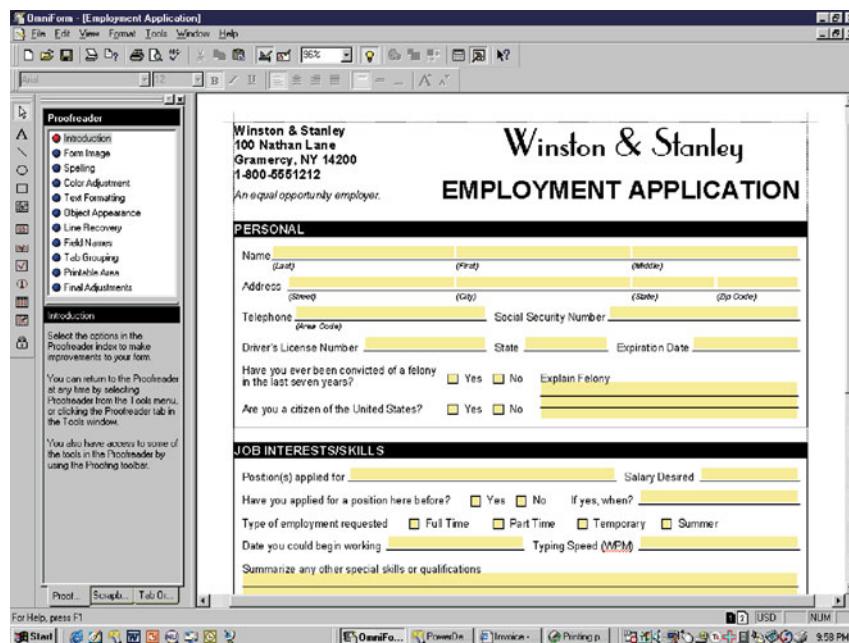
## Keeping Forms Attractive

Although attractiveness of forms is dealt with last, its order of appearance is not meant to diminish its importance. Rather, it is addressed last because making forms appealing is accomplished by applying the techniques discussed in the preceding sections. Aesthetic forms draw people into them and encourage completion.

Forms should look uncluttered. To be attractive, forms should elicit information in the expected order: convention dictates asking for name, street address, city, state, and zip or postal code (and country, if necessary). Proper layout and flow contribute to a form's attractiveness.

Using different type fonts in the same form can help make it appealing for users to fill in. Separating categories and subcategories with thick and thin lines can also encourage interest in the form. Type fonts and line weights are useful design elements for capturing attention and making people feel secure that they are filling in the form correctly.

Forms design packages are available for PCs. Figure 12.3 shows how forms can be created using software that allows the analyst to automate quickly business processes for which paper forms are already in existence. The analyst can use a set of tools to set up fields, check boxes, lines, boxes, and many other features. Paper forms can also be scanned in and then published to the Web.



**FIGURE 12.3**

Software allows a user to take an existing form, scan it into the computer, and define fields so that the form can be easily filled out on a PC.

### Controlling Business Forms

Controlling business forms is an important task. Businesses often have a forms specialist who controls forms, but sometimes this job falls to the systems analyst, who sets up and implements forms control.

The basic duties for controlling forms include making sure that each form in use fulfills its specific purpose in helping workers accomplish their tasks and that the specified purpose is integral to organizational functioning, preventing duplication of the information that is collected and of the forms that collect it, designing effective forms, deciding on how to reproduce forms in the most economical way, and establishing procedures that make forms available (when needed) at the lowest possible cost. Often this entails making forms available on the Web for printing out. A unique form number and revision date (month/year) should be included on each form, regardless of whether it is completed and submitted manually or electronically. This helps users be organized and efficient.

## GOOD DISPLAY AND WEB FORMS DESIGN

Much of what we have already said about good form design is transferable to display design and the design of Web sites and Web pages. Once again, the user must remain foremost in the analyst's thoughts during the design of displays.

There are differences, however, and systems analysts should strive to realize the unique qualities of displays rather than to adopt blindly the conventions of paper forms. One big difference is the constant presence of a cursor on the display, which orients the user to the current data entry position. As data are entered onscreen, the cursor moves one character ahead, pointing the way.

Another major difference among electronic, Web, and static forms is that designers can include context-sensitive user help in any electronic fill-in form. This practice can reduce the need for instructions being shown for each line, thus reducing the clutter of the form and cutting down on calls to Technical Support. Using a Web-based approach also permits the designer to take advantage of hyperlinks, thus ensuring that the forms are filled out correctly by providing users with hyperlinked examples of correctly completed forms.

In this section, we present guidelines for effective display design. They are presented in order to aid the attainment of the overall input design goals of effectiveness, accuracy, ease of use, simplicity, consistency, and attractiveness.

The four guidelines for display design are important but not exhaustive. As noted in Chapter 11, they include the following:

1. Keep the display simple.
2. Keep the display presentation consistent.
3. Facilitate user movement among display screens and pages.
4. Create an attractive and pleasing display.

In the next subsections, we develop each of these guidelines, and we present many design techniques for observing the four guidelines.

### Keeping the Display Simple

The first guideline for good display design is to keep the display simple. The display should show only that which is necessary for the particular action being undertaken. For the occasional user, 50 percent of the display area should contain useful information.

**THREE SCREEN SECTIONS.** Display output should be divided into three sections. The top of the screen features a “heading” section. The heading contains titles of software and open files, pull-down menus, and icons that do certain tasks.

The middle section is called the “body” of the display. The body can be used for data entry and is organized from left to right and top to bottom, because people in Western cultures move their eyes on a page in this way. Captions and instructions should be supplied in this section to help the user enter the pertinent data in the right place. Context-sensitive help can also be made available by having the user click the right mouse button in the body section of the display.



## CONSULTING OPPORTUNITY 12.1

### This Form May Be Hazardous to Your Health

**F**igure 12.C1 is a printed medical history form that Dr. Mike Robe, a family practitioner, has his receptionist give to all new patients. All patients must fill it out before they see the doctor.

The receptionist is getting back many incomplete or confusing responses, which makes it difficult for Dr. Robe to review the forms and understand why the new patient is there. In addition, the poor responses make it time consuming for the receptionist to enter new patients into the files.

Redesign the form on 8½" × 11" paper so that pertinent new patient data can be collected in a logical and inoffensive way. Make sure the form is self-explanatory to new patients. It should also be easy for Dr. Robe to read and easy for the receptionist to enter into the patient database, which is sorted by patient name and Social Security number. The office uses PCs connected by a LAN. How would you redesign the form so that it can be electronically submitted by the receptionist? Which office procedures would you have to change?

<b>Medical History Form</b>		
Name _____	Employer _____	Age _____
Address _____	Zip _____	Phone _____ Office _____
Insurer _____	Is this [ ] your policy [ ] your spouse's policy	
Blue Cross [ ] State Physician's Service [ ] Other [ ] (state) _____		
Have you ever had surgery? Yes _____ No _____ If so, when? _____		
Describe the surgery _____		
Have you ever been hospitalized? Yes _____ No _____ If so, when? _____		
Why? _____		
Complete the following.		
Diabetes	I have had	Family history
Heart trouble	<input type="checkbox"/>	<input type="checkbox"/>
Cancer	<input type="checkbox"/>	<input type="checkbox"/>
Seizure	<input type="checkbox"/>	<input type="checkbox"/>
Fainting	<input type="checkbox"/>	<input type="checkbox"/>
What have you been immunized for?		
Family: _____	Spouse or next of kin	Relationship
		Address _____
Date of last exam ____ / ____	Who referred you? _____	
Why are you seeing the doctor today?		
Are you currently having pain? _____ Constant _____ Sporadic _____		
How long does it last? _____ Please give us your soc. sec. # _____		
IMPORTANT! We need your correct insurance carrier number _____		

**FIGURE 12.C1**

Your help in improving this form is greatly appreciated.

The third section of the display is the “comments and instructions” section. This section may display a short menu of commands that remind the user of basics such as how to change pages or functions, save the file, or terminate entry. Inclusion of such basics can make inexperienced users feel infinitely more secure about their ability to complete their task.

Other ways to keep the display simple is to use context-sensitive help, roll-over buttons that reveal more information, and other pop-up windows. Users can minimize or maximize the size of windows as needed. In this way, users start with a simple, well-designed display that they can customize and control through the use of multiple windows. Hyperlinks on a Web-based fill-in form serve a similar purpose.

### Keeping the Display Consistent

The second guideline for good display design is to keep the display consistent. If users are working from paper forms, displays should follow what is shown on paper. Displays can be kept consistent by locating information in the same area each time a new display is accessed. Also, information that logically belongs together should be consistently grouped together: Name and address go together, not name and zip code. Although the display should have a natural movement from one region to another, information should not overlap from one group to another. You would not want name and address in one area and zip code in another.

### Facilitating Movement

The third guideline for good display design is to make it easy to move from one page to another. The “three-clicks” rule says that users should be able to get to the pages they need within three mouse or keyboard clicks. Web-based forms facilitate movement with the use of hyperlinks to other relevant Web pages. Another common method for movement is to have users feel as if they are physically moving to a new page. This illusion of physical movement among screens can be obtained by scrolling using arrows, context-sensitive pop-up windows, or on-screen dialog.

### Designing an Attractive and Pleasing Display

The fourth guideline for good display design is to create an attractive display for the user. If users find displays appealing, they are likely to be more productive, need less supervision, and make fewer errors. Displays should draw users into them and hold their attention. This goal is accomplished with the use of plenty of open area surrounding data entry fields so that the display achieves an uncluttered appearance. You would never crowd a form; similarly, you should never crowd a display. You are far better off using multiple windows or hyperlinks than jamming everything onto one page.

Use logical flows in the plan to your display pages. Organize material to take advantage of the way people conceptualize their work so that they can easily find their way around. With the advent of GUIs, it is possible to make input displays very attractive. By using color or shaded boxes and creating three-dimensional boxes and arrows, you can make forms user friendly and fun to use.

When contemplating the use of different font styles and sizes, ask yourself if they truly assist the user in understanding and approving of the display. If they draw undue attention to the art of display design or if they serve as a distraction, leave them out. Be aware that not all Web pages are viewed identically by different browsers. Test your prototype forms with a variety of combinations to see if users declare preferences for combinations or whether they are distressing to the majority of users. For Web fonts use Verdana or Arial.

### Using Icons in Display Design

Icons are pictorial, onscreen representations symbolizing computer actions that users may select using a mouse, keyboard, lightpen, touch screen, or joystick. Icons serve functions similar to those of words and may replace them in many menus, because their meaning is more quickly grasped than words. Mobile devices such as Apple’s iPhone and iPod have popularized the use of icons on touch screens and made this a familiar interface for many business and other users.

There are some guidelines for the design of effective icons. Shapes should be readily recognizable so that the user is not required to master a new vocabulary. Numerous icons are already known to most users. Use of standard icons can quickly tap into this reservoir of common



## CONSULTING OPPORTUNITY 12.2

### Squeezin' Isn't Pleasin'

The Audiology Department in a large veteran's hospital is using a PC and monitor so that audiology technicians can enter data directly into the patient records system. After talking with Earl Lobes, one of the technicians, you determine that the screen design is a major problem.

"We used a form at one time, and that was decent," said Mr. Lobes. "The display doesn't make sense, though. I guess they had to squeeze everything on there, and that ruined it."

You have been asked to redesign the display (see Figure 12.C2) to capture the same information but simplify it, and by doing so reduce the errors that have been plaguing the technicians. You realize that squeezing isn't the only problem with the display.

Explain your reasons for changing the display as you did. You may use more than one display page if you think it is necessary.

AUDIOLOGICAL EXAMINATION REPORT											
Patient Last Name		Examining Station		First		Middle Initial					
Patient Number				Date of Exam							
First Exam				Social Security Number							
AIR CONDUCTION											
Right ear						Left ear					
500	1000	2000	4000	6000		500	1000	2000	4000	6000	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>					
BONE CONDUCTION											
Right ear						Left ear					
500	1000	2000	4000	6000		500	1000	2000	4000	6000	
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>		<input type="checkbox"/>					
SPEECH AUDIOMETRY SECT.											
SPEECH RECEP. THRESHOLD											
Right Ear [ ]	Comments [ ]										
Left Ear [ ]	Referred by [ ]										
RIGHT EAR DISCR.	Reason for referral										
% [ ] Masking [ ]	Examining Audiologist										
LEFT EAR DISCRIM. Exam. Audiologist's No.											
% [ ] Masking [ ]	Next Appt.										

**FIGURE 12.C2**

This screen can be designed to be more user friendly.

meaning. A user may point to a file cabinet, "pull out" a file folder icon, "grab" a piece of paper icon, and "throw" it in the wastebasket icon. By employing standard icons, designers and users all save time.

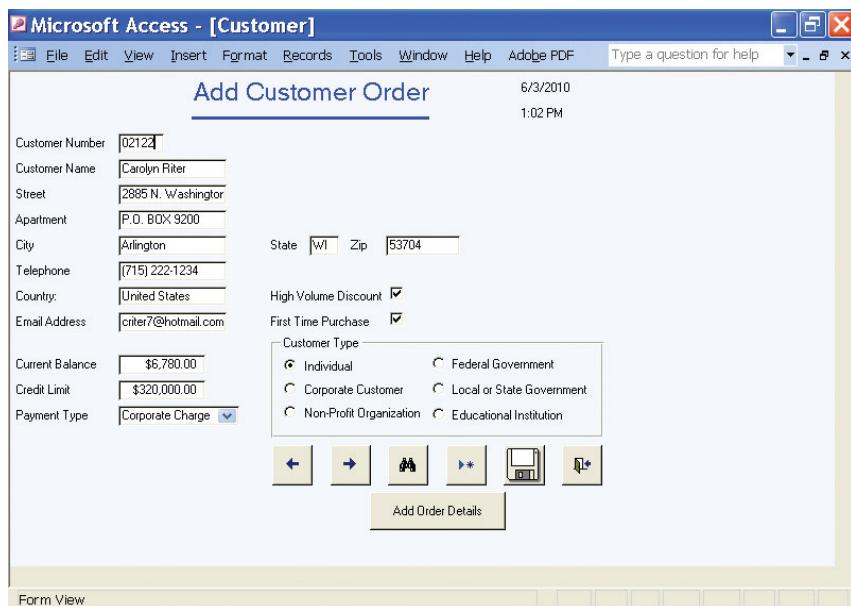
Icons for a particular application should be limited to approximately 20 recognizable shapes, so that icon vocabulary is not overwhelming and so that a worthwhile coding scheme can still be realized. Use icons consistently throughout applications where they will appear together to ensure continuity and understandability. Generally, icons are worthwhile for users if they are meaningful.

### Graphical User Interface Design

A graphical user interface (GUI, pronounced "goo'ë") is the way that users interface with the Windows and Macintosh operating systems. This is also referred to as a point-and-click interface. Users can use a mouse to click on an object and drag it into position. Graphical user interfaces

**FIGURE 12.4**

The designer has many GUI components that allow flexibility in designing input screens for the Web or other software packages. This example is from Microsoft Access.



take advantage of additional features in display design such as text boxes, check boxes, option buttons, list and drop-down list boxes, sliders and spin buttons, tab control dialog boxes, and image maps. Figure 12.4 is a Microsoft Access input display showing a variety of GUI controls.

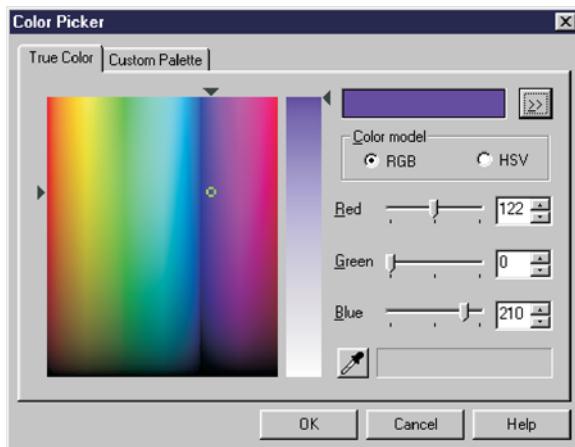
**TEXT BOXES.** A rectangle represents a text box, as mentioned previously, and is used to outline data entry and display fields. Care must be taken to ensure that the text box is large enough to accommodate all the characters that must be entered. Each text box should have a caption to the left, identifying what is to be entered or what is displayed in the box. In Microsoft Access, character data are aligned on the left, and numeric data are aligned on the right.

**CHECK BOXES.** In the GUI controls example, a check box is used to indicate a new customer. Check boxes contain an **X** or are empty, corresponding to whether or not the user selected the option; they are used for nonexclusive choices in which one or more of the options may be checked. An alternative notation is to use a square button with a check mark (**✓**) to indicate that the option has been selected. Note that check box text, or label, is usually placed to the right of the box. If there is more than one check box, the labels should have some order to them, either alphabetic or with the most commonly checked item appearing first in a list. If there are more than 10 check boxes, group them together in a bordered box.

**OPTION BUTTONS.** A circle, called an option button or a radio button, is used to select exclusive choices. Only one of several options can be chosen. In this way you can make it clear to users that they must decide among options. Choices are again listed to the right of the button, usually in some sequence. If there is a commonly selected option, it is usually selected as a default when the page first displays. Often there is a rectangle, called an option group, surrounding the radio buttons. If there are more than six option buttons, consider using a list box or a drop-down list box.

**LIST AND DROP-DOWN LIST BOXES.** A list box displays several options that may be selected with the mouse. A drop-down list box is used when there is little room available on the page. A single rectangle with an arrow points down toward a line located on the right side of the rectangle. Selecting this arrow causes a list box to be displayed. Once a user makes a choice, it is displayed in the drop-down selection rectangle and the list box disappears. If there is a commonly selected choice, it is usually displayed in the drop-down list by default.

**TAB CONTROL DIALOG BOXES.** Tab control dialog boxes are another part of graphical user interfaces and another way to get users organized and into system material efficiently. In designing tab control boxes, create a separate tab for each unique feature, place the most commonly used tabs in front and display them first, and include buttons for OK, Cancel, and Help.

**FIGURE 12.5**

Sliders and spin buttons are two additional GUI components the analyst can use to design input screens.

**SLIDERS AND SPIN BUTTONS.** Sliders and spin buttons are used to change data that have a continuous range of values, giving users more control when choosing values. Moving the slider in one direction or the other (either left/right or up/down) increases or decreases the values. Figure 12.5 illustrates the use of sliders to change the amount of red, green, and blue when selecting a new color. Spin buttons are also used to change a continuous value and are shown to the right of the sliders.

**IMAGE MAPS.** Image map fields are used to select values within an image. The user clicks on a point within an image and the corresponding *x*- and *y*-coordinates are sent to the program. Image maps are used when creating Web pages containing maps with instructions to click in a certain area in order to view a detailed map of the region.

**TEXT AREAS.** A text area is used for entering a larger amount of text. These areas include a number of rows, columns, and scroll bars that allow the user to enter and view text greater than the size of the box area. There are two ways to handle this text. One is to avoid the use of word wrap, forcing the user to press the **Enter** key to move to the next line; the text will scroll to the right if it exceeds the width of the text area. The other option is to allow word wrap.

**MESSAGE BOXES.** Message boxes are used to warn users and provide other feedback messages in a dialog box, often overlapping the display. These message boxes have different formats. Each should appear in a rectangular window and should clearly spell out the message so that the user knows precisely what is happening and what actions are possible.

**COMMAND BUTTONS.** A command button performs an action when the user selects it with the mouse. Calculate Total, Add Order, and OK are all examples. The text is centered inside the button, which has a rectangular shape. If there is a default action, the text is surrounded with a dashed line. The button may also be shaded to indicate that it is the default. Users press the Enter key to select the default button.

### Form Controls and Values

Each of the controls included in a GUI interface must have some way of storing the data associated with the control. On a Web page this is done using a name and a value pair that are transmitted to the server or in an email sent along with the form, such as a name of city and a value of Paris. The name is defined on the Web page form and the server software must recognize the name to understand what to do with the value or data sent with the Web form.

How the value is obtained differs for each Web form control. In text boxes or text areas, the value consists of the characters keyed into the boxes. In radio buttons and check boxes, the text that displays to the right of each radio button or check box is for human use only. The value is defined in the Web form and is transmitted when the form is sent. If these data are used to update a database, the values are often codes that are sent and then stored at the server, and the analyst must decide what the appropriate values should be when each radio button or check box is clicked. Drop-down lists are somewhat different from radio buttons or check boxes in that there are many options for a given drop-down list. Values must be decided for each of the drop-down list options

**FIGURE 12.6**

A Web-based input form for users to register for a cruise.

The screenshot shows a Mozilla Firefox browser window displaying a cruise registration form. The title bar reads "Festive Seas Cruise Registration Form - Mozilla Firefox". The address bar shows the URL "http://www.festiveseascruise.com/register.php". The main content area has a header "Festive Seas Cruise Registration Form" flanked by two circular icons of cruise ships. Below the header is a sub-header: "Complete and print this form to register for the summer cruise season. You will be contacted by one of our friendly service representatives." The form contains the following fields:

- Last Name: Chen
- First Name: David
- Middle Name: R
- Address: 123 Oak St
- City: Breckenridge
- State: Colorado
- Zip: 80424
- Phone: (970) 231-2244
- Email: dchen@skhillcondo.org

Below these fields is a note: "Please choose a 4-day, 7-day or 14-day cruise. If you prefer an ocean view room, please click on the box directly below the cruise you choose."

For a 4-day cruise, there are two radio buttons:

- I wish to sail on the 14-day cruise. Cost per person \$1950
- I prefer an ocean side room. Add \$490

For a 7-day cruise, there are two radio buttons:

- I wish to sail on the 7-day cruise. Cost per person \$1150
- I prefer an ocean side room. Add \$290

For a 14-day cruise, there are two radio buttons:

- I wish to sail on the 4-day cruise. Cost per person \$825
- I prefer an ocean side room. Add \$190

At the bottom left is a text box labeled "Total amount due" containing "1440". At the bottom right are "Submit" and "Reset" buttons.

and, when an option is chosen, the selected value is sent with the form. Form values may also be used in calculations that are performed using JavaScript on the browser. These may be used to multiply, add, and make decisions.

Figure 12.6 is an example of a form used to obtain prices and to register for a cruise. The text in the Name, Address, City, State, Zip, Phone, and Email areas is sent to the server when the form is submitted. Only one of the radio buttons for the 4-day, 7-day, or 14-day cruise may be selected. The values sent are S for short if the 4-day cruise is selected, A for average length if 7 days has been selected, and L for a long cruise if the 14-day cruise is selected. In addition, when one of these cruises is selected, the dollar amount is inserted into one of the text boxes on the left side of the Web form, and any previously selected radio buttons and amounts are cleared. If the ocean side room check box is checked, a value of Y for yes is transmitted to the server, the amount is inserted into the left-side text box, and the total is updated. If the customer tries to change the amounts in the calculated text boxes, they are reset. When the submit button is clicked, the amounts are sent to the server along with all the other data.

### Hidden Fields

Another type of control found on Web forms is a hidden field. These are not visible to the viewer, do not take up any space on the Web page, and can contain only a name and a value. Often hidden fields are used to store values sent from one Web form to the server. These typically need to be included on a second form when multiple forms are required to capture all the transaction data. Sometimes they are used to retain information about the type of browser being used, the viewer's operating system, and so on. Sometimes a hidden field will contain a key field used to locate a record for the customer or the browsing session.

### Event-Response Charts

When there are complicated interactions on a Web form (or any other GUI form), an event-response chart may be used to list the variety of events that can occur. Event-response charts may be used at a high level to model business events and responses (covered in Chapter 7), but the events that occur on a Web form or other display are usually limited to user actions. These events may be clicking a button, changing a value, focusing the field (moving the cursor inside the field or to a radio button, check box, or other control), blurring a field (the user moves the cursor out of the field), loading the Web page, detecting keystrokes, and many other events. The response lists how the Web page should react when the event occurs. Events are for a particular object, such as a button, a text field, the whole Web page, and so on.

**FIGURE 12.7**

A Web site permitting users to estimate the cost of staying at Azure Islé Resort. Cost changes depend on the number of people included, length of stay, and extra activities added.

Figure 12.7 is a Web site used to estimate the cost of staying at Azure Islé Resort. The user can enter the number of people, change the starting and ending dates, and enter the number of people for a variety of extra activities, such as scuba diving or golf.

The event-response chart is shown in Figure 12.8. Notice that there may be a number of events for each Web form control. Since the user may do any number of actions in any order, the event-response chart is useful to show what should happen. For example, the user may click the Calculate button first, change the starting and ending dates, or change the number of people. The event-response chart is also useful for building a Web form that requires minimal action from the user. An example of this is when the user changes the starting month or day; the ending month or day is then changed to match the starting month or day. The year changes when the month is earlier than the current month, since people cannot stay at the resort prior to the current day in the same year.

Sometimes the event-response chart may be used to explore improvements to the Web page. Suppose that Azure Islé Resort determined that most of its customers stayed for seven days. When the starting month or day changes, the ending date could be set for seven days in the future as a default. It might also be a good idea to have radio buttons that allow the customer to select a stay of 4, 7, or 14 days and calculate the ending date. Other improvements to a Web page might be detecting when a number of characters have been entered, for example the three digits that comprise a U.S. telephone area code, and then moving the cursor into the next field.

Events are not limited to working within a single Web page. They may also be used to control navigation among Web pages. This can happen when changing a selection in a drop-down list or clicking a radio button. Events may also be used to change the contents of drop-down lists. For example, on a job search page, by selecting one category of job, detailed positions for that job appear in a second drop-down list.

### Dynamic Web Pages

Dynamic Web pages change themselves as the result of user action. They often use JavaScript to modify some part of the Web page or a style. Changing an image when the mouse moves over it or rotating random images at a given time interval are common examples of dynamic Web pages. The Web page may detect the width of the browser window and modify the page accordingly. Menus that expand when the user clicks a small plus sign to the left of the menu or when the mouse moves over a menu are other examples of dynamic Web pages.

The power of dynamic Web pages has been greatly expanded in recent Web browsers. By using JavaScript, a Web form may morph or change itself to add new fields or remove old fields, or change field attributes, such as the length of a field or a radio button changing into a

Form Control	Event	Response
Web Page	Page loads	Place the current year in the <b>Starting Year</b> and <b>Ending Year</b> fields.
Number of People	Value changes	Place the cursor in the <b>Number of People</b> field. Verify that <b>Number of People</b> contains a number greater than zero.
Starting Month	Selection changes	Set the <b>Ending Month</b> in the drop-down list to the <b>Starting Month</b> . If the month is less than the current month, change the <b>Starting Year</b> and <b>Ending Year</b> values to the next year.
Starting Day	Selection changes	Set the <b>Ending Day</b> in the drop-down list to the <b>Starting Day</b> . Use the <b>Starting Month</b> value to set the <b>Starting Year</b> and <b>Ending Year</b> values.
Starting Year	Receives focus	Use the <b>Starting Month</b> value to calculate the <b>Starting Year</b> and <b>Ending Year</b> values.
Number of Days	Receives focus; value changes	Calculate the <b>Number of Days</b> that the customer is staying. If the number is less than or equal to zero, display an error message.
Basic Charge	Receives focus	Calculate the <b>Basic Charge</b> and put the cursor in the <b>Scuba Adventure Number of People</b> field.
Scuba Adventure Number of People	Receives focus	Select the current amount displayed (zero) so the customer may replace it.
Scuba Adventure Number of People	Value changes	Calculate the <b>Scuba Cost</b> based on the value of <b>Scuba Adventure Number of People</b> and put the cursor in the <b>Golf Number of People</b> field.
Scuba Cost	Value changes	Recalculate the <b>Scuba Cost</b> and put the cursor in the <b>Golf Number of People</b> field.
Golf Number of People	Receives focus	Select the current amount (zero) so the customer may replace it.
Golf Number of People	Value changes	Calculate the <b>Golf Cost</b> and put the cursor in the <b>Horseback Riding Number of People</b> field.
Golf Cost	Value changes	Recalculate the <b>Golf Cost</b> and put the cursor in the <b>Horseback Riding Number of People</b> field.
Horseback Riding Number of People	Receives focus	Select the current amount displayed (zero) so the customer may replace it.
Horseback Riding Number of People	Value changes	Calculate the <b>Horseback Riding Cost</b> based on the value of <b>Horseback Riding Number of People</b> and put the cursor in the <b>Last Name</b> field.
Horseback Riding Cost	Value changes	Recalculate the <b>Horseback Riding Cost</b> and put the cursor in the <b>Last Name</b> field.
Total Cost	Value changes	Calculate the total cost and put the cursor in the <b>Last Name</b> field.
Calculate Button	Button clicked	Validate the form data and display an error message if any errors occur.
Reset Button	Button clicked	Calculate the <b>Total Cost</b> if there are no errors.
Print Button	Button clicked	Clear the form and place the current year in the <b>Starting Year</b> and <b>Ending Year</b> fields. Place the cursor in the <b>Number of People</b> field.
Submit Button	Button clicked	Validate the form data and display an error message if any errors occur. Calculate <b>Total Cost</b> if there are no errors. Use a Web cookie to pass the data to a confirmation page that does not allow the users to change any data.
		Validate the form data and display an error message if any errors occur. Calculate <b>Total Cost</b> if there are no errors. Send the form to the server and send confirmation to the user.

**FIGURE 12.8**

An event-response chart that lists the form control, event, and response for a number of events that can occur as a user interacts with the Azure Islé Resort cost estimator screen.

check box. This makes the Web page more responsive to user actions and often will eliminate the need to load new Web pages based on user choices.

The analyst should think about the information that would make sense to the Web site viewer. For example, placing the country selection list on a Web page before other address elements would allow the user to change the country list and then to change captions to reflect the country. If the person selected United States from the drop-down list, the captions would say ‘State’ and ‘Zip Code.’ If the country was Canada, the captions would say ‘Province’ and ‘Postal Code.’ If Japan, ‘Prefecture’ and ‘Mail Code.’

### Three-Dimensional Web Pages

Dynamic Web pages may also be used to temporarily display information, such as a block of help information, a calendar with clickable dates used to assist date entry fields, airport codes, and other information. This information may be stored by using a series of stacked layers (using the cascading styles *z-index* property) in the Web page design, each on top of another. The main Web page is the base plane, the standard layer of the Web page that displays or obtains information, while others below the page are not visible.

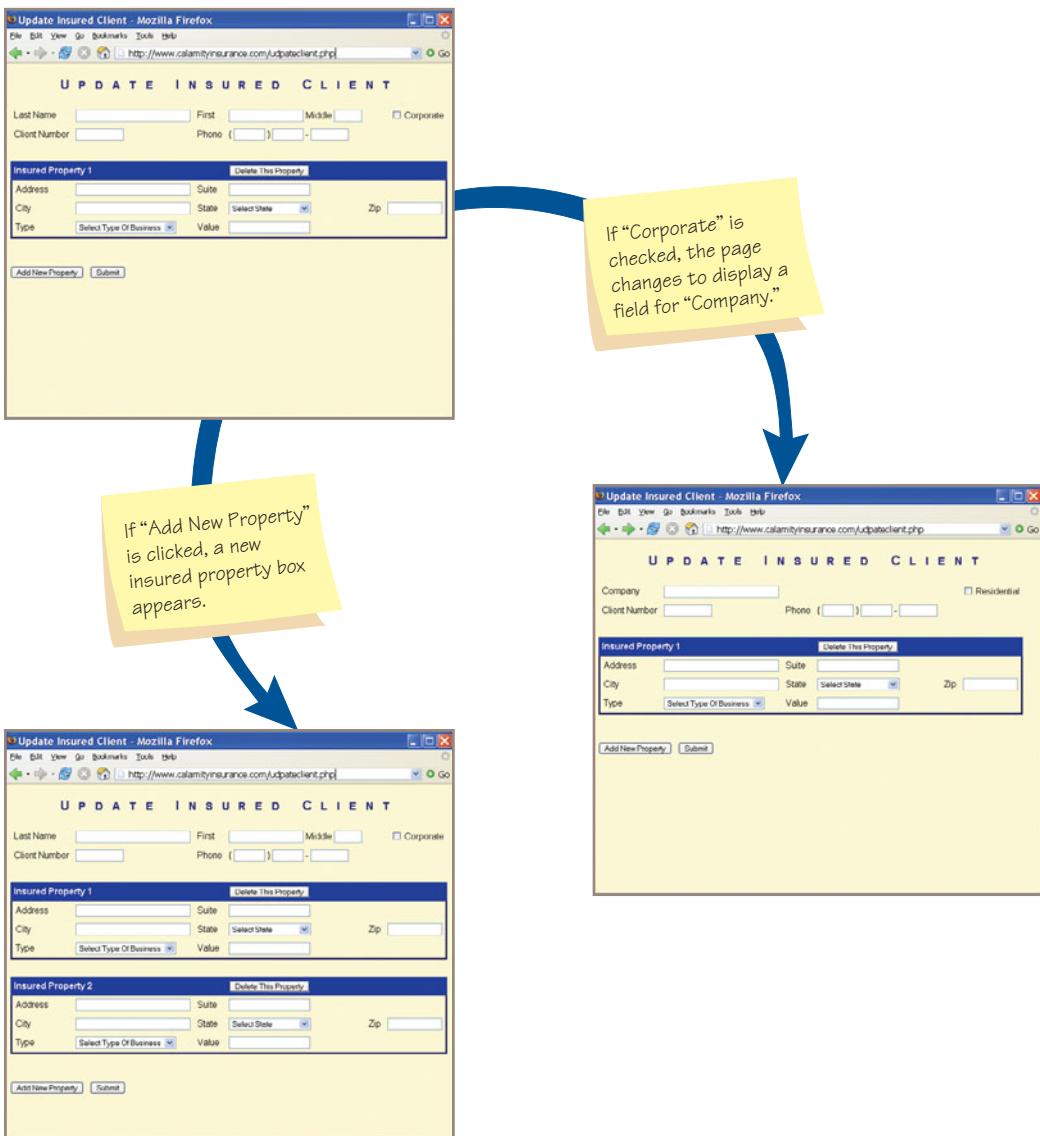
When help is requested or the user clicks in the date field, the layer is either moved to the top and becomes visible or is generated by JavaScript code and appears. The position of the layer is determined by the designer or analyst, such as a calendar appearing on the right side of a date field. When a date is selected, a close link is clicked, or the user clicks outside of the calendar, the layer then moves below the surface of the Web page or is removed. The analyst must determine when it makes sense to include a layer, often examining each field on a Web page to determine if additional information would help to ensure accurate information and good communication with the user.

The analyst should determine the following:

1. ***How is the layer built?*** Is it created using JavaScript code, such as a calendar, or is additional information required to build the layer? If additional information is required, where is the data located and how should it be obtained? Ideally the information is obtained from only one database table on the server using Ajax techniques.
2. ***What events cause the layer to be created?*** These include a user clicking or tabbing into a field, clicking a link, or counting the number of keystrokes entered into a field. An example would be a hotel chain with many locations. To include all the locations in a drop-down list would make the list too long. When the user enters three characters, a block surfaces listing hotels starting with those three letters, including the country, city, state or province, and other information. If the event was detecting only two letters, the list may be too large for the display block.
3. ***What events remove the layer, such as a close button, clicking a date, clicking outside the region, or selecting a hotel from the list?***
4. ***Where should the surfaced block be placed?*** Typically next to the field that created the block, in *x*- and *y*-coordinates.
5. ***How large should the block be, measured in pixels?*** If the information is too large for the block, such as a list of hotels, the analyst should decide how to handle the additional information. Options include adding scroll bars or positioning a link at the bottom to the next page of information.
6. ***What should the region formatting attributes, such as color and border, be?*** If there is a series of links, review their appearance with the users. Ask the users if they would like the color to change as the mouse moves over each row.
7. ***What should happen when an option is selected?*** In the case of a reservation calendar, when a date is clicked, the date is placed in the starting date. If a hotel is selected, the city, state or province, and country information, along with a link to the hotel, should populate the Web form fields.

Using layers is an effective way to build Web sites since it does not require any pop-up pages (which may be blocked by Internet security software). Additionally, a new Web page does not have to load, and, because the information is contained in a layer, it does not take up any space on the main Web page.

Figure 12.9 is an example of a Web form used by an insurance company to change client information; to add a new location for a client, such as a new store or restaurant for an existing client; or

**FIGURE 12.9**

An example of a dynamic Web page from an insurance company. If a user clicks on “Add New Property,” a new insured property box appears.

to remove a store for the client. If the **Corporate** check box is checked, the **Last Name**, **First Name**, and **Middle** are changed to a **Company** name field, with the caption text changing as well. If the **Add New Property** button is clicked, a new set of fields for the third property is added. Care must be taken to generate unique names that the server will recognize for the additional fields. When the form is submitted, the server updates the database tables for the additional fields.

The analyst must decide when the use of dynamic Web pages is appropriate. If the data change when other parts of the Web page change (such as clicking a radio button or selecting an item from a drop-down list), it may be good policy to design the Web pages as a dynamic form. If, however, some parts of the Web form are unsecured and other parts require encryption, it is probably best not to use dynamic forms.

A good example of a form that modifies itself may be found at Expedia.com ([www.expedia.com](http://www.expedia.com)). Clicking radio buttons for a flight, hotel, car, or cruise causes the form to change to gather the data appropriate to reserving a flight, hotel, and so on.

Dynamic Web pages have the advantage of modifying themselves quickly, with fewer interruptions to send and receive data from the server. However, there are several disadvantages when creating dynamic Web pages. One is that they will not work if JavaScript is turned off. The analyst must decide what to do in this situation.

If the person must use the Web site (as in a corporate intranet environment, in a site used to obtain student loans, or in the case of processing government or other transactions), the Web page

can state clearly that it will not function if JavaScript is turned off and then direct the user on how to turn it on. Most commerce Web sites will not require JavaScript to be turned on and will have an alternate Web site for customers.

A second disadvantage when using dynamic Web pages is that they may not be compliant with the American Disabilities Act. (For more on Web accessibility for all users, please see Chapter 14 on designing human-computer interaction.)

## Ajax (Asynchronous JavaScript and XML)

Ajax is a technique that works in more recent Web browsers. It involves the use of JavaScript and extensible markup language (XML). Traditionally, each time a Web page needed data from a different database table, a request was sent to the server and a whole new page was loaded. This is effective but slow, because an entire page must be loaded just to provide additional data for a drop-down list or some other Web form control based on the one selected previously.

Ajax allows Web developers to build a Web page that works more like a traditional desktop program. As new data are needed, the browser sends a request to the server, and the server sends a small amount of data back to the browser, which updates the current page. This means that the viewer does not experience an interruption of work and the Web page does not reload. The page is dynamically updated with the new data.

The data may be either a small text file or an XML document containing many customers or other repeating data. If the data is an XML file, each customer element is called a node, and each node is numbered (starting with zero) from the beginning of the XML document. This allows the Web page to go to the first or last customer or to loop through all the customers one by one with a button click.

Let's say a systems analyst was designing a traditional Web site, without Ajax, for making a reservation for a European ferry. The resultant Web site might contain several pages. The first page would ask the customer about the origin and destination of the journey, the date of the planned trip, and the number of passengers. Since pricing is determined by the number and ages of the passengers, a second Web page would display asking for the ages of the passengers. A third would ask the type of vehicle desired for land transportation, and so on.

The same information may be obtained using Ajax techniques, illustrated in Figure 12.10. The same starting and ending destinations, as well as dates, are entered on the top of the Web form. The Web page uses the destinations and dates to determine whether there is any available space on the ferry. After the customer changes the number of passengers, the form dynamically changes to add the three drop-down lists for each passenger, along with instructions on the side—without reloading the entire page. When the type of vehicle changes, in this example to **Car**, the selected vehicle type is sent to the server. The caption on the form changes the text from vehicle to **Car Make**. The server sends the possible car makes, and the **Car Make** drop-down list is populated with the data. When the car make is selected, the chosen value is sent to the server and the **Car Model** drop-down list is populated, and so on.

The Web page used in this example responds much faster than the alternative, which is having several different pages displayed, and it is easier for the user to work with. There is still a need to have a confirmation Web page (although the page could dynamically change to remove form fields and replace them with text), and another Web page for name, address, and credit card information. The analyst must decide how to partition the transaction into a series of pages, some using Ajax and some not. If small amounts of data need to be obtained to continue the transaction, and the data logically fits on a single Web form or page, then Ajax may be the best approach. At times it is better to use several pages, as in the case when a user makes an airline reservation. One Web form would obtain all the flight information, and another page would be used to display the flights. A third page might be used to obtain passenger information, and a fourth page might use Ajax to select seat locations, meals, and other individual needs for each passenger.

Ajax has the advantage of making the Web work faster and of providing a smoother viewing experience for users. The disadvantages are that JavaScript must be enabled and that the Web page may violate the Americans with Disabilities Act. Security must be taken into consideration if needed. There are numerous examples of Ajax Web sites. Some notable ones include Google Earth ([earth.google.com](http://earth.google.com)), and Google Suggest, which responds to the viewer's keystrokes by providing a drop-down list of possible search terms. Ajax Write ([www.ajaxlaunch.com/ajaxwrite](http://www.ajaxlaunch.com/ajaxwrite)) is a Web-based word processor. There is also an Ajax spreadsheet and a sketching tool.

The figure consists of four screenshots of a Mozilla Firefox browser window for the "European Ferry Booking Agent".

- Screenshot 1:** Shows the initial form with fields for Outbound route (Belfast to Stranraer), Return route (Stranraer to Belfast), Starting Date (18 June 2008), Ending Date (26 June 2008), and Number of people (set to 4). A yellow sticky note says: "After the customer selects four passengers, the server generates four drop-down lists."
- Screenshot 2:** The same form after selecting 4 passengers. The "Age of passenger 1" dropdown is open, showing options: Adult 18-64, Adult 18-64, Student 6-17, and Student 6-17. A yellow sticky note says: "After identifying all four passengers, a question regarding a vehicle appears."
- Screenshot 3:** The form now includes a "Type of Vehicle" section with a dropdown menu showing Car, None, Bus, Van, Motorcycle, and Pickup. A yellow sticky note says: "More questions appear until the form is complete."
- Screenshot 4:** The final state of the form with additional fields: Car Make (Ford), Car Model (Focus Estate), and Trailer (None). A "Get Sailing Quote" button is at the bottom.

**FIGURE 12.10**

When analysts use Ajax techniques, a dynamic Web page responds more rapidly to short user input than it would if several different pages were required for display.

## Using Color in Display Design

Color is an appealing and proven way to facilitate users with tasks requiring computer input. Appropriate use of color in display screens allows you to contrast foreground and background, highlight important fields on forms, feature errors, highlight special code input, and call attention to many other special attributes.

Highly contrasting colors should be used for display foreground and background so that users can grasp what is presented quickly. Background color will affect perception of foreground color. For example, dark green may look like a different color if taken off a white background and placed on a yellow one.

The top five most legible combinations of foreground lettering on background are (starting with the most legible combination):

1. Black on yellow.
2. Green on white.
3. Blue on white.
4. White on blue.
5. Yellow on black.

The least legible are red on green and blue on red. As can be gathered from these foreground and background combinations, bright colors should be used for foregrounds, with less bright colors for the background. Strongly contrasting colors should be assigned first to fields that must be differentiated; then other colors can be assigned.

Use color to highlight important fields on displays. Fields that are important can be colored differently than the rest. Take into consideration cultural norms. Red usually means danger, but “in the red” also means a company is losing money. Green means “go” and is a safe color in Western countries.

By observing Web accessibility guidelines, you will also want to take into consideration that 8 to 10 percent of the male population has color blindness, but less than 1 percent of females suffer from it. Use other indicators in addition to color to support users in completing their tasks.

As with any enhancement, designers need to question the added value of using color. Use of color can be overdone; a useful heuristic is no more than four colors for new users and only up to seven for experienced ones. Irrelevant colors distract users and detract from their performance. In numerous instances, however, color has been shown to facilitate use in very specific ways. Color should be considered an important way to contrast foreground and background, highlight important fields and data, point out errors, and allow special coding of input.

## INTRANET AND INTERNET PAGE DESIGN

In Chapter 11, the rudiments of designing Web sites were discussed. There are more hints about designing a good Internet or intranet fill-in form that should be noted now that you have learned some of the elementary aspects of input form and display design. Figure 12.11 shows a fill-in form order page that shows many elements of good design for the Web. Guidelines include the following:

1. Provide clear instructions, because Web users may not be familiar with technical terminology.
2. Demonstrate a logical entry sequence for fill-in forms, especially because the users may have to scroll down to a region of the page that is not visible at first.
3. Use a variety of text boxes, push buttons, drop-down menus, check boxes, and radio buttons to serve specific functions and to create interest in the form.
4. Provide a scrolling text box if you are uncertain about how much space users will need to respond to a question, or about what language, structure, or form users will use to enter data.
5. Prepare two basic buttons on every Web fill-in form: Submit and Clear Form.
6. If the form is lengthy and the users must scroll excessively, divide the form into several simpler forms on separate pages.
7. Create a feedback screen that refuses submission of a form unless mandatory fields are filled in correctly. The returned form screen can provide detailed feedback to the user in a different color. Red is appropriate here. For example, a user may be required to fill in a country in the country field, or indicate a credit card number if that type of payment has been checked off. Often a required field is denoted on an initial input screen with a red asterisk.



## CONSULTING OPPORTUNITY 12.3

### It's Only Skin Deep

**W**hen contemplating upgrading the design of the ecommerce Web site for Marathon Vitamin Shops, Bill Berry, the owner, realized that his customers were diverse.

"We've worked hard to attract many different types of customers. As far as the store goes, we are succeeding. People with many different interests come in. I've met sports enthusiasts who want high-energy vitamins to boost their power. Other customers want to lose weight with the help of vitamin supplements. Some of our customers are health conscious and believe that a vitamin a day keeps the doctor away. Some even embrace the lifestyle first cultivated in the 1970s. By the way the store is set up, you can see that we're trying to segment the space so that each kind of consumer feels welcome. It's hard to translate that to the Web, though."

Bill turns to one of his employees, Jin Singh, and asks her, "Is there anything we can do to transform the online catalog so that it attracts different customers? And what about being responsive to the different people who visit the site?"

Jin, who just happens to be an Internet Webcast enthusiast, says, "I have just the thing," as she turns to her computer and brings up her Windows Media Player. "Personally, I like to get into a frame of mind that matches the music or videos I am experiencing on the Web."

Jin shows Bill examples of some "skins" on the screen. You can see a variety of skins for the Microsoft Windows Media Player displayed in Figure 12.C3.

Jin continues, "Skins allow me to customize the appearance of my Media Player. When I play oldies, I choose a rusty skin. When I am playing something new age, I opt for a skin that has a rainbow of colors, and so on."

Peering at the screen, Bill exclaims, "I think you're onto something. What did you call those things again?"

Jin laughs and explains, "They're called skins, but they're just fun overlays that customers can add to whatever it is they're viewing. I can envision that eventually the Web site can take on an entirely new appearance depending on customer preferences for a particular kind of skin."

Based on your assessment of the different types of customers Marathon would like to attract to its Web site, design, draw, and describe a series of skins that would be appropriate for the company's purposes. Explain in two paragraphs how the inclusion of user-controlled skins on a Web site can further the analyst's design objectives of attractiveness and ease of use for input.



**FIGURE 12.C3**

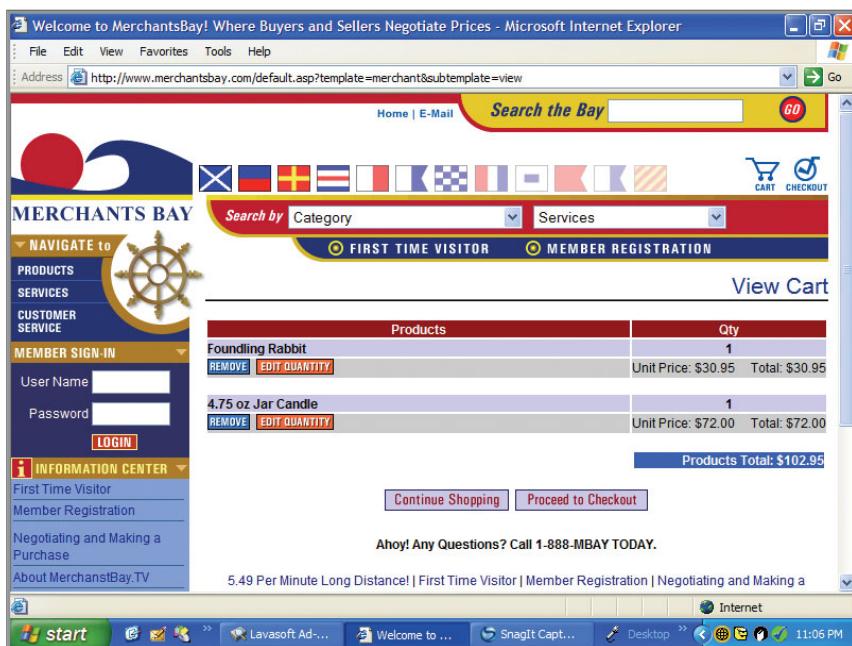
Six skins from Microsoft's Windows Media Player allow users to customize their players to fit their moods.

**FIGURE 12.11**

The order screen from the Merchants Bay Web site ([www.merchantsbay.com](http://www.merchantsbay.com)) is a good example of how to design an input form that is clear, easy to use, and functional.

Ecommerce applications involve more than just good design of Web sites. Customers need to feel confident that they are buying the correct quantity, that they are getting the right price, and that the total cost of an Internet purchase, including shipping charges, is what they expect. The most common way to establish this confidence is to use the metaphor of a shopping cart or shopping bag. Figure 12.12 shows the contents of a shopping cart for a customer making a purchase. An important feature of the shopping cart is that the customer can edit the quantity of the item ordered or can remove the item entirely.

Ecommerce applications place additional demands on the analyst who must design Web sites to meet several user and business objectives, including setting forth the corporate mission and values regarding confidentiality, preserving user privacy, and easy and rapid product returns; the efficient processing of transactions; and building good customer relationships.

**FIGURE 12.12**

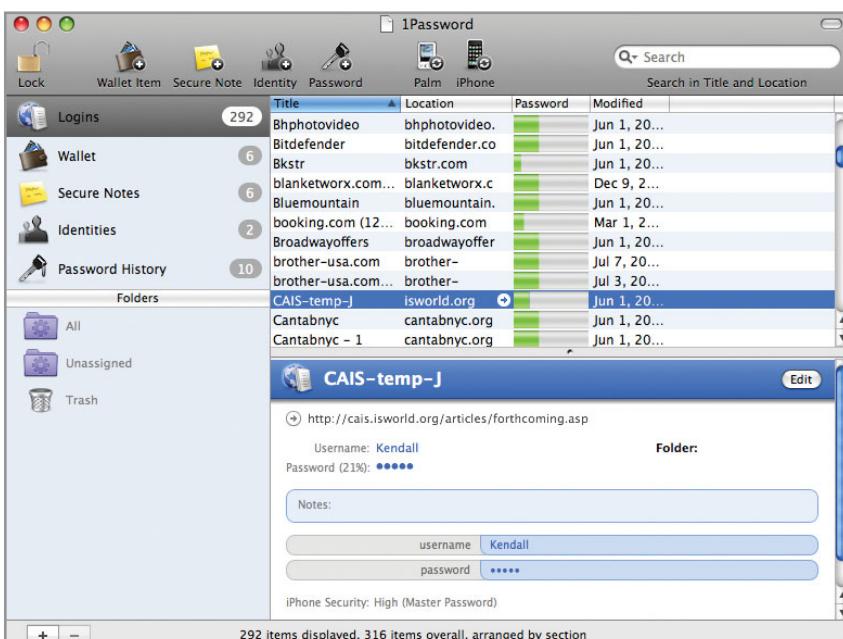
The Merchants Bay Web site ([www.merchantsbay.com](http://www.merchantsbay.com)) is a good example of a shopping cart.



## MAC APPEAL

Ecommerce has changed the world by asking users to enter their own information directly to Web-based input forms and in doing so has increased the accuracy of data entry. While this approach is efficient for the companies receiving data, it pushes the keying of that information to the user. Fortunately software is available to automate that process so users merely make a couple of clicks rather than typing in long strings of alphanumeric characters that make up IDs, passwords, and credit card numbers. On a PC, RoboForm by Siber Systems is a good alternative. On the Mac, 1Password by Agile Web Solutions appears to be the current leader.

1Password allows a user to automate logins, complete credit card information, fill in an identity complete with street address and email, and key secure notes. Like every good password program, 1Password includes important features such as strong password generators, antiphishing technology, and built-in protection from keyloggers. 1Password is also an app for the iPhone and a program for the Palm, so users can take their passwords with them.



Title	Location	Password	Modified
Bhphotovideo	bhphotovideo.		Jun 1, 20...
Bitdefender	bitdefender.co		Jun 1, 20...
Bkstr	bkstr.com		Jun 1, 20...
blanketworx.com...	blanketworx.c		Dec 9, 2...
Bluemountain	bluemountain.		Jun 1, 20...
booking.com (12...	booking.com		Mar 1, 2...
Broadwayoffers	broadwayoffer		Jun 1, 20...
brother-usa.com	brother-		Jul 7, 20...
brother-usa.com...	brother-		Jul 3, 20...
CAIS-temp-J	isworld.org		Jun 1, 20...
Cantabnyc	cantabnyc.org		Jun 1, 20...
Cantabnyc - 1	cantabnyc.org		Jun 1, 20...

**FIGURE 12.MAC**  
1Password from Agile Web Solutions.  
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## SUMMARY

This chapter has covered elements of input design for forms, displays, and Web fill-in forms. Well-designed input should meet the goals of effectiveness, accuracy, ease of use, simplicity, consistency, and attractiveness. Knowledge of many different design elements will allow the systems analyst to reach these goals.

The four guidelines for well-designed input forms are the following: (1) make forms easy to fill in, (2) ensure that forms meet the purpose for which they are designed, (3) design forms to ensure accurate completion, and (4) keep forms attractive.

Design of useful forms, displays, and Web fill-in forms overlaps in many important ways, but there are some distinctions. Displays show a cursor that continually orients the user. Displays often provide assistance with input, whereas with the exception of preprinted instructions, it may be difficult to get additional assistance with a form. Web-based documents have additional capabilities, such as embedded hyperlinks,



## HYPERCASE® EXPERIENCE 12

**I**sn't spring the most beautiful season here? The architect really captured the essence of the landscape, didn't he? I mean, you can't go anywhere in the building without seeing another beautiful vista through those huge windows. When Snowden came back, he looked at your output displays. The good news is that he thinks they'll work. The project is blossoming, just like the flowers and trees. When Snowden returns from Finland, would you have some input display screens ready to demonstrate? He doesn't want things to slow down just because he's out of the country. By the way, the Singapore trip was very successful. Maybe MRE will be worldwide someday."

### HYPERCASE Questions

1. Using either a paper layout form, Microsoft Visio, or form design software, design a prototype paper form that captures client information for the Training Unit.

2. Test your form on three classmates by having each of them fill it out. Ask them for a written critique of the form.
3. Redesign your input form to reflect your classmates' comments.
4. Using either a paper layout form, Microsoft Visio, or form design software, design a prototype display form that captures client information for the Training Unit.
5. Test your input display on three classmates by having each of them try it out. Ask them for a written critique of the display's design.
6. Redesign the input display based on the comments you receive. In a paragraph, explain how you have addressed each comment.

**FIGURE 12.HC1**

Take a look at some of the input screens in HyperCase. You may want to redesign some of the electronic forms.

context-sensitive help functions, and feedback forms, to correct input before final submission. Skins can be added as an option to personalize a Web site.

The four guidelines for well-designed displays are as follows: (1) keep the display simple, (2) keep the display presentation consistent, (3) facilitate user movement among display screens and pages, and (4) create an attractive and pleasing display. Many different design elements allow the systems analyst to meet these guidelines.

The proper flow of paper forms, display screens, and fill-in forms on the Web is important. Forms should group information logically into seven categories, and displays should be divided into three main sections. Captions on forms and displays can be varied, as can font types and the weights of lines dividing subcategories of

information. Multiple-part forms are another way to ensure that forms meet their intended purposes. Designers can use windows, pop-ups, dialog boxes, and defaults onscreen to ensure the effectiveness of design.

Event-response charts help the analyst to document what should happen when events occur. Dynamic Web pages modify the Web page in response to events. These can be constructed as three-dimensional Web pages. Ajax techniques request and receive a small amount of data from the server and use the data to modify the Web page on the fly.

Web fill-in forms should be constructed with the following seven guidelines in mind as well as those in Chapter 11:

1. Provide clear instructions.
2. Demonstrate a logical entry sequence for fill-in forms.
3. Use a variety of text boxes, push buttons, drop-down menus, check boxes, and radio buttons.
4. Provide a scrolling text box if you are uncertain about how much space users will need to respond to a question.
5. Prepare two basic buttons on every Web fill-in form: Submit and Clear Form.
6. If the form is lengthy and the users must scroll extensively, divide the form into several simpler forms on separate pages.
7. Create a feedback screen that highlights errors in an appropriate color and refuses submission of the form until mandatory fields are correctly filled in.

## KEYWORDS AND PHRASES

Ajax	line caption
base plane	list box
box caption	message box
check box	onscreen color
command button	onscreen dialog
control of business forms	onscreen icon
cursor	option button
display color combinations	prompt
drop-down list box	radio button
dynamic Web pages	response time
event-response chart	seven sections of a form
facilitating movement on pages	skins
form flow	slider
form values	specialty form
hidden field	spin button
horizontal check-off caption	table caption
image map	text box
Internet/intranet fill-in form	three sections of a display
layer	vertical check-off caption

## REVIEW QUESTIONS

1. What are the design objectives for paper input forms, input screens, or Web-based fill-in forms?
2. List the four guidelines for good form design.
3. What is proper form flow?
4. What are the seven sections of a good form?
5. List four types of captioning for use on forms.
6. What is a specialty form? What are some disadvantages of using specialty forms?
7. List the four guidelines for good display design.
8. What are the three sections useful for simplifying a display?
9. What are the advantages of using onscreen windows?
10. What are the disadvantages of using onscreen windows?
11. List two ways display screens can be kept consistent.
12. Give three ways to facilitate movement between display pages.
13. List four graphical interface design elements. Alongside each one, describe when it would be appropriate to incorporate each of them in a display design or on a Web-based fill-in form.
14. When should check boxes be used?
15. When should option buttons be used?

16. What are two different ways that form values are used?
17. What are hidden fields used for on a Web form?
18. List four different types of events.
19. What are dynamic Web pages?
20. What are three-dimensional Web pages?
21. How does Ajax improve a Web page that changes based on user actions?
22. List the five most legible foreground and background color combinations for display use.
23. Define what is meant by the term *skins* when used in Web design.
24. What are four situations in which color may be useful for display and Web-based fill-in form design?
25. List seven design guidelines for a Web-based fill-in form.

## PROBLEMS

1. Here are captions used for a U.S. state census form:

Name

Occupation

Address

Zip code

Number of people in household

Age of head of household

- a. Redo the captions so that the state census bureau can capture the same information requested on the old form without confusing respondents.
- b. Redesign the form so that it exhibits proper flow. (*Hint:* Make sure to provide an access and identification section so that the information can be stored in the state's computer system.)
- c. Redesign the form so it can be filled in by citizens who visit the state's Web site. What changes were necessary in moving from a paper form to one that will be submitted electronically?
2. Elkhorn College needs to keep better track of students and others who use the many computers available in the Buck Memorial Library.
  - a. Design and draw a representation of a display screen for students to use in signing into the computers in the library. Label the three sections of a display that you included.
  - b. Design a paper form to be left alongside each computer daily that users who are part of the community (but are not students) are required to fill out. The form should ask for name, date and time of visit, general purpose for computer use (i.e., word processing, Web surfing, examining real estate documents online), and the time they have logged off. Label the seven sections of a form that you included.
3. Speedy Spuds is a fast-food restaurant offering all kinds of potatoes. The manager has a 30-second rule for serving customers. Servers at the counter say they could achieve that rule if the form they must fill out and give to the kitchen crew were simplified. The information from the completed form is entered into the computer system at the end of the day, when the data entry person needs to enter the kind of potato purchased, additional toppings purchased, the quantity, and the price charged. The current form is difficult for servers to scan and fill out quickly.
  - a. Design and draw a form (you choose the size, but be sensible) that lists possible potatoes and toppings in a manner that is easy for counter servers and kitchen crew to scan, and can also be used as input for the inventory/reorder system that is on the extranet connecting Speedy Spuds and Idaho potato growers. (*Hint:* Remember to observe *all* the guidelines for good form design.)
  - b. Design and draw a representation of a display screen that can be used by the servers and clerks to fill in the information captured on the form.
  - c. Design a display screen based on the display you designed in Problem 3b. This time, it should function as a display that shows a kitchen crew member what to prepare for each Spuds order. List three changes to the existing display that you made to adapt it to function as an output display.

4. Sherry's Meats, a regional meat wholesaler and retailer, needs to collect up-to-date information on how much of each meat product it has in each store. It will then use that information to schedule deliveries from its central warehouse. Currently, customers entering the store fill out a detailed form specifying their individual orders. The form lists over 150 items; it includes meat and meat products available in different amounts. At the end of the day, between 250 and 400 customer orders are tabulated and deducted from the store's inventory. Then the office worker in each store phones in an order for the next day. Store employees have a difficult time tabulating sales because of the mistakes customers make in filling out their forms.
  - a. It is not possible to have the solitary office worker in each store fill out the numerous customer order forms. Change the form ( $3\frac{1}{2}'' \times 6''$  either horizontal or vertical) and draw it so that it is easier for customers to fill out correctly and for office workers to tabulate.
  - b. Design and draw a specialty form of the same size that will meet the needs of Sherry's customers, office workers, and warehouse workers.
  - c. Design and draw two different forms of the same size to meet the purposes in Problem 4b, because Sherry's carries both poultry and beef products. (*Hint:* Think about ways to make forms easy to distinguish visually.)
  - d. Design a fill-in form for onscreen display. When a customer submits an order, it is entered into Sherry's inventory system by any person who is serving customers at the counter. This information will be captured and sent to the central warehouse computer to help control inventory.
  - e. In a paragraph, describe the drawbacks of having lots of different people at different locations enter data. In a paragraph, list steps you can take as the designer so that the fill-in form is designed to ensure accuracy of entry.
  - f. Design a Web page used by a customer to enter an order directly to Sherry's.
  - g. Design a Web page to obtain credit card information for a Web order. Partition the data onto two Web pages for additional security.
  - h. Design a three-dimensional dynamic Web page that allows Sherry's to customize certain products, such as requesting specific ingredients in a meatloaf or a salad. When the customer selects a product from a drop-down list, the ingredients must be displayed with a means of selecting which ones should be included in the product.
5. R. George's, a fashionable clothing store that also has a catalog business, would like to keep track of the customers coming into the store so as to expand its mailing list.
  - a. Design and draw a simple form that can be printed on  $3'' \times 5''$  cards and given to in-store customers to fill out. (*Hint:* The form must be aesthetically appealing to encourage R. George's upscale clientele to complete it.)
  - b. Design and draw a representation of a display screen that captures in-store customer information from the cards in Problem 5a.
  - c. Design and draw a second onscreen tab control dialog box that compares in-store customers with catalog customers.
  - d. The owner is having you help enhance his catalog business by setting up an ecommerce site. Design a Web-based form to capture information from those who visit the Web site. In a paragraph, explain how it will differ from the printed form.
6. Recently, an up-and-coming discount brokerage house expressed an interest in developing its own Web-based portfolio management software that clients could use at home on their PCs to make trades, get real-time stock quotes, and so on.
  - a. Design two input displays that make data entry easy for the client. The first display should allow users to enter stock symbols for the stocks they want to track on a daily basis. The second display should allow the client to use an icon-based system to design a customized report showing stock price trends in a variety of graphs or text.
  - b. Suggest two other input displays that should be included in this new portfolio management software.
7. My Belle Cosmetics is a large business that has sales well ahead of any other regional cosmetics firm. As an organization, it is very sensitive to color, because it introduces new color lines in its products every fall and spring. The company has recently begun using technology to electronically show in-store customers how they appear in different shades of cosmetics without requiring them to actually apply the cosmetics.
  - a. Design and draw a representation of a display screen that can be used by sales clerks at a counter to try many shades of lipstick and makeup on an individual customer very quickly and with a high degree of accuracy. Input from customers should be their hair color, the color of their favorite clothing, and their typical environmental lighting (fluorescent, incandescent, outdoor, and so on).

- b. Design and draw a representation of a display screen that is equivalent to the one in Problem 7a but that vividly demonstrates to decision makers in My Belle how color improves the understandability of the screen.
  - c. One of the affiliates My Belle has on the Web is a large department store chain. In a paragraph, describe how the display screen in Problem 7a can be altered so that an individual can use it and My Belle can put it on the department store's ecommerce site to attract customers.
8. The Home Finders Realty Corporation specializes in locating homes for prospective buyers. Home information is stored in a database and is to be shown on an inquiry display screen. Design a GUI interface, Web-based display to enter the following data fields, which are used to select and display homes matching the criteria. Keep in mind the features available for a GUI display. The design elements (which are not in any particular sequence) are as follows:
- a. Minimum size (in square feet).
  - b. Maximum size (in square feet, optional).
  - c. Minimum number of bedrooms.
  - d. Minimum number of bathrooms.
  - e. Garage size (number of cars, optional).
  - f. School district (a limited number of school districts are available for each area).
  - g. Swimming pool (yes/no, optional).
  - h. Setting (either city, suburban, or rural).
  - i. Fireplace (yes/no, optional).
  - j. Energy efficient (yes/no).
- In addition, describe the hyperlinks necessary to achieve this type of interaction.
9. Design a Web entry page for the Home Finders Realty Corporation display screen created in Problem 8.
10. The five-year-old TowerWood hotel chain needs help designing its Web site. The company maintains properties in all the large U.S. tourist communities such as Orlando, Florida (near Disney World); Maui, Hawaii; Anaheim, California (near Disneyland); Las Vegas, Nevada; and New Orleans, Louisiana. Their properties feature a variety of rooms in all these locations.
- a. In a paragraph, discuss how the company can use skins on its Web site to attract different types of clientele, including families with small children, young couples on their honeymoon, retired couples who want to travel on a budget, and business travelers who need business services.
  - b. Design and draw a series of skins that would appeal to the different types of hotel clientele listed in Problem 10a. (*Hint:* Use a graphics package or drawing program to help design the skins.)
  - c. Add a group of potential Web site users for the TowerWood hotel chain who were *not* mentioned in Problem 10a and design and draw additional skins for them. Then create a table that matches each client group with a particular skin you designed.
11. Sludge's Auto is an auto parts recycling center, including classic and antique cars. Rhode Wheeler, the owner, would like to get his bearings on a Web site for customers to browse for parts. Design an Ajax Web page used to find parts. The customer needs to know the make, model, and year of a car as well as the part. If the part is in stock, the description, condition of the part, price, and shipping cost are displayed, with the quantity available for each part, along with a picture of the part. Provide a button for each part that may be clicked to purchase the part.
12. Design the Add Customer Web page for Sludge's auto. Include a profile that would allow Sludge's to send the customer an email if a certain part becomes available.
13. Design the Purchase Web page for Sludge's Auto. Assume that the customer has been added and has been logged on. Display some information about the customer. Split credit card information (type of credit card, credit card number, expiration date, and the security code found on the back of the card) between two Web pages.
14. Design a Web page using Ajax for registering an electronic product, either hardware or software. The form should have the purchaser's name and address, telephone number, email address, and a drop-down list of product categories. When the category is changed, send the category value to the server, which returns an XML document containing the products for the category, used to create a drop-down list of products. When the customer selects a product, the product value is sent to the server, which returns an XML document used to create a model or version of the product.

## GROUP PROJECTS

1. Maverick Transport is considering updating its input display screens. With your team, brainstorm about what should appear on input screens of computer operators who are entering delivery load data as loads are approved. Fields will include date of delivery, contents, weight, special requirements (for example, whether contents are perishable), and so on.

2. Each team member should design an appropriate input display using either a CASE tool, a drawing tool such as Microsoft Visio, or paper and pencil. Share your results with your team members.
3. Make a list of other input displays that Maverick Transport should develop. Remember to include dispatcher screens as well as screens to be accessed by customers and drivers. Indicate which should be PC screens or displays on wireless handheld devices.
4. Design a Web-based screen that will allow Maverick Transport customers to track the progress of a shipment. Brainstorm with team members for a list of elements, or perform an interview with a local trucking company to find out its requirements. List what hyperlinks will be essential. How will you control access so that customers can track only their own shipments?

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## EPISODE 12

### CPU Case

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Forming Screens and Screening Forms

Pooling information from the output design and reviewing their progress, Chip and Anna proceed to the next stage, the design of input. “Web pages must be designed to capture input information easily and accurately,” remarks Anna.

Chip starts working on modifying the display used to enter the form data. The ADD NEW COMPUTER entry display is shown in Figure E12.1. One of the considerations of the entry display is ease of entering data, and another is accuracy. Still another consideration is the availability of help. New employees would not be familiar with the operation of the system or with what is required for a particular field entry. To achieve these goals, Chip includes drop-down lists for the OPTICAL DRIVE, COMPUTER TYPE, and OPERATING SYSTEM. “I like the way these drop-down lists work,” he remarks to Anna. “The users can easily select the codes that should be stored in the database.”

“Why have the users select codes?” replies Anna. “There must be a way for them to select descriptive code meanings, such as the name of the operating system, and have the computer store the codes.”

“That’s an excellent idea!” exclaims Chip. A short time later, the modifications have been implemented.

Anna reviews the display screen and remarks, “This looks terrific! I like the grouping of the check boxes and descriptive information contained in the drop-down lists.”

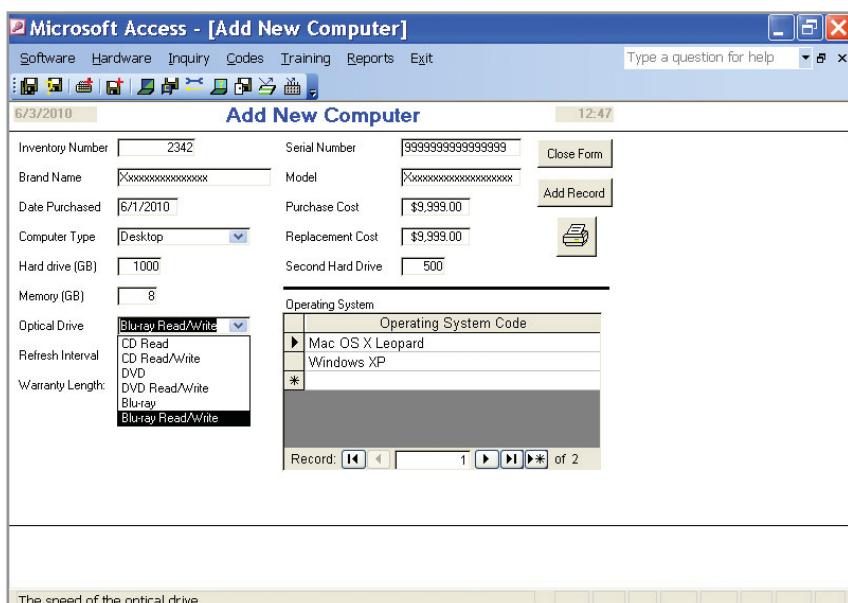
“Watch this one in action,” replies Chip. “I’ve added a button for the users to click when they have entered all the data and made all the selections. They can also print the completed form.”

“What about help?” asks Anna.

“I’ve thought about that also,” answers Chip. “As the cursor moves from field to field, the status line on the bottom of the screen displays one line of help appropriate for that field. I can also add tool-tip help, a small box of help options that appears when the mouse cursor remains over one entry area for a short amount of time.” Notice that the pull-down lists have meaningful names in the data areas. Help is shown in the status line at the bottom of the display.

Dot reviews the completed display and enters some test data. “I’m really impressed!” she exclaims. “It is much smoother than I ever expected. When can we expect the rest of the system?” Chip smiles with appreciation and remarks that great progress is being made. “I do hope that the rest of the system is as clear to use and easy to operate!” Dot says appreciatively.

Meanwhile, Anna is meeting with Hy Perteks, who is desperately seeking help. “I’m swamped with requests for help on software packages! Is there any way to design a portion of the system for maintaining



**FIGURE E12.1**

Pull-down lists on the ADD NEW COMPUTER Microsoft Access screen.

information on the available software experts?" asks Hy. "I have names written on scraps of paper and I keep misplacing them. Often I find out who these experts are only after someone else finds them first."

Anna asks some questions about what information would be required and how Hy would like to maintain and display the records. Hy replies, "There is so much expertise available, but the only way I have of locating the person's information is by using their name as an index. And, I confess, I'm awful at remembering the correct spelling of the first name, let alone the last name." Anna assures him that there will be an easy-to-use system available soon.

Back at her desk, Anna thinks about the problem. "The ADD display screen would be easy to create, but what about the CHANGE one?" She wonders, "How can I?" and then thinks, "Ah ha!" as she snaps her fingers. The design becomes clear. There would be a display with two distinct regions on it. The first region would contain the last and first name of the software expert. Included with the display is a **Find** button as well as buttons for scrolling back and forth through records. If the users make a mistake entering data, there is an **Undo** button, and there is also a button to save the changes. The completed display screen is illustrated in Figure E12.2.

"Great-looking display," grins Chip. "I want to be here when you show it to Hy."

The problem of deleting software course records for software that is no longer in use requires a different approach. Anna reasons that it would be easy if she used the **Find** feature to locate a record and then used a **Find Next** button to locate the next record that matches the criteria. There would also be buttons that allow her to move to the next or previous records. (See the **DELETE SOFTWARE COURSE**.)

After the record is located, the **DELETE SOFTWARE COURSE** program would display pertinent information. All codes on the file, such as **COURSE LEVEL** and **OPERATING SYSTEM**, would be replaced with the full code meaning. None of the data would be able to be modified at this time. The operator would have the opportunity to review the record and then choose to either delete or not delete the record. When the delete button is clicked, a dialog box is displayed asking the users if they really want to delete the record. They may choose to cancel the delete at that time.

Hy is delighted with the prototype display screens. As he tests each of them, he remarks, "You don't know how easy it's going to be for me to answer help requests. These are fabulous!" He pauses for a long moment and then asks, "I have a lot of requests about providing periodically scheduled training courses. Do you think we could work on a system to register for courses?"

Anna purses her lips for a moment and remarks, "Did you ever hear of a project having scope creep, always adding little things and the project never ends? The university does, however, have a Web initiative. We can design an interactive Web page for registering courses."

"That's great!" replies Hy. "That's more than I ever hoped for."

Anna starts to design the Web page, including the users' first and last names as well as their email addresses and office phone. Additional areas are used to enter the campus where they are located, the software they use, and their class level. Chip reviews the form and remarks, "How about using Ajax to have them enter their campus email address and click a Find Employee button? The server would find the employees and then populate the Web page with their first and last names, along with their office phone. They could

**FIGURE E12.2**

The **CHANGE SOFTWARE EXPERT** Microsoft Access screen.

The screenshot shows a Microsoft Access application window titled "Microsoft Access - [Change Software Expert]". The main title bar includes standard icons for minimize, maximize, and close. Below the title bar is a menu bar with options: Software, Hardware, Inquiry, Codes, Training, Reports, and Exit. A search bar on the right says "Type a question for help". The main area is divided into two sections: "Change Software Expert" and "Change Software Expert - Software Packages".

**Change Software Expert:** This section contains several input fields and buttons. The fields are: Last Name (Rockwell), First name (Amy), Phone ([246] 049-4494), Campus Description (Central Administration), Room (300), and Department (Computer Information Systems). To the right of each field are small icons: binoculars, a computer monitor, a right arrow, a left arrow, and a magnifying glass.

**Change Software Expert - Software Packages:** This section displays a table with five rows of data. The columns are: Title, Version, Operating System, and Expert Teach Course. The data is as follows:

Title	Version	Operating System	Expert Teach Course
Visible Analyst	7.5	Windows XP	Yes
Adobe Photoshop	CS4	Windows XP	Yes
Adobe Flash	CS4	Windows XP	Yes
Microsoft Visio	2007	Windows XP	Yes
Adobe Dreamweaver	CS4	Mac OS X Leopard	Yes

At the bottom of the screen, there is a status bar with the text "Record: 1 of 5" and a footer bar with the text "Employee last name".

The screenshot shows a Mozilla Firefox browser window displaying the 'CENTRAL PACIFIC UNIVERSITY Training Course Registration' page. The page header includes the CPU logo, navigation links for Home, Problem Reporting, Training, Software, Classroom, Resources, Other, and Search, and a Google search bar. The main content area is titled 'Training Course Registration'. It contains instructions for registering for a training class, mentioning a 'Find Employee' button and a 'training calendar'. Below this, there are input fields for Email Address, First Name, Last Name, Campus (set to 'Central'), Phone, Software (dropdown menu), and Select the level of training (dropdown menu). On the left, there are two checkboxes labeled 'Course Title' and 'Starting Date' (mm/dd/yyyy) and 'Ending Date' (mm/dd/yyyy). At the bottom are 'Submit' and 'Reset' buttons.

**FIGURE E12.3**

An intranet Web form for Training Registration on the CPU Web site.

overtype the office phone with a cell phone if they were traveling. Rather than have them type in the campus and software information, why not have them select options from a drop-down list? And what about allowing them to select convenient times for training?"

"Good idea," replies Anna. "And I think the levels of training should be a drop-down list as well." The completed intranet Web page is illustrated in Figure E12.3. Notice that there are buttons to submit the query or reset it and a drop-down list containing their campus as a default value. Other drop-down lists contain instructions on what to select. There are check boxes on the left to select the course they are registering for. Included on the bottom is a link for submitting email questions to the training officer.

Hy is thrilled. "This form is better than I ever imagined. I think we are really providing effective training registration, and I know that my phone will not be ringing as much. I've got another great idea!"

The following exercises may be done by designing the report or display screen using printer or display screen layout forms, or they may be created using any word processor with which you are familiar. The fields and other related information for the reports are contained in a repository Web page or in the Visible Analyst data flow repository entries. The names for the data flow are listed for each exercise.

Corresponding reports and displays (called forms in Microsoft Access) have been created. All the information is present in the Microsoft Access database; you only have to modify the existing reports and display screens to produce the final versions. Modifications are made by clicking on the desired report or screen and then clicking the Design button. The following modifications may be made. The Page Header contains column headings. The Detail area contains the print fields for the report.

Click in a field to select it. Click on several fields while holding the Shift key to select them.

Drag a selected field (or fields) to move them.

Click on one of the small boxes surrounding the field to change the field size.

Select several fields and click Format and either:

Align, to align all fields with the top, left, and so on field.

Size, to make fields equal to the widest, tallest, and so on field.

Horizontal spacing, to make horizontal spacing equal, or to increase or decrease the spacing.

Vertical spacing, to make vertical spacing equal, or to increase or decrease the spacing.

## EXERCISES

- E-1.** Cher Ware has remarked several times that a good form would make the task of adding new software much easier. It would also provide permanent paper documentation for software additions.

Design a form to add software to the SOFTWARE MASTER. Open Data Flow Diagram 0 in Visio or Visible Analyst. View the SOFTWARE RECEIVED FORM repository entry for the data flow. Click on the link for the NEW SOFTWARE RECORD in the Composition to view the data structure containing the elements required on the form. Click the link (or Jump in Visible Analyst) to each element to determine the length of the screen field.



- E-2. Design the ADD SOFTWARE RECORD display screen, either on paper or by modifying the Microsoft Access screen. Use the fields created in Exercise E-1. The Repository Web page or Visible Analyst data structure name is NEW SOFTWARE RECORD.



- E-3. Hy Perteks would like a form to fill in as he learns about new software experts. Use the repository data structure called ADD SOFTWARE EXPERT to determine the fields required for the form.



- E-4. Create the ADD SOFTWARE EXPERT display on paper, using a word processor, or by modifying the Microsoft Access form. Test the ADD SOFTWARE EXPERT display, using the drop-down lists and observing the status bar on the bottom of the screen.



- E-5. Design or modify the Microsoft Access form for the DELETE SOFTWARE EXPERT display. Which fields are drop-down lists? Use the repository data structure called DELETE SOFTWARE EXPERT.



- E-6. Design or modify the Microsoft Access form for the DELETE COMPUTER RECORD display. The repository data structure is called DELETE COMPUTER RECORD.



- E-7. Cher Ware and Anna spent the better part of a morning working out the details on the software portion of the system. Plagued by the problem of providing consistent software upgrades for all machines, Cher would like an easy method of upgrading. A few older versions of software may also be retained for special needs.

Part of the solution is to produce a report, sorted by location, of all machines containing the software to be upgraded. As the new software is installed, a check mark is placed on the report after each machine.

Design the UPGRADE SOFTWARE display design. Add a **Find** button to locate the title and to provide a field that can be used to enter the new VERSION NUMBER. The update program will display a line for each machine containing the old version of the installed software. These lines are sorted by CAMPUS LOCATION and ROOM LOCATION.

Columns are CAMPUS LOCATION, ROOM LOCATION, INVENTORY NUMBER, BRAND NAME, MODEL, UPGRADE, and RETAIN OLD VERSION. The UPGRADE column contains a check box that is to be checked if the software is to be upgraded. The RETAIN OLD VERSION is also a check box, unchecked by default. The users would check the box for a specific machine that must retain the old and new versions of the software.

Look in the repository data structure called SOFTWARE UPGRADE for the elements contained on the screen.



- E-8. Explain why the UPGRADE SOFTWARE display screen would display machines rather than have Cher enter the machine IDs. In a paragraph, discuss why the display shows records in a CAMPUS/ROOM sequence.



- E-9. Design the CHANGE SOFTWARE display screen. This allows Cher Ware to modify data that have been entered incorrectly, as well as information that routinely changes, such as SOFTWARE EXPERT and NUMBER OF COPIES. The SOFTWARE INVENTORY NUMBER is the primary key and may not be changed. The other SOFTWARE MASTER fields that should be included on the screen are found in the repository data structure called SOFTWARE CHANGES. Use these fields to design the display screen. A limited display screen, CHANGE SOFTWARE RECORD, has been created in Microsoft Access. Use the Microsoft Access Field List to add fields to it. Include the following buttons: **Find, Find Next, Previous Record, Next Record, Save Record, and Cancel Changes**.



- E-10. Hy Perteks is concerned that old courses for obsolete versions of software are cluttering the drives. Create and print the DELETE SOFTWARE COURSE display.

Entry fields are the SOFTWARE TITLE, OPERATING SYSTEM, and VERSION NUMBER. The program displays a line for each course taught for the software version. The first column contains an entry field with a D (for delete) presented as a default. Placing a space in the field will prevent the record from being deleted. The other columns for each line are COURSE TITLE, LEVEL, and CLASS LENGTH. Add a meaningful operator message.



- E-11. Design the UPDATE MAINTENANCE INFORMATION display screen. It contains entry fields that allow Mike Crowe to change maintenance information as computers are repaired or as routine maintenance is performed on them. The repository data structure is UPDATE MAINTENANCE INFORMATION.

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

# CHAPTER 13

## Designing Databases

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand database concepts.
2. Use normalization to efficiently store data in a database.
3. Use databases for presenting data.
4. Understand the concept of data warehouses.
5. Comprehend the usefulness of publishing databases to the Web.



Data storage is considered by some to be the heart of an information system. First, the data have to be available when the user wants to use them. Second, the data must be accurate and consistent (they must possess integrity). Beyond this requirement, the objectives of database design include efficient storage of data as well as efficient updating and retrieval. Finally, it is necessary that information retrieval be purposeful. The information obtained from the stored data must be in a form useful for managing, planning, controlling, or decision making.

There are two approaches to the storage of data in a computer-based system. The first is to store the data in individual files, each unique to a particular application. The second approach involves building a database. A database is a formally defined and centrally controlled store of data intended for use in many different applications.

Individual files are often designed only with immediate needs in mind, so it becomes important to query the system for a combination of some of the attributes, these attributes may be contained in separate files or may not even exist. Databases are planned, so that data is organized for efficient storage and effective retrieval. Data warehouses are very large databases that store summarized data relating to a specific subject so that queries are answered very efficiently.

### DATABASES

Databases are not merely a collection of files. Rather, a database is a central source of data meant to be shared by many users for a variety of applications. The heart of a database is the database management system (DBMS), which allows the creation, modification, and updating of the database; the retrieval of data; and the generation of reports and displays. The person who ensures that the database meets its objectives is called the database administrator.

The effectiveness objectives of the database include the following:

1. Ensuring that data can be shared among users for a variety of applications.
2. Maintaining data that are both accurate and consistent.
3. Ensuring that all data required for current and future applications will be readily available.



## CONSULTING OPPORTUNITY 13.1

### Hitch Your Cleaning Cart to a Star

The Marc Schnieder Janitorial Supply Company has asked for your assistance in cleaning up its data storage. As soon as you begin asking Marc Schnieder detailed questions about his database, his face gets flushed. "We don't really have a database as you describe it," he says with some embarrassment. "I've always wanted to clean up our records, but I couldn't find a capable person to head the effort."

After talking with Mr. Schnieder, you walk down the hall to the closet-sized office of Stan Lessink, the chief programmer. Stan fills you in on the historical development of the current information system. "The Marc Schnieder Janitorial Supply Company is a rags-to-riches story," Stan remarks. "Mr. Schnieder's first job was as a janitor in a bowling alley. He saved enough money to buy some products and started selling them to other alleys. Soon he decided to expand the janitorial supply business. He found out that as his business grew, he had more product lines and types of customers. Salespeople in the company are assigned to different major product

lines (stores, offices, and so on); some are in-house sales, and some specialize in heavy equipment, such as floor strippers and waxers. Records were kept in separate files."

You recall Mr. Schnieder saying, "The problem is that we have no way to compare the profits of each division. We would like to set up incentive programs for salespeople and provide better balance in allocating salespeople to each product line."

When you talk with Stan, however, he adds, "Each division has its own incentive system. Commissions vary. I don't see how we can have a common system. Besides, I can get our reports out quickly because our files are set up the way we want them. We have never issued a paycheck late."

Describe how you would go about analyzing the data storage needs of the Marc Schnieder Janitorial Supply Company. Would you trash the old system or just polish it up a bit? Discuss the implications of your decision in two paragraphs.

4. Allowing the database to evolve as the needs of the users grow.
5. Allowing users to construct their personal view of the data without concern for the way the data are physically stored.

The foregoing list of objectives provides us with a reminder of the advantages and disadvantages of the database approach. First, the sharing of the data means that data need to be stored only once. That in turn helps achieve data integrity, because changes to data are accomplished more easily and reliably if the data appear once rather than in many different files.

When a user needs particular data, a well-designed database anticipates the need for such data (or perhaps it has already been used for another application). Consequently, the data have a higher probability of being available in a database than in a conventional file system. A well-designed database can also be more flexible than separate files; that is, a database can evolve as the needs of users and applications change.

Finally, the database approach has the advantage of allowing users to have their own view of the data. Users need not be concerned with the actual structure of the database or its physical storage.

Many users are extracting parts of the central database from mainframes and downloading them onto PCs or handheld devices. These smaller databases are then used to generate reports or answer queries specific to the end user.

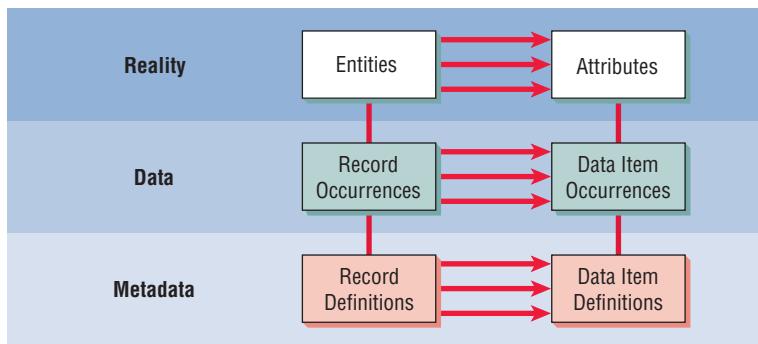
Relational databases for PCs have improved dramatically over the last few years. One major technological change has been the design of database software that takes advantage of the GUI. With the advent of programs such as Microsoft Access, users can drag and drop fields between two or more tables. Developing relational databases with these tools has been made relatively easy.

## DATA CONCEPTS

It is important to understand how data are represented before considering the use of files or the database approach. In this section, critical definitions are covered, including the abstraction of data from the real world to the storage of data in tables and database relations.

### Reality, Data, and Metadata

The real world will be referred to as reality. Data collected about people, places, or events in reality will eventually be stored in a file or database. To understand the form and structure of the

**FIGURE 13.1**

Reality, data, and metadata.

data, information about the data itself is required. The information that describes data is referred to as metadata.

The relationship between reality, data, and metadata is pictured in Figure 13.1. Within the realm of reality are entities and attributes; within the realm of actual data are record occurrences and data item occurrences; and within the realm of metadata are record definitions and data item definitions. The meanings of these terms are discussed in the following subsections.

**ENTITIES.** Any object or event about which someone chooses to collect data is an entity. An entity may be a person, place, or thing (for example, a salesperson, a city, or a product). Any entity can also be an event or unit of time such as a machine breakdown, a sale, or a month or year. In addition to the entities discussed in Chapter 2 is an additional minor entity called an entity subtype. Its symbol is a smaller rectangle within the entity rectangle.

An entity subtype is a special one-to-one relationship used to represent additional attributes (fields) of another entity that may not be present on every record of the first entity. Entity subtypes eliminate the situation in which an entity may have null fields stored on database tables.

An example is the primary entity of a customer. Preferred customers may have special fields containing discount information, and this information would be in an entity subtype. Another example is students who have internships. The STUDENT MASTER should not have to contain information about internships for each student, because perhaps only a small number of students have internships.

**RELATIONSHIPS.** Relationships are associations between entities (sometimes they are referred to as data associations). Figure 13.2 is an entity-relationship (E-R) diagram that shows various types of relationships.

The first type of relationship is a one-to-one relationship (designated as 1:1). The diagram shows that there is only one PRODUCT PACKAGE for each PRODUCT. The second one-to-one relationship shows that each EMPLOYEE has a unique OFFICE. Notice that all these entities can be described further (a product price would not be an entity, nor would a phone extension).

Another type of relationship is a one-to-many (1:M) or a many-to-one association. As shown in the figure, a PHYSICIAN in a health maintenance organization is assigned many PATIENTS, but a PATIENT is assigned only one PHYSICIAN. Another example shows that an EMPLOYEE is a member of only one DEPARTMENT, but each DEPARTMENT has many EMPLOYEES.

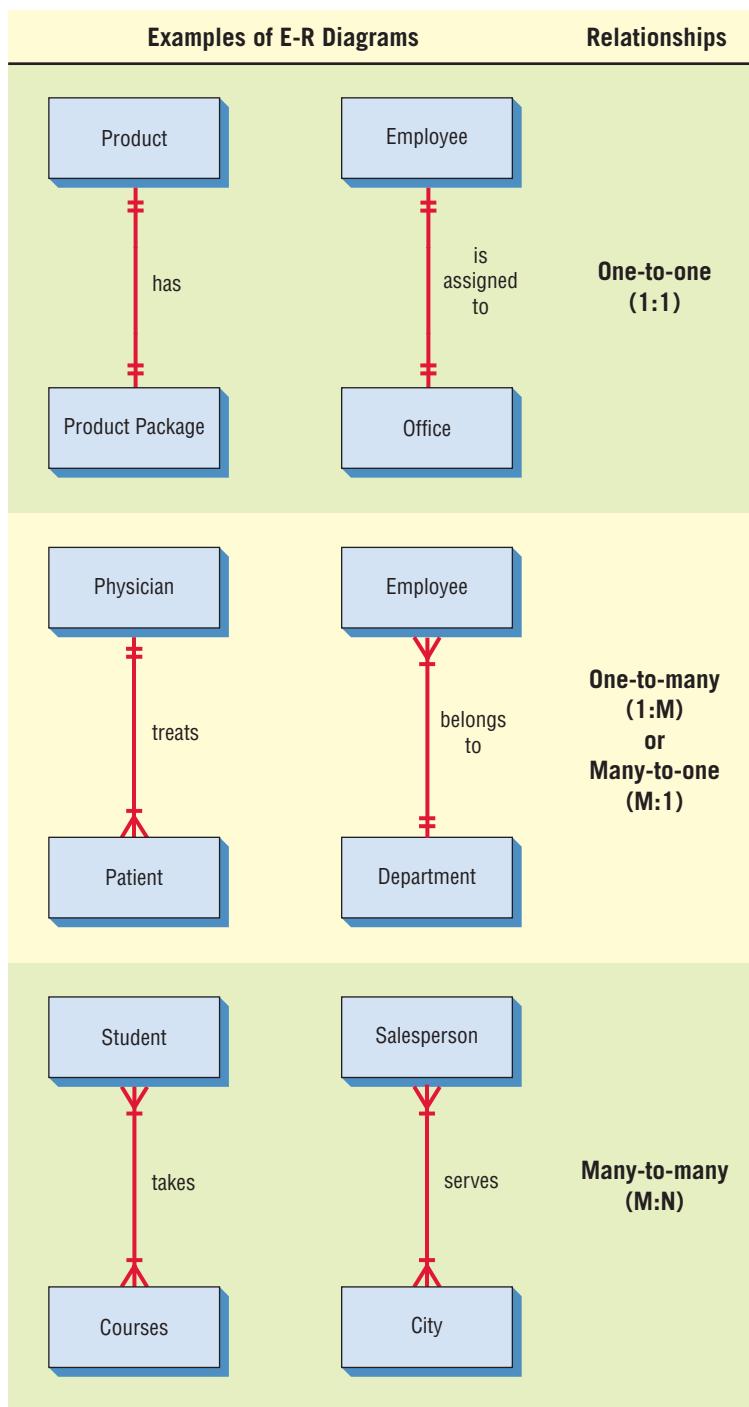
Finally, a many-to-many relationship (designated as M:N) describes the possibility that entities may have many associations in either direction. For example, a STUDENT can have many COURSE(s), and at the same time a COURSE may have many STUDENT(s) enrolled in it. The second example shows that a SALESPERSON can call on many CITY(s) and a CITY can be a sales area for many SALESPERSON(s).

The standard symbols for crow's foot notation, the official explanation of the symbols, and what they actually mean, are all given in Figure 13.3. Notice that the symbol for an entity is a rectangle. An entity is defined as a class of a person, place, or thing. A rectangle with a diamond inside stands for an associative entity, which is used to join two entities. A rectangle with an oval in it stands for an attributive entity, which is used for repeating groups.

The other notations necessary to draw E-R diagrams are the connections, of which there are five different types. In the lower portion of the figure, the meaning of the notation is explained.

**FIGURE 13.2**

Entity-relationship (E-R) diagrams can show one-to-one, one-to-many, many-to-one, or many-to-many associations.



When a straight line connects two plain entities and the ends of the line are both marked with two short marks (||), a one-to-one relationship exists. Following that you will notice a crow's foot with a short mark (|); when this notation links entities, it indicates a relationship of one-to-one or one-to-many (to one or more).

Entities linked with a straight line plus a short mark (|) and a zero (which looks more like a circle, O) are depicting a relationship of one-to-zero or one-to-one (only zero or one). A fourth type of link for relating entities is drawn with a straight line marked on the end with a zero (O) followed by a crow's foot. This type shows a zero-to-zero, zero-to-one, or zero-to-many relationship. Finally, a straight line linking entities with a crow's foot at the end depicts a relationship to more than one.

Symbol	Official Explanation	What It Really Means
	Entity	A class of persons, places, or things
	Associative entity	Used to join two entities
	Attributive entity	Used for repeating groups
	To 1 relationship	Exactly one
	To many relationship	One or more
	To 0 or 1 relationship	Only zero or one
	To 0 or more relationship	Can be zero, one, or more
	To more than 1 relationship	Greater than one

**FIGURE 13.3**

The entity-relationship symbols and their meanings.

An entity may have a relationship connecting it to itself. This type of relationship is called a self-join relationship; the implication is that there must be a way to link one record in a file to another record in the same file. An example of a self-join relationship can be found in the HyperCase simulations found throughout these chapters. A task may have a precedent task (that is, one that must be completed before starting the current task). In this situation, one record (the current task) points to another record (the precedent task) in the same file.

The relationships in words can be written along the top or the side of each connecting line. In practice, you see the relationship in one direction, although you can write relationships on both sides of the line, each representing the point of view of one of the two entities. (See Chapter 2 for more details about drawing E-R diagrams.)

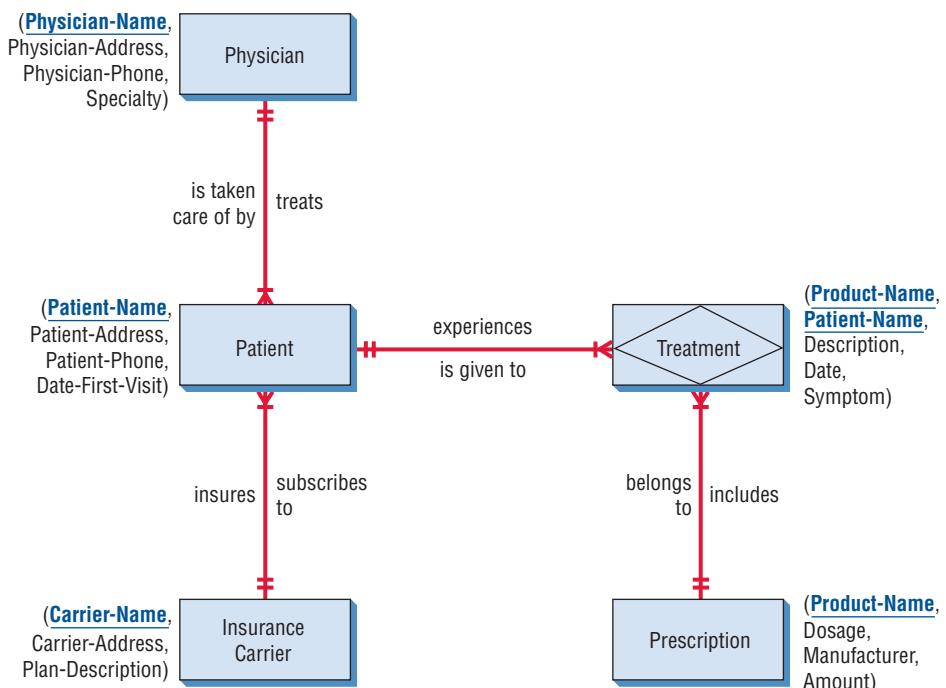
**AN ENTITY-RELATIONSHIP EXAMPLE.** An entity-relationship diagram containing many entities, many different types of relations, and numerous attributes is featured in Figure 13.4. In this E-R diagram, we are concerned about a billing system, and in particular with the prescription part of the system. (For simplicity, we assume that office visits are handled differently and are outside the scope of this system.)

The entities are PRESCRIPTION, PHYSICIAN, PATIENT, and INSURANCE CARRIER. The entity TREATMENT is not important for the billing system, but it is part of the E-R diagram because it is used to bridge the gap between PRESCRIPTION and PATIENT. We therefore drew it as an associative entity in the figure.

Here, a PHYSICIAN treats many PATIENT(s) (1:M), who each subscribe to an individual INSURANCE CARRIER. Of course, the PATIENT is only one of many patients that subscribe to that particular INSURANCE CARRIER (M:1).

**FIGURE 13.4**

The entity-relationship diagram for patient treatment. Attributes can be listed alongside the entities. In each case, the key is underlined.



To complete the PHYSICIAN's records, the physician needs to keep information about the treatments a PATIENT has. Many PATIENT(s) experience many TREATMENT(s), making it a many-to-many (M:N) relationship. TREATMENT is represented as an associative entity because it is not important in our billing system by itself. TREATMENT(s) can include the taking of PRESCRIPTION(s), and thus is also an M:N relationship, because many treatments may call for combinations of pharmaceuticals and many drugs may work for many treatments.

Some detail is then filled in for the attributes. The attributes are listed next to each of the entities, and the key is underlined. For example, the entity PRESCRIPTION has a PRODUCT-NAME, DOSAGE, MANUFACTURER, and AMOUNT. Ideally, it would be beneficial to design a database in this fashion, using entity-relationship diagrams and then filling in the details concerning attributes. This top-down approach is desirable, but it is sometimes very difficult to achieve.

**ATTRIBUTES.** An attribute is some characteristic of an entity. There can be many attributes for each entity. For example, a patient (entity) can have many attributes, such as last name, first name, street address, city, state, and so on. The date of the patient's last visit as well as the prescription details are also attributes. When the data dictionary was constructed in Chapter 8, the smallest particular described was called a data element. When files and databases are discussed, these data elements are generally referred to as data items. Data items are in fact the smallest units in a file or database. The term *data item* is also used interchangeably with the word *attribute*.

Data items can have values. These values can be of fixed or variable length; they can be alphabetic, numeric, special characters, or alphanumeric. Examples of data items and their values can be found in Figure 13.5.

Sometimes a data item is also referred to as a field. A field, however, represents something physical, not logical. Therefore, many data items can be packed into a field; the field can be read and converted to a number of data items. A common example of this is to store the date in a single field as MM/DD/YYYY. To sort the file in order by date, three separate data items are extracted from the field and sorted first by YYYY, then by MM, and finally by DD.

**RECORDS.** A record is a collection of data items that have something in common with the entity described. Figure 13.6 is an illustration of a record with many related data items. The record shown is for an order placed with a mail-order company. The ORDER-#, LAST NAME, INITIAL, STREET ADDRESS, CITY, STATE, and CREDIT CARD are all attributes. Most records are of fixed length, so there is no need to determine the length of the record each time.

Entity	Data Item	Value
Salesperson	Salesperson Number	87254
	Salesperson Name	Kaytell
	Company Name	Music Unlimited
	Address	45 Arpeum Circle
	Sales	\$20,765
Package	Width	2
	Height	16
	Length	16
	Weight	3
	Mailing Address	765 Dulcinea Drive
	Return Address	P.O. Box 341, Spring Valley, MN
Order	Product(s)	B521
	Description(s)	"My Fair Lady" compact disc
	Quantity Ordered	1
	Last Name of Customer	Kiley
	First Initial	R.
	Street Address	765 Dulcinea Drive
	City	La Mancha
	State	CA
	Zip Code	93407
	Credit Card Number	65-8798-87
	Date Order Was Placed	01/03/2010
	Amount	\$6.99
	Status	Backordered

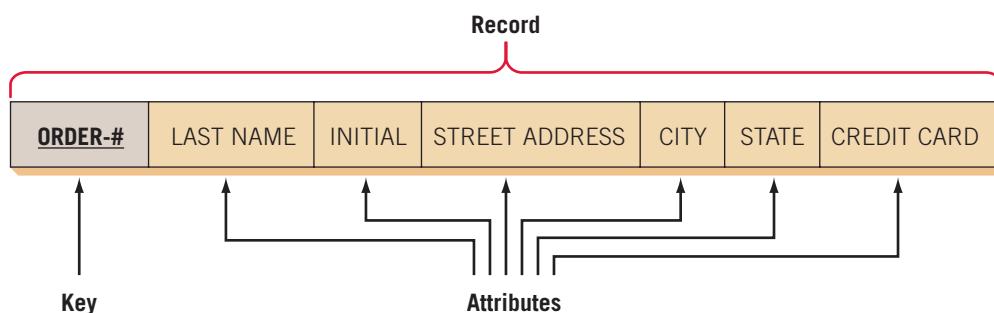
**FIGURE 13.5**

Typical values assigned to data items may be numbers, alphabetic characters, special characters, and combinations of all three.

Under certain circumstances (for instance, when space is at a premium), variable-length records are used. A variable-length record is used as an alternative to reserving a large amount of space for the longest possible record, such as the maximum number of visits a patient has made to a physician. Each visit would contain many data items that would be part of the patient's full record (or file folder in a manual system). Later in this chapter, normalization of a relation is discussed. Normalization is a process that eliminates repeating groups found in variable-length records.

**KEYS.** A key is one of the data items in a record that is used to identify a record. When a key uniquely identifies a record, it is called a primary key. For example, ORDER-# can be a primary key because only one number is assigned to each customer order. In this way, the primary key identifies the real-world entity (customer order).

Special care must be taken when designing the primary key. Often it is a sequential number or a sequential number with a self-checking number (called a check digit) at the end of the digits. At times there is some meaning built into the primary key, but defining a primary key based on an attribute is considered a risk. If the attribute changes, the primary key will also change, creating a dependency between the primary key and the data.

**FIGURE 13.6**

A record has a primary key and may have many attributes.

An example of a primary key based on data is using a state abbreviation for the state name or an airline luggage code for an airport name. An attribute or a collection of attributes that can serve as a primary key is called a candidate key. A primary key should also be minimal and contain no extra attributes than are necessary to identify a record.

A key is called a secondary key if it cannot uniquely identify a record. Secondary keys either may be unique or may identify multiple records in a database. Secondary keys can be used to select a group of records that belong to a set (for example, orders from the state of Virginia).

When it is not possible to identify a record uniquely by using one of the data items found in a record, a key can be constructed by choosing two or more data items and combining them. This key is called a concatenated, or composite, key. When a data item is used as a key in a record, the description is underlined. Therefore, in the ORDER record (ORDER-#, LAST NAME, INITIAL, STREET ADDRESS, CITY, STATE, CREDIT CARD), the key is ORDER-#. If an attribute is a key in another file, it should be underlined with a dashed line.

Some databases allow the developer to use an object identifier (OID), which is a unique key for each record in the database, not just in a table. Given an object identifier, one record will be obtained regardless of the table on which it exists. This may be included with an order or a payment confirmation, along with a message like, “This is your confirmation number.”

**METADATA.** Metadata are data about the data in the file or database. Metadata describe the name given and the length assigned to each data item. Metadata also describe the length and composition of each of the records.

Figure 13.7 is an example of metadata for a database for some generic software. The length of each data item is indicated according to a convention, where 7.2 means that seven spaces are reserved for the number, two of which are to the right of the decimal point. The letter N signifies “numeric,” and the A stands for “alphanumeric.” The D stands for “date” and is automatically in the form MM/DD/YYYY. Some programs, such as Microsoft Access, use plain English for metadata, so words such as *text*, *currency*, and *number* are used. Microsoft Access provides a default of 50 characters as the field length for names, which is fine when working with small systems. If, however, you are working with a large database for a bank or a utility company, for example, you do not want to devote that much space to that field. Otherwise, the database would become quite large and filled with wasted space. That is when you can use metadata to plan ahead and design a more efficient database.

## Files

A file contains groups of records used to provide information for operations, planning, management, and decision making. The types of files used are discussed first, followed by a description of the many ways conventional files can be organized.

**FILE TYPES.** Files can be used for storing data for an indefinite period of time, or they can be used to store data temporarily for a specific purpose. Master files and table files are used to store data for a long period. The temporary files are usually called transaction files, work files, or report files.

**Master Files** Master files contain records for a group of entities. The attributes may be updated often, but the records themselves are relatively permanent. These files tend to have large records containing all the information about a data entity. Each record usually contains a primary key and several secondary keys.

Although the analyst is free to arrange the data elements in a master file in any order, a standard arrangement is to place the primary key field first, followed by descriptive elements, and finally by elements that change frequently with business activities. Examples of a master file include patient records, customer records, a personnel file, and a parts inventory file.

**Table Files** A table file contains data used to calculate more data or performance measures. One example is a table of postage rates used to determine the shipping costs of a package. Another example is a tax table. Table files usually are read only by a program.

**Transaction Files** A transaction file is used to enter changes that update the master file and produce reports. Suppose a newspaper subscriber master file needs to be updated; the transaction file would contain the subscriber number, and a transaction code such as E for extending the subscription, C for canceling the subscription, or A for address change. Then only information

Data Item	Value	
Salesperson Number	N	5
Salesperson Name	A	20
Company Name	A	26
Address	A	36
Sales	N	9.2
Width	N	2
Height	N	2
Length	N	2
Weight	N	2
Mailing Address	A	36
Return Address	A	36
Product(s)	A	4
Description(s)	A	30
Quantity Ordered	N	2
Last Name of Customer	A	24
First Initial	A	1
Street Address	A	28
City	A	12
State	A	2
Zip Code	N	9
Credit Card Number	N	10
Date Order Was Placed	D	8
Amount	\$	7.2
Status	A	22

Fields

N	Numeric
A	Alphanumeric or text
D	Date MM/DD/YYYY
\$	Currency
M	Memo

7.2 means that the field takes up 7 digits, two of which are right of the decimal.

Special formats for fields may be specified.

**FIGURE 13.7**

Metadata includes a description of what the value of each data item looks like.

relevant to the updating needs to be entered; that is, the length of renewal if E, and the address if A. No additional information would be needed if the subscription were canceled. The rest of the information already exists in the master file. Transaction files may contain several different types of records, such as the three used for updating the newspaper subscription master, with a code on the transaction file indicating the type of transaction.

**Report Files** When it is necessary to print a report when no printer is available (e.g., when the printer is busy printing other jobs), a report file is used. Sending the output to a file rather than a printer is called spooling. Later, when the device is ready, the document can be printed. Report files are very useful, because users can take files to other computer systems and output to specialty devices.

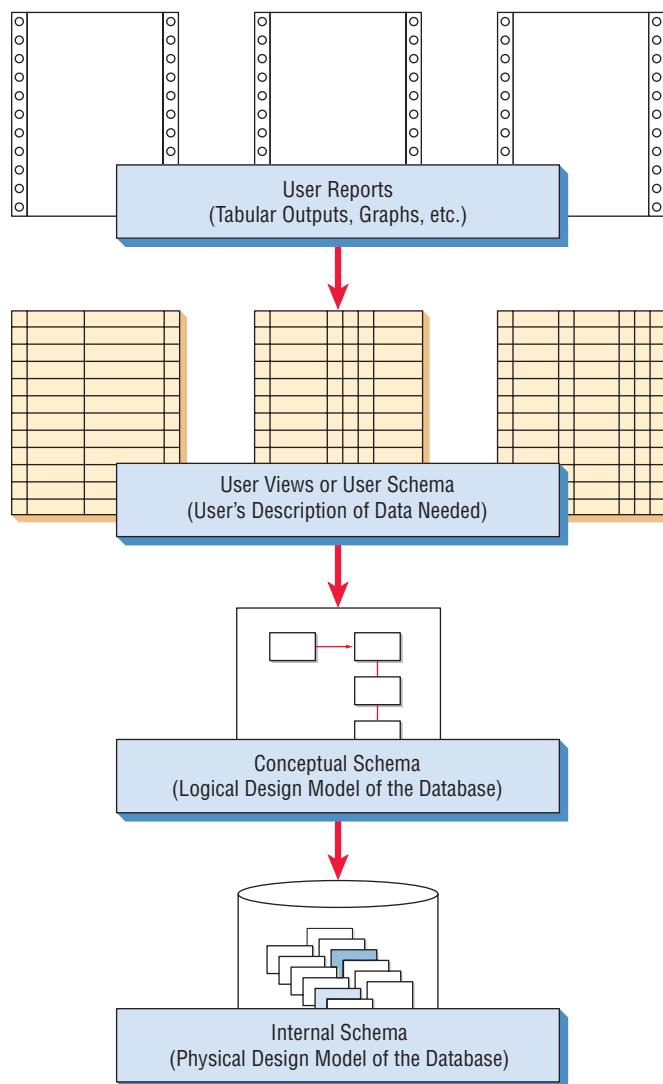
## Relational Databases

Databases can be organized in several ways. The most common type of database is a relational database. A relational database is organized in meaningful tables, which minimizes the repetition of data, which in turn minimizes errors and storage space.

**LOGICAL AND PHYSICAL VIEWS OF DATA.** A database, unlike a file, is intended to be shared by many users. It is clear that the users all see the data in different ways. We refer to the way a user pictures and describes the data as a user view. The problem, however, is that different users have different user views. These views need to be examined by the systems analyst, and an overall logical model of the database developed. Finally, the logical model of the database must be transformed into a corresponding physical database design. Physical design is involved with how data are stored and related, as well as how they are accessed.

**FIGURE 13.8**

Database design includes synthesizing user reports, user views, and logical and physical designs.



In database literature, the views are referred to as schema. Figure 13.8 shows how the user reports and user views (user schema) are related to the logical model (conceptual schema) and physical design (internal schema).

There are three main types of logically structured databases: hierarchical, network, and relational. The first two types may be found in legacy (older) systems. An analyst today would typically design a relational database.

**RELATIONAL DATA STRUCTURES.** A relational data structure consists of one or more two-dimensional tables, which are referred to as relations. The rows of the table represent the records, and the columns contain attributes.

Figure 13.9 shows the relational structure for a music CD ordering database. Here, three tables are needed to (1) describe the items and keep track of the current price of CDs (ITEM PRICE), (2) describe the details of the order (ORDER), and (3) identify the status of the order (ITEM STATUS).

To determine the price of an item, we need to know the item number to be able to find it in the relation ITEM PRICE. To update G. MacRae's credit card number, we can search the ORDER relation for MacRae and correct it only once, even though he ordered many CDs. To find out the status of part of an order, however, we must know the ITEM-# and ORDER-#, and then we must locate that information in the relation ITEM STATUS.

Maintaining the tables in a relational structure is usually quite simple when compared with maintaining a hierarchical or network structure. One of the primary advantages of relational structures is that ad hoc queries are handled efficiently.

ITEM PRICE		
ITEM-#	TITLE	PRICE
B235	Guys and Dolls	8.99
B521	My Fair Lady	6.99
B894	42nd Street	10.99
B992	A Chorus Line	10.99

ORDER						
ORDER-#	LAST NAME	I	STREET ADDRESS	CITY	ST	CHARGE ACCT
10784	MacRae	G	2314 Curly Circle	Lincoln	NE	45-4654-76
10796	Jones	S	34 Dream Lane	Oklahoma City	OK	44-9876-74
11821	Preston	R	1008 Madison Ave.	River City	IA	34-7642-64
11845	Channing	C	454 Harmonia St.	New York	NY	34-0876-87
11872	Kiley	R	765 Dulcinea Drive	La Mancha	CA	65-8798-87

ITEM STATUS		
ITEM-#	ORDER-#	STATUS
B235	10784	Shipped 5/12
B235	19796	Shipped 5/14
B235	11872	In Process
B521	11821	In Process
B894	11845	Backordered
B894	11872	Shipped 5/12
B992	10784	Shipped 5/12

**FIGURE 13.9**

In a relational data structure, data are stored in many tables.

When relational structures are discussed in database literature, different terminology is often used. A file is called either a table or relation, a record is usually referred to as a tuple, and the attribute value set is called a domain.

For relational structures to be useful and manageable, the relational tables must first be normalized. Normalization is detailed in the following section.

## NORMALIZATION

Normalization is the transformation of complex user views and data stores to a set of smaller, stable data structures. In addition to being simpler and more stable, normalized data structures are more easily maintained than other data structures.

### The Three Steps of Normalization

Beginning with either a user view or a data store developed for a data dictionary (see Chapter 8), the analyst normalizes a data structure in three steps, as shown in Figure 13.10. Each step involves an important procedure, one that simplifies the data structure.

The relation derived from the user view or data store will most likely be unnormalized. The first stage of the process includes removing all repeating groups and identifying the primary key. To do so, the relation needs to be broken up into two or more relations. At this point, the relations may already be of the third normal form, but it is likely more steps will be needed to transform the relations to the third normal form.

The second step ensures that all nonkey attributes are fully dependent on the primary key. All partial dependencies are removed and placed in another relation.

The third step removes any transitive dependencies. A transitive dependency is one in which nonkey attributes are dependent on other nonkey attributes.

**FIGURE 13.10**

Normalization of a relation is accomplished in three major steps.

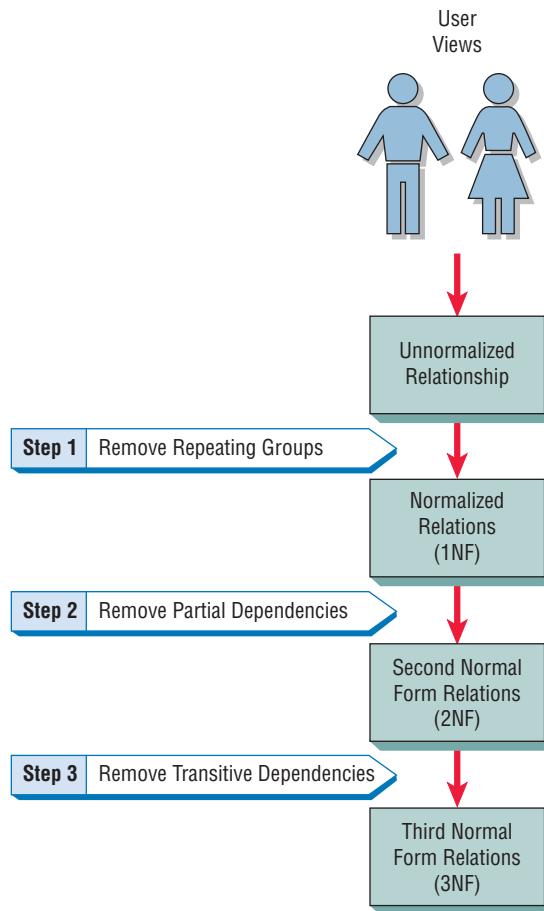
**A Normalization Example**

Figure 13.11 is a user view for the Al S. Well Hydraulic Equipment Company. The report shows the (1) SALESPEOPLE-NUMBER, (2) SALESPEOPLE-NAME, and (3) SALES-AREA. The body of the report shows the (4) CUSTOMER-NUMBER and (5) CUSTOMER-NAME. Next is the (6) WAREHOUSE-NUMBER that will service the customer, followed by the (7) WAREHOUSE-LOCATION, which is the city in which the company is located. The final information contained in the user view is the (8) SALES-AMOUNT. The rows (one for each customer) on the user view show that items 4 through 8 form a repeating group.

If the analyst was using a data flow/data dictionary approach, the same information in the user view would appear in a data structure. Figure 13.12 shows how the data structure would appear at the data dictionary stage of analysis. The repeating group is also indicated in the data structure by an asterisk (\*) and indentation.

Before proceeding, note the data associations of the data elements in Figure 13.13. This type of illustration is called a bubble diagram or data model diagram. Each entity is enclosed in an ellipse, and arrows are used to show the relationships. Although it is possible to draw these relationships with an E-R diagram, it is sometimes easier to use the simpler bubble diagram to model the data.

In this example, there is only one SALESPEOPLE-NUMBER assigned to each SALESPEOPLE-NAME, and that person will cover only one SALES-AREA, but each SALES-AREA may be assigned to many salespeople: hence, the double arrow notation from SALES-AREA to SALESPEOPLE-NUMBER. For each SALESPEOPLE-NUMBER, there may be many CUSTOMER-NUMBER(s).

Furthermore, there would be a one-to-one correspondence between CUSTOMER-NUMBER and CUSTOMER-NAME; the same is true for WAREHOUSE-NUMBER and WAREHOUSE-LOCATION. CUSTOMER-NUMBER will have only one WAREHOUSE-NUMBER and WAREHOUSE-LOCATION, but each WAREHOUSE-NUMBER or WAREHOUSE-LOCATION may

**FIGURE 13.11**

A user report for the Al S. Well Hydraulic Equipment Company.

**Al S. Well  
Hydraulic Equipment Company  
Spring Valley, Minnesota**

Salesperson #: 3462  
Name: Waters  
Sales Area: West

CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER	WAREHOUSE LOCATION	SALES
18765	Delta Services	4	Fargo	13,540
18830	M. Levy and Sons	3	Bismarck	10,600

service many CUSTOMER-NUMBER(s). Finally, to determine the SALES-AMOUNT for one salesperson's calls to a particular company, it is necessary to know both the SALESPERSON-NUMBER and the CUSTOMER-NUMBER.

The main objective of the normalization process is to simplify all the complex data items that are often found in user views. For example, if the analyst were to take the user view discussed previously and attempt to make a relational table out of it, the table would look like Figure 13.14. Because this relation is based on our initial user view, we refer to it as SALES-REPORT.

SALES-REPORT is an unnormalized relation, because it has repeating groups. It is also important to observe that a single attribute such as SALESPERSON-NUMBER cannot serve as the key. The reason is clear when one examines the relationships between SALESPERSON-NUMBER and the other attributes in Figure 13.15. Although there is a one-to-one correspondence between SALESPERSON-NUMBER and two attributes (SALESPERSON-NAME and SALES-AREA), there is a one-to-many relationship between SALESPERSON-NUMBER and

**FIGURE 13.12**

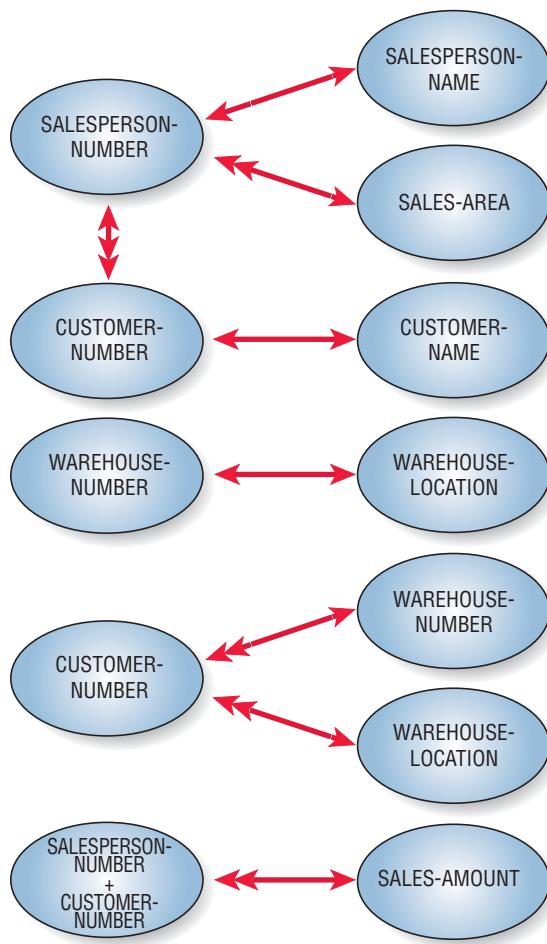
The analyst would find a data structure (from a data dictionary) useful in developing a database.

SALESPERSON-NUMBER  
SALESPERSON-NAME  
SALES-AREA

CUSTOMER-NUMBER\* (1- )  
CUSTOMER-NAME  
WAREHOUSE-NUMBER  
WAREHOUSE-LOCATION  
SALES-AMOUNT

**FIGURE 13.13**

Drawing data model diagrams for data associations sometimes helps analysts appreciate the complexity of data storage.



the other five attributes (CUSTOMER-NUMBER, CUSTOMER-NAME, WAREHOUSE-NUMBER, WAREHOUSE-LOCATION, and SALES-AMOUNT).

SALES-REPORT can be expressed in the following shorthand notation:

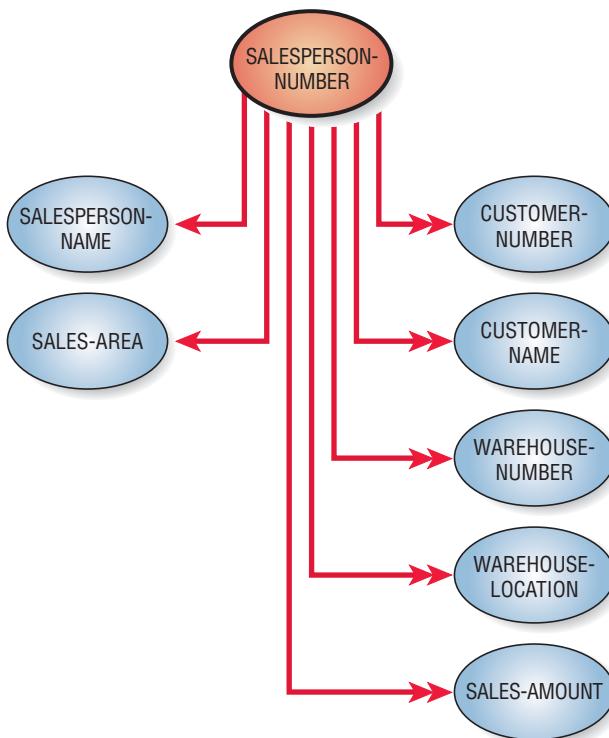
SALES REPORT      (SALESPERSON-NUMBER,  
SALESPERSON-NAME, SALES-AREA,  
(CUSTOMER-NUMBER,  
CUSTOMER-NAME,  
WAREHOUSE-NUMBER,  
WAREHOUSE-LOCATION,  
SALES-AMOUNT))

where the inner set of parentheses represents the repeated group.

**FIGURE 13.14**

If the data were listed in an unnormalized table, there could be repeating groups.

SALESPERSON NUMBER	SALESPERSON NAME	SALES AREA	CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER	WAREHOUSE LOCATION	SALES AMOUNT
3462	Waters	West	18765 18830 19242	Delta Systems A. Levy and Sons Ranier Company	4 3 3	Fargo Bismarck Bismarck	13540 10600 9700
3593	Dryne	East	18841 18899 19565	R. W. Flood Inc. Seward Systems Stodola's Inc.	2 2 1	Superior Superior Plymouth	11560 2590 8800
etc.							

**FIGURE 13.15**

A data model diagram shows that in the unnormalized relation, the SALESPERSON-NUMBER has a one-to-many association with some attributes.

**FIRST NORMAL FORM (1NF).** The first step in normalizing a relation is to remove the repeating groups. In our example, the unnormalized relation SALES-REPORT will be broken into two separate relations. These new relations will be named SALESPERSON and SALESPERSON-CUSTOMER.

Figure 13.16 shows how the original, unnormalized relation SALES-REPORT is normalized by separating the relation into two new relations. Notice that the relation SALESPERSON contains the primary key SALESPERSON-NUMBER and all the attributes that were not repeating (SALESPERSON-NAME and SALES-AREA).

The second relation, SALESPERSON-CUSTOMER, contains the primary key from the relation SALESPERSON (the primary key of SALESPERSON is SALESPERSON-NUMBER), as well as all the attributes that were part of the repeating group (CUSTOMER-NUMBER, CUSTOMER-NAME, WAREHOUSE-NUMBER, WAREHOUSE-LOCATION, and SALES-AMOUNT). Knowing the SALESPERSON-NUMBER, however, does not automatically mean that you will know the CUSTOMER-NAME, SALES-AMOUNT, WAREHOUSE-LOCATION, and so on. In this relation, one must use a concatenated key (both SALESPERSON-NUMBER and CUSTOMER-NUMBER) to access the rest of the information. It is possible to write the relations in shorthand notation as follows:

SALESPERSON      (SALESPERSON NUMBER,  
                  SALESPERSON-NAME, SALES AREA)

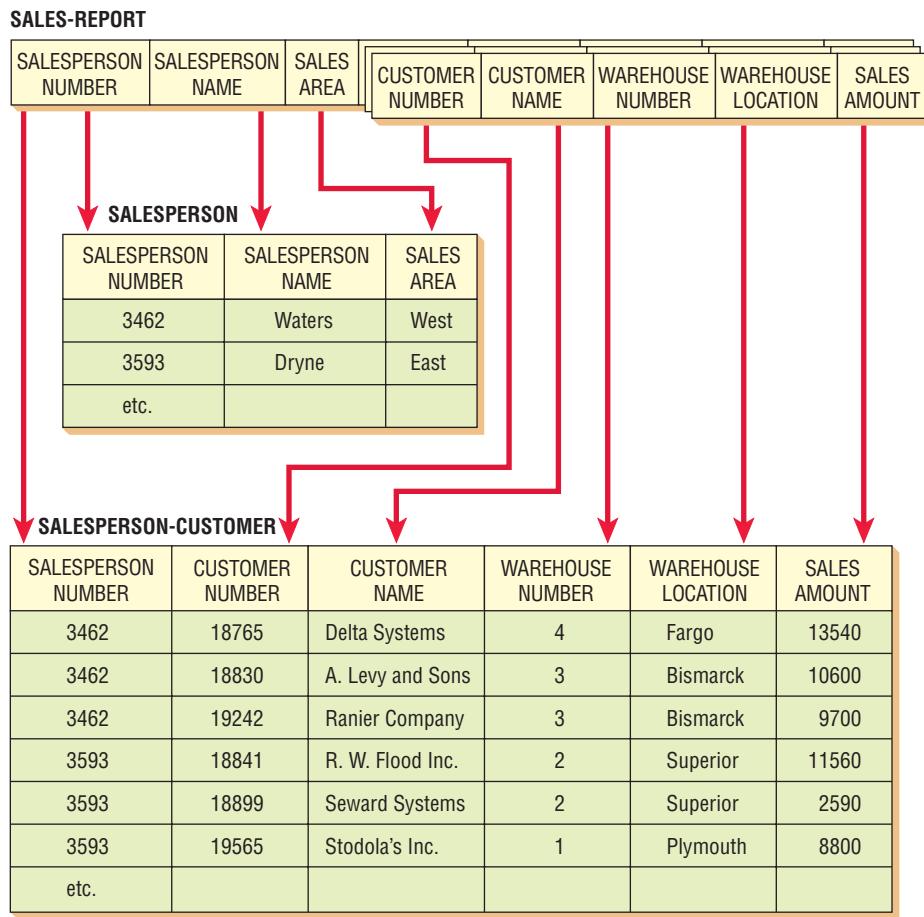
and

SALESPERSON-CUSTOMER      (SALESPERSON-NUMBER,  
                  CUSTOMER-NUMBER,  
                  CUSTOMER-NAME,  
                  WAREHOUSE-NUMBER,  
                  WAREHOUSE-LOCATION,  
                  SALES-AMOUNT)

The relation SALESPERSON-CUSTOMER is a first normal relation, but it is not in its ideal form. Problems arise because some of the attributes are not functionally dependent on the primary key

**FIGURE 13.16**

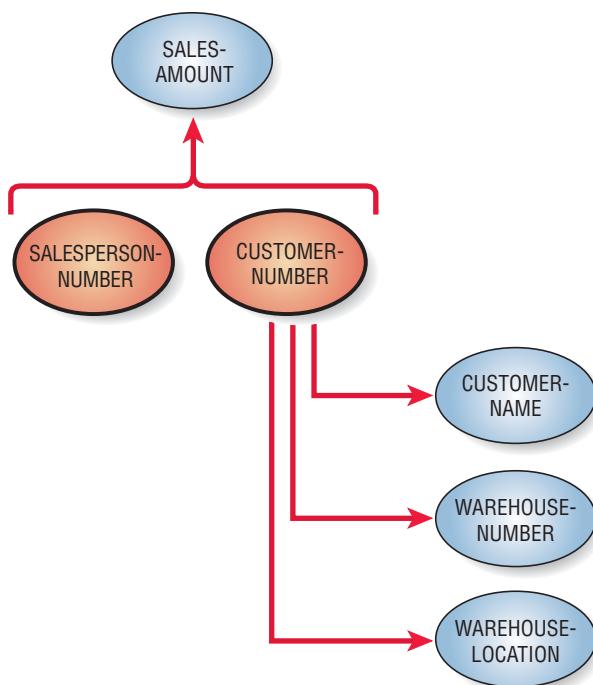
The original unnormalized relation SALES-REPORT is separated into two relations, SALESPERSON (3NF) and SALESPERSON-CUSTOMER (1NF).



(that is, SALESPERSON-NUMBER, CUSTOMER-NUMBER). In other words, some of the non-key attributes are dependent only on CUSTOMER NUMBER and not on the concatenated key. The data model diagram in Figure 13.17 shows that SALES-AMOUNT is dependent on both SALESPERSON-NUMBER and CUSTOMER-NUMBER, but the other three attributes are dependent only on CUSTOMER-NUMBER.

**FIGURE 13.17**

A data model diagram shows that three attributes are dependent on CUSTOMER-NUMBER, so the relation is not yet normalized. Both SALESPERSON-NUMBER and CUSTOMER-NUMBER are required to look up SALES-AMOUNT.



**SECOND NORMAL FORM (2NF).** In the second normal form, all the attributes will be functionally dependent on the primary key. Therefore, the next step is to remove all the partially dependent attributes and place them in another relation. Figure 13.18 shows how the relation SALESPERSON-CUSTOMER is split into two new relations: SALES and CUSTOMER-WAREHOUSE. These relations can also be expressed as follows:

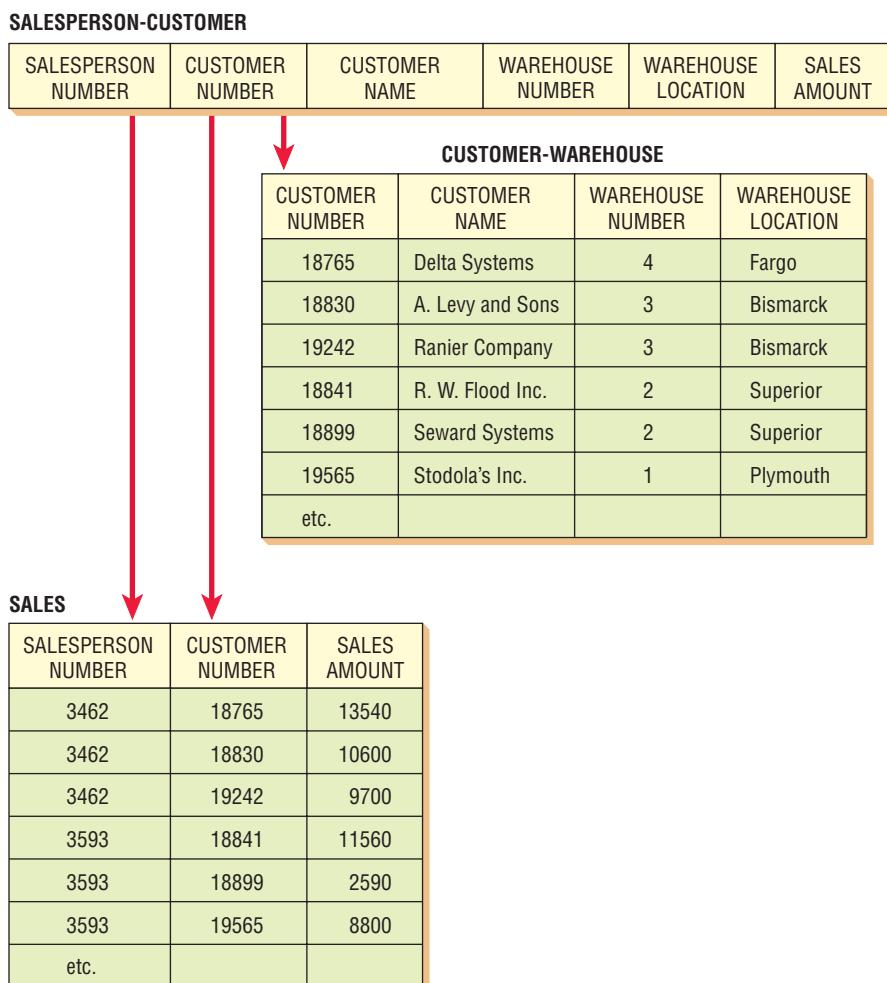
SALES (SALESPERSON-NUMBER, CUSTOMER-NUMBER,  
SALES-AMOUNT)

and

CUSTOMER WAREHOUSE (CUSTOMER-NUMBER,  
CUSTOMER-NAME,  
WAREHOUSE-NUMBER,  
WAREHOUSE-LOCATION)

The relation CUSTOMER-WAREHOUSE is in the second normal form. It can still be simplified further because there are additional dependencies in the relation. Some of the nonkey attributes are dependent not only on the primary key, but also on a nonkey attribute. This dependency is referred to as a transitive dependency.

Figure 13.19 shows the dependencies in the relation CUSTOMER-WAREHOUSE. For the relation to be a second normal form, all the attributes must be dependent on the primary key CUSTOMER-NUMBER, as shown in the diagram. WAREHOUSE-LOCATION, however, is obviously dependent on WAREHOUSE-NUMBER also. To simplify this relation, another step is required.

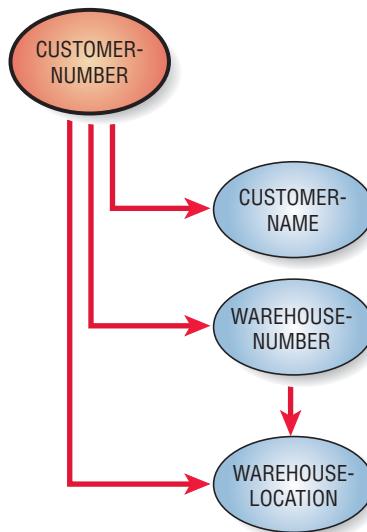


**FIGURE 13.18**

The relation SALESPERSON-CUSTOMER is separated into a relation called CUSTOMER-WAREHOUSE (2NF) and a relation called SALES (1NF).

**FIGURE 13.19**

A data model diagram shows that a transitive dependency exists between WAREHOUSE-NUMBER and WAREHOUSE-LOCATION.



**THIRD NORMAL FORM (3NF).** A normalized relation is in the third normal form if all the nonkey attributes are fully functionally dependent on the primary key and there are no transitive (nonkey) dependencies. In a manner similar to the previous steps, it is possible to break apart the relation CUSTOMER-WAREHOUSE into two relations, as shown in Figure 13.20.

The two new relations are called CUSTOMER and WAREHOUSE, and can be written as follows:

CUSTOMER (CUSTOMER-NUMBER, CUSTOMER-NAME,  
WAREHOUSE-NUMBER)

and

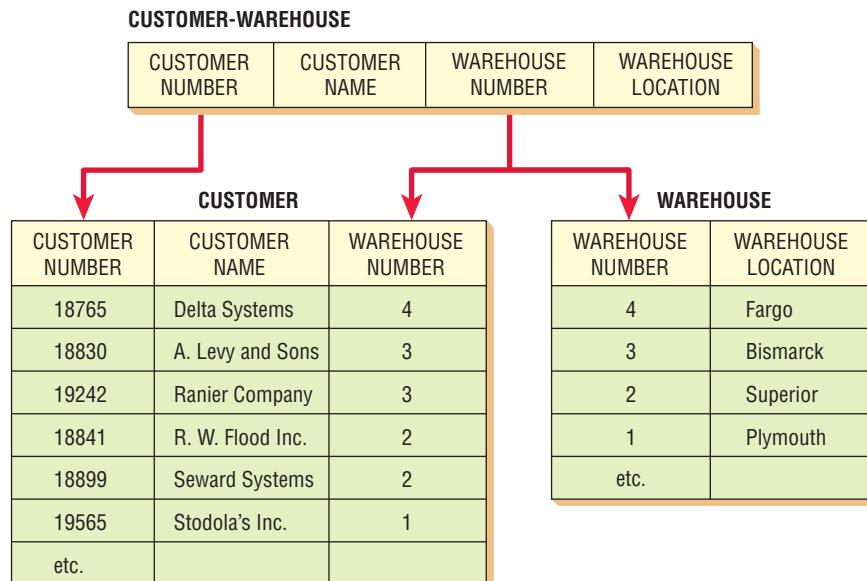
WAREHOUSE (WAREHOUSE-NUMBER,  
WAREHOUSE-LOCATION)

The primary key for the relation CUSTOMER is CUSTOMER-NUMBER, and the primary key for the relation WAREHOUSE is WAREHOUSE-NUMBER.

In addition to these primary keys, we can identify WAREHOUSE-NUMBER to be a foreign key in the relation CUSTOMER. A foreign key is any attribute that is nonkey in one relation but

**FIGURE 13.20**

The relation CUSTOMER-WAREHOUSE is separated into two relations called CUSTOMER (1NF) and WAREHOUSE (1NF).



a primary key in another relation. We designated WAREHOUSE-NUMBER as a foreign key in the previous notation and in the figures by underscoring it with a dashed line: \_\_\_\_\_.

Finally, the original, unnormalized relation SALES-REPORT has been transformed into four 3NF relations. In reviewing the relations shown in Figure 13.21, one can see that the single relation SALES-REPORT was transformed into the following four relations:

SALESPERSON	( <u>SALESPERSON-NUMBER</u> , SALESPERSON-NAME, SALES-AREA)
SALES	( <u>SALESPERSON-NUMBER</u> , <u>CUSTOMER-NUMBER</u> , SALES-AMOUNT)
CUSTOMER	( <u>CUSTOMER-NUMBER</u> , CUSTOMER-NAME, WAREHOUSE-NUMBER)

and

WAREHOUSE	( <u>WAREHOUSE-NUMBER</u> , WAREHOUSE-LOCATION)
-----------	--

The third normal form is adequate for most database design problems. The simplification gained from transforming an unnormalized relation into a set of 3NF relations is a tremendous benefit when it comes time to insert, delete, and update information in the database.

An E-R diagram for the database is shown in Figure 13.22. One SALESPERSON serves many CUSTOMER(s), who generate SALES and receive their items from one WAREHOUSE (the closest WAREHOUSE to their location). Take the time to notice how the entities and attributes relate to the database.

### Using the Entity-Relationship Diagram to Determine Record Keys

The E-R diagram may be used to determine the keys required for a record or a database relation. The first step is to construct the E-R diagram and label a unique (primary) key for each data entity.

SALESPERSON		
SALESPERSON NUMBER	SALESPERSON NAME	SALES AREA
3462	Waters	West
3593	Dryne	East
etc.		

SALES		
SALESPERSON NUMBER	CUSTOMER NUMBER	SALES AMOUNT
3462	18765	13540
3462	18830	10600
3462	19242	9700
3593	18841	11560
3593	18899	2590
3593	19565	8800
etc.		

CUSTOMER		
CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER
18765	Delta Systems	4
18830	A. Levy and Sons	3
19242	Ranier Company	3
18841	R. W. Flood Inc.	2
18899	Seward Systems	2
19565	Stodola's Inc.	1
etc.		

WAREHOUSE	
WAREHOUSE NUMBER	WAREHOUSE LOCATION
4	Fargo
3	Bismarck
2	Superior
1	Plymouth
etc.	

**FIGURE 13.21**

The complete database consists of four 1NF relations called SALESPERSON, SALES, CUSTOMER, and WAREHOUSE.

**FIGURE 13.22**

An entity-relationship diagram for the Al S. Well Hydraulic Company database.

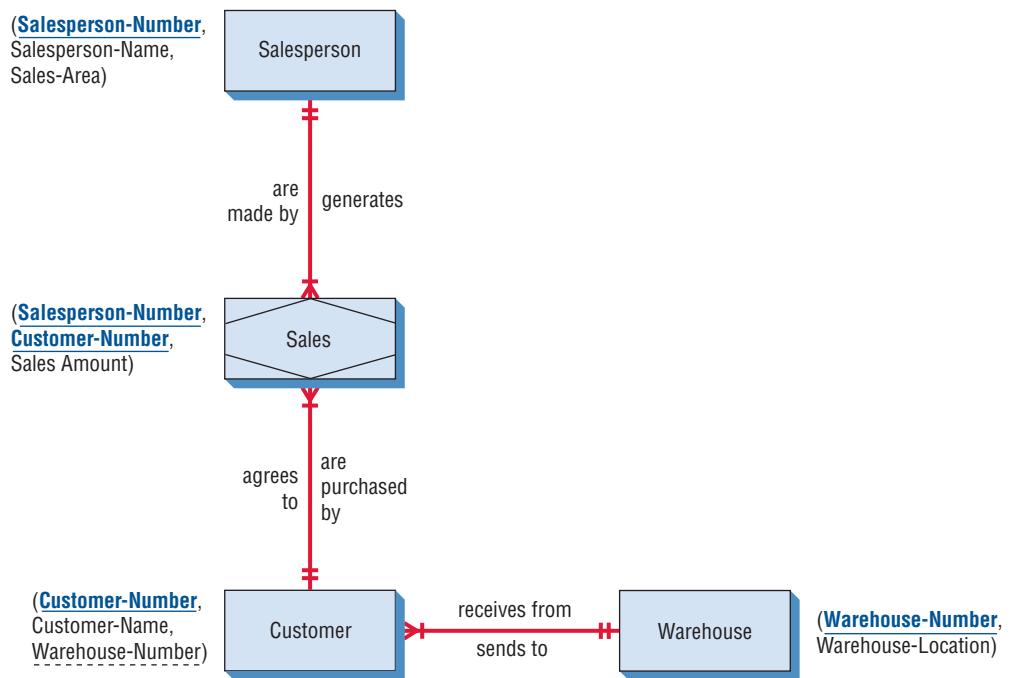


Figure 13.23 shows an E-R diagram for a customer order system. There are three data entities: CUSTOMER, with a primary key of CUSTOMER-NUMBER; ORDER, with a primary key of ORDER-NUMBER; and ITEM, with ITEM-NUMBER as the primary key. One CUSTOMER may place many orders, but each ORDER can be placed by one CUSTOMER only, so the relationship is one-to-many. Each ORDER may contain many ITEM(s), and each ITEM may be contained in many ORDER(s), so the ORDER-ITEM relationship is many-to-many.

A foreign key, however, is a data field on a given file that is the primary key of a different master file. For example, a DEPARTMENT-NUMBER indicating a student's major may exist on the STUDENT MASTER table. DEPARTMENT-NUMBER could also be the unique key for the DEPARTMENT MASTER table.

### One-to-Many Relationship

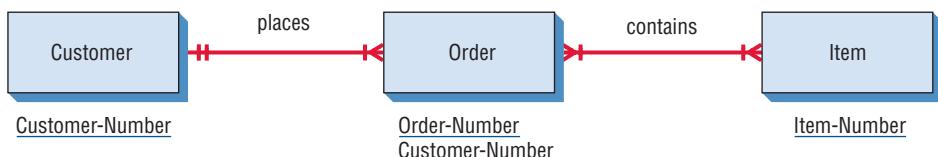
A one-to-many relationship is the most common type of relationship, since all many-to-many relationships must be broken down into two one-to-many relationships. When a one-to-many relationship occurs, place the primary key on the table at the one end of the relationship as a foreign key on the table on the many end of the relationship. For example, since one customer may have many orders, place the customer number on the order record.

The design of Web pages, displays, or reports that include information from only one record of the many relationship, along with information from the one end of the relationship, is easy to construct. The display will not have any repeating information. An example is an order inquiry using an order number to look up a single order. Since the order is for one customer, the result would be fields from the order and a single customer.

Designing the reverse is more complicated, since the table at the one end of the relationship may have many records for the many end. These are implemented in a variety of ways. For a simple display screen, the information from the one end is displayed with a repeating number of

**FIGURE 13.23**

An entity-relationship diagram for customer orders.



groups of information from the many end of the relationship. In Microsoft Access, this might be a form with a subform, such as a customer with a subform of all the customer's orders. If there was a large number of records from the many end, scroll bars would appear.

In simple situations, the relationship might also be implemented by using a drop-down list, with each record from the many end becoming one entry in the one end; an example is the display of a car along with a drop-down list containing all the models for the car. When designing Web sites, the information from the one end might be at the top of the page, with multiple groups of data below it or multiple links to the data. An example is one search engine topic resulting in many matching links or one genre of music and many artists that match the genre.

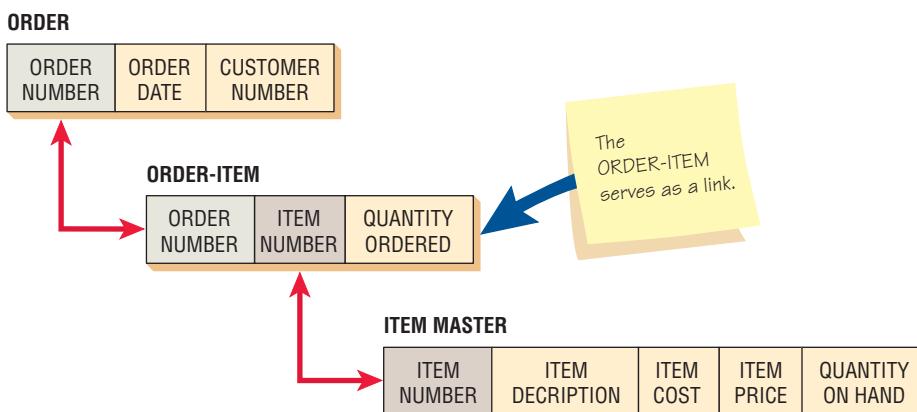
### Many-to-Many Relationship

When the relationship is many-to-many, three tables are necessary: one for each data entity and one for the relationship. The ORDER and ITEM entities in our example have a many-to-many relationship. The primary key of each data entity is stored as a foreign key of the relational table. The relational table may simply contain the primary keys for each data entity or may contain additional data, such as the grade received for a course or the quantity of an item ordered. Refer to the table layout illustrated in Figure 13.24. The ORDER ITEM table contains information about which order contains which items, and provides a link between the ORDER table and the ITEM MASTER table.

The relationship table should be indexed on each foreign key—one for each of the tables in the relationship—and may have a primary key consisting of a combination of the two foreign keys. Often corporations will use a unique key, such as sequence number, as the primary key for the relational table. To find many records from a second table given the first table, directly read the relational table for the desired key. Locate the matching record in the second *many* table. Continue to loop through the relational table until the desired key is no longer found. For example, to find records in the ITEM MASTER for a specific record in the ORDER table, directly read the ORDER-ITEM table using the ORDER-NUMBER as the index. Records are logically sequenced based on the data in the index, so all records for the same ORDER-NUMBER are grouped together. For each ORDER-ITEM record that matches the desired ORDER-NUMBER, directly read the ITEM MASTER table using the ITEM-NUMBER as an index.

The logic is the same for the reverse situation, such as finding all the orders for a backordered item that has been received. Use the desired ITEM-NUMBER to read the ORDER-ITEM table directly. The ORDER-ITEM index is set to the ITEM-NUMBER. For all matching ORDER ITEM records, use the ORDER-NUMBER to read the ORDER table directly. Finally, read the CUSTOMER MASTER table directly to obtain the CUSTOMER-NAME and ADDRESS using the CUSTOMER-NUMBER on the ORDER table.

Relational tables may have relationships to more tables in the database than just the two to which they directly connect. For example, there might be a relational table called Class or Section to link students and courses, since each student may take many courses and each course may have many students. The Section table may have a relationship to the Textbook or to the Instructor for that section.



**FIGURE 13.24**

When the relationship is many-to-many, three files are necessary.

## GUIDELINES FOR MASTER FILE/DATABASE RELATION DESIGN

The following guidelines should be taken into account when designing master files or database relations:

1. Each separate data entity should create a master database table. Do not combine two distinct entities on one file. For example, items are purchased from vendors. The ITEM MASTER table should contain only item information, and the VENDOR MASTER table should contain only vendor information.
2. A specific data field should exist only on one master table. For example, the CUSTOMER NAME should exist only on the CUSTOMER MASTER table, not on the ORDER table or any other master table. The exceptions to this guideline are the key or index fields, which may be on as many tables as necessary. If a report or screen needs information from many tables, the indexes should provide the linkage for obtaining the required records.
3. Each master table or database relation should have programs to Create, Read, Update, and Delete (abbreviated CRUD) the records. Ideally, only one program should add new records and only one program should delete specified records. Many programs, however, may be responsible for changing data fields in the course of normal business activities. For example, a CUSTOMER MASTER file may have a CURRENT BALANCE field that is increased by the ORDER TOTAL in the order processing program and decreased by a PAYMENT AMOUNT or an AMOUNT RETURNED from two additional programs.

### Integrity Constraints

Integrity constraints are rules that govern changing and deleting records, and that help keep the data in the database accurate. Three types of integrity constraints apply to a database:

1. Entity integrity.
2. Referential integrity.
3. Domain integrity.

Entity integrity constraints are rules that govern the composition of primary keys. The primary key cannot have a null value, and if the primary key is a composite key, none of the component fields in the key can contain a null value. Some databases allow you to define a unique constraint or a unique key. This unique key identifies only one record, which is not a primary key. The difference between a unique key and a primary key is that a unique key may contain a null value.

Referential integrity governs the nature of records in a one-to-many relationship. The table that is connected to the one end of the relationship is called the parent. The table connected to the many end of the relationship is called the child table. Referential integrity means that all foreign keys in the many table (the child table) must have a matching record in the parent table. Hence, you cannot add a record in the child (many) table without a matching record in the parent table.

A second implication is that you cannot change a primary key that has matching child table records. If you could change the parent record, the result would be a child record that would have a different parent record or an orphan record, or a child record without a parent record. Examples are a GRADE record for a student that would not be on the STUDENT MASTER table and an ORDER record for a CUSTOMER NUMBER that did not exist. The last implication of referential integrity is that you cannot delete a parent record that has child records. That would also lead to the orphan records mentioned earlier.

Referential integrity is implemented in two different ways. One way is to have a restricted database, in which the system can update or delete a parent record only if there are no matching child records. A cascaded database will delete or update all child records when a parent record is deleted or changed (the parent triggers the changes).

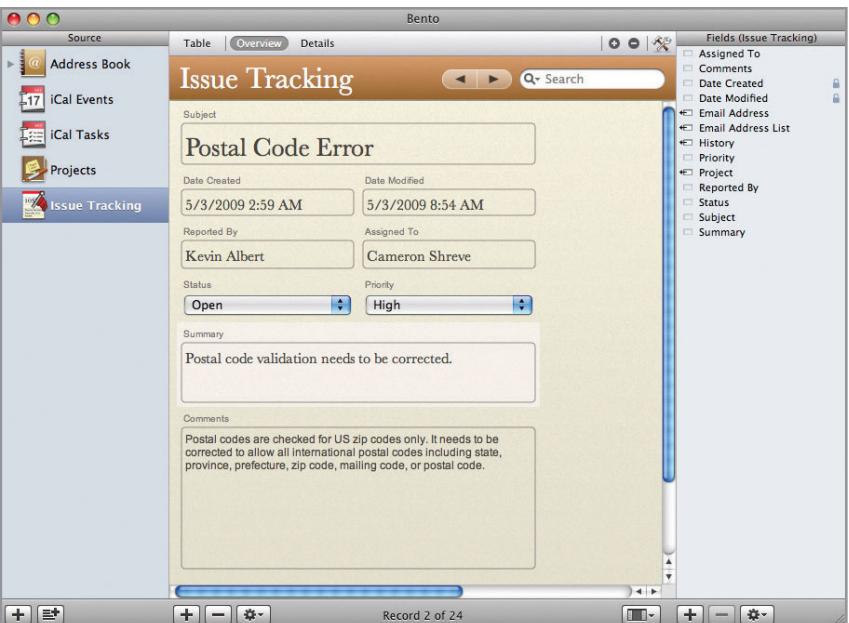
A restricted relationship is better when deleting records. You would not want to delete a customer record and have all the outstanding invoices deleted as well! The cascaded approach is better when changing records. If the primary key of a student record is changed, all the course records for that student would have their foreign keys (the STUDENT NUMBER on the COURSE MASTER) changed as well.

Domain integrity rules are used to validate the data, such as table, limit, range, and other validation checks. They are further explained in Chapter 15. The domain integrity rules are usually

## MAC APPEAL

Although Microsoft Word, Excel, and PowerPoint are available for the Mac operating system, the only way to run Microsoft Access is to run Windows in virtualization mode or by booting into Windows. There are two other options for the Mac—Bento and FileMaker Pro. Bento is a personal database that allows users to efficiently gather information from the address book, calendar application, Apple Mail, and Microsoft Excel, and then quickly add new fields to create a customizable database.

Some users may find Bento limiting; so another option is Bento's big brother, FileMaker Pro. It is a full, relational database program that has support for direct access to SQL databases. Its distinguishing characteristic is that the screens, forms, and reports that access the database are fully integrated with the database engine.



**FIGURE 13.MAC**

A screen from Bento, a personal database. Screenshot used with permission from FileMaker, Inc.

stored in the database structure in one of two forms. Check constraints are defined at the table level and can refer to one or more fields in the table. An example is that the DATE OF PURCHASE is always less than or equal to the current date. Rules are defined at the database level as separate objects and can be used with a number of fields. An example is a value that is greater than zero, used to validate a number of elements.

### Anomalies

Four anomalies may occur when creating database tables:

1. Data redundancy.
2. Insert anomaly.
3. Deletion anomaly.
4. Update anomaly.

Data redundancy occurs when the same data are stored in more than one place in the database (except for primary keys stored as foreign keys). This problem is solved by creating tables that are in 3NF.

An insert anomaly occurs when the entire primary key is not known and the database cannot insert a new record, which would violate entity integrity. This problem usually occurs when the primary key is a composite key containing several smaller attributes. An insert anomaly may be avoided by using a sequence number for the primary key.

A deletion anomaly happens when a record is deleted, resulting in the loss of other related data. An example is an item that has a vendor number and a particular item is the only reference to a certain vendor. If that item is deleted, there would be no reference to the vendor record.

An update anomaly results when a change to one attribute value either causes the database to contain inconsistent data or causes multiple records to need changing. An example is when a street name changes in a city. You might change some of the street names and not others, or you will have to ensure that all street names have been changed. This can occur when you have transitive dependencies and may be prevented by creating tables that are in 3NF (although in the street example, the data may be in 3NF).

## MAKING USE OF THE DATABASE

There are several steps you must take in sequential order to assure that the database will be useful for presenting data.

### Steps in Retrieving and Presenting Data

There are eight steps in the retrieval and presentation of data:

1. Choose a relation from the database.
2. Join the relations together.
3. Project columns from the relation.
4. Select rows from the relation.
5. Derive new attributes.
6. Index or sort rows.
7. Calculate totals and performance measures.
8. Present data.

The first and last steps must be done, but the six steps in between are optional, depending on how data are to be used. Figure 13.25 is a visual guide to the steps.

The final step in the retrieval of data is presentation. Presentation of the data abstracted from the database can take many forms. Sometimes the data will be presented in tabular form, sometimes in graphs, and other times as a single-word answer on a screen. Output design, as covered in Chapter 11, provides a more detailed look at presentation objectives, forms, and methods.

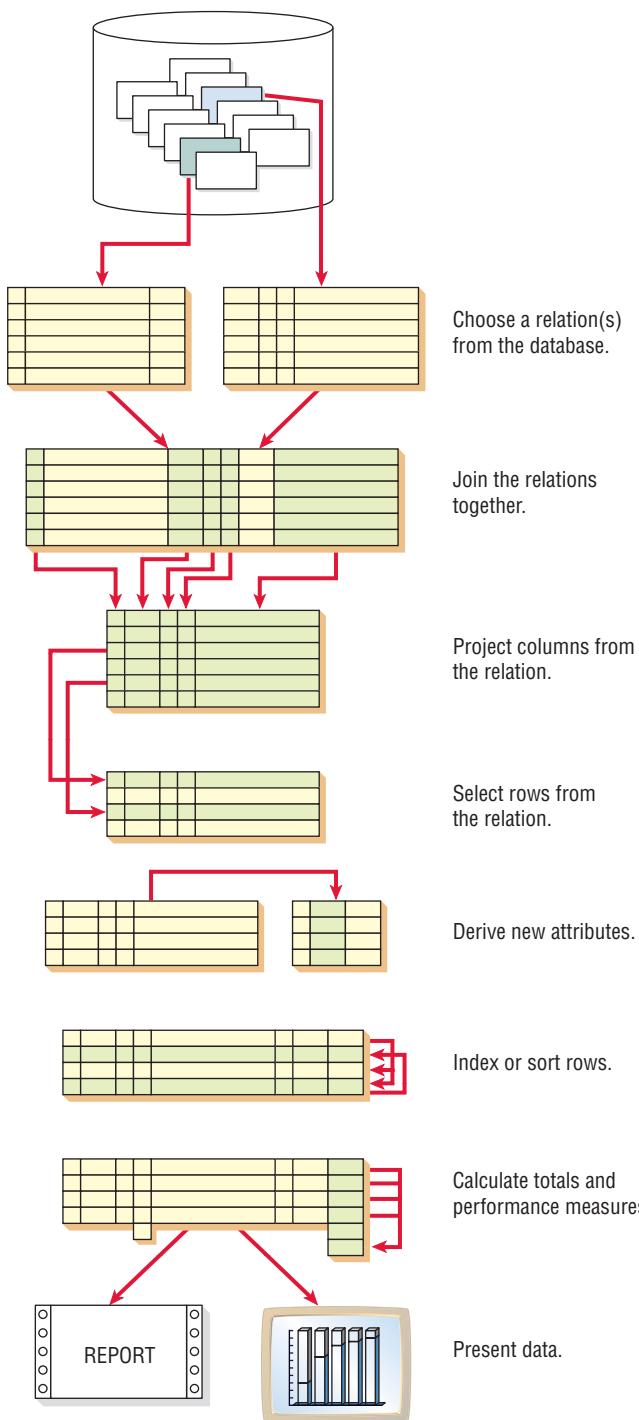
## DENORMALIZATION

One of the main reasons for normalization is to organize data so as to reduce redundant data. If you are not required to store the same data over and over again, you can save a great deal of space. Such organization allows the analyst to reduce the amount of storage needed, something that was very important when storage was expensive.

We learned in the last section that to use normalized data we had to progress through a series of steps that involved joining, sorting, and summarizing. When speed of querying the database (that is, asking a question and requiring a rapid response) is critical, it may be important to store data in other ways.

Denormalization is the process of taking the logical data model and transforming it into a physical model that is efficient for the most often needed tasks. These tasks can include report generation, but they can also mean more efficient queries. Complex queries such as online analytic processing (OLAP), as well as data mining and knowledge data discovery (KDD) processes, can also make use of databases that are denormalized.

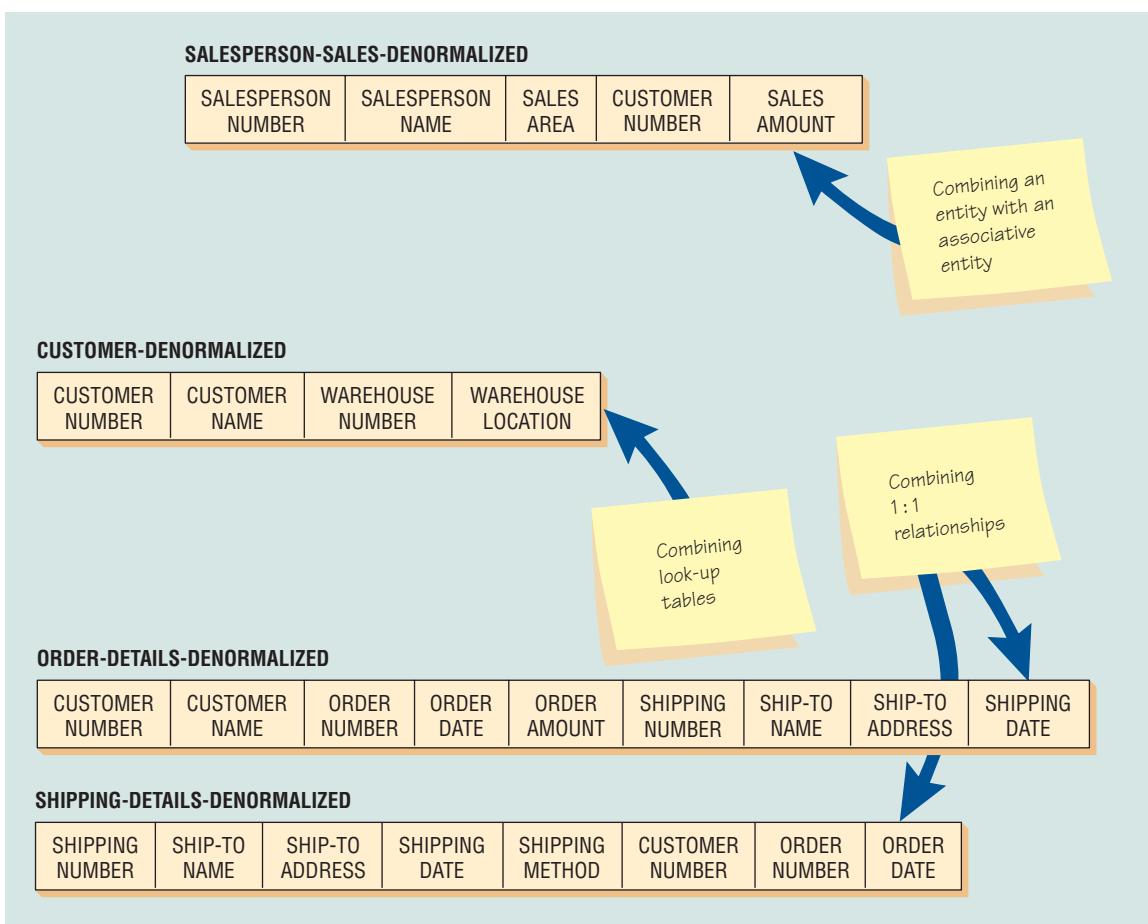
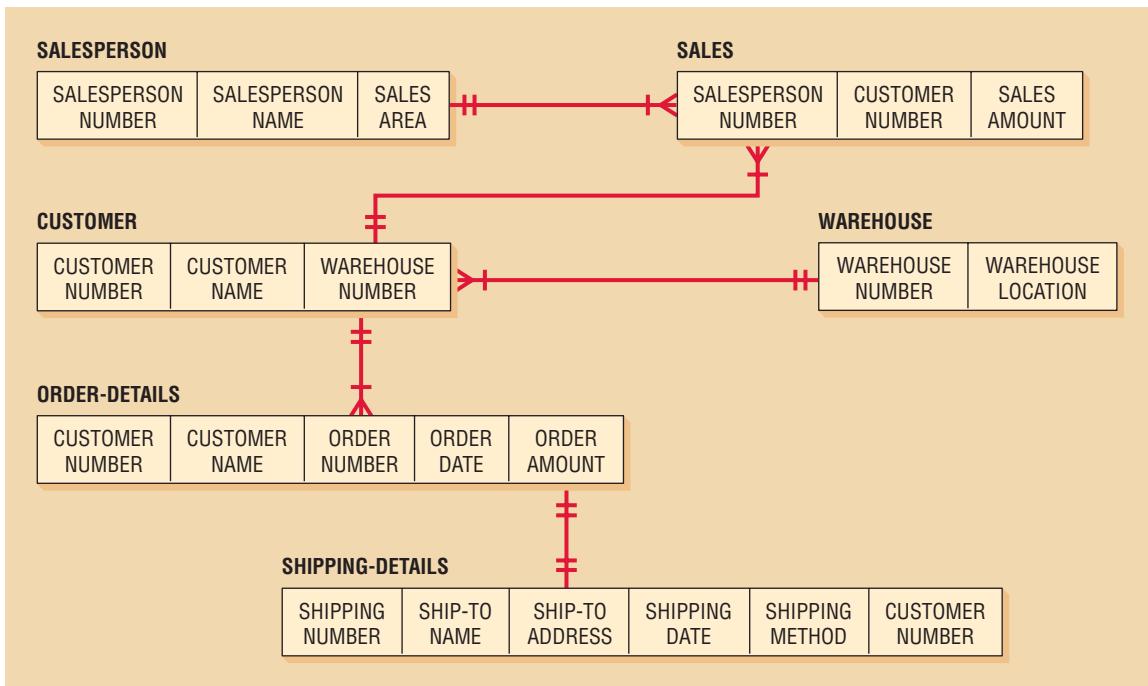
Denormalization can be accomplished in a number of different ways. Figure 13.26 depicts some of these approaches. First, we can take a many-to-many relationship, such as that of SALESPERSON and CUSTOMER, which share the associative entity SALES. By combining the attributes from SALESPERSON and SALES we can avoid one of the join processes. This may result in a considerable amount of data duplication, but it makes the queries about sales patterns more efficient.

**FIGURE 13.25**

Data are retrieved and presented in eight distinct steps.

Another reason for denormalization is to avoid repeated reference to a lookup table. It may be more efficient to repeat the same information—for example, the city, state, and zip code—even though this information can usually be stored as a zip code only. Hence, in the sales example, CUSTOMER and WAREHOUSE may be combined.

Finally, we look at one-to-one relationships because they are very likely to be combined for practical reasons. If we learn that many of the queries regarding orders also are interested in how the order was shipped, it would make sense to combine, or denormalize. Hence, in the example, some of the details can appear in both ORDER-DETAILS and SHIPPING-DETAILS when we go through denormalization.

**FIGURE 13.26**

Three examples of denormalization in order to make access more efficient.

## DATA WAREHOUSES

Data warehouses differ from traditional databases. The purpose of a data warehouse is to organize information for quick and effective queries. In effect, they store denormalized data, but they go one step further. They organize data around subjects. Most often, a data warehouse is more than one database processed so that data are represented in uniform ways. Therefore, the data stored in data warehouses comes from different sources, usually databases that were set up for different purposes.

The data warehouse concept is unique. Differences between data warehouses and traditional databases include the following:

1. In a data warehouse, data are organized around major subjects rather than individual transactions.
2. Data in a data warehouse are typically stored as summarized data rather than the detailed, raw data found in a transaction-oriented database.
3. Data in a data warehouse cover a much longer time frame than data in traditional transaction-oriented databases because queries usually concern longer-term decision making rather than daily transaction details.
4. Most data warehouses are organized for fast queries, whereas the more traditional databases are normalized and structured in such a way as to provide efficient storage of information.
5. Data warehouses are usually optimized for answering complex queries, known as OLAP, from managers and analysts, rather than simple, repeatedly asked queries.
6. Data warehouses allow easy access via data mining software (called software) that searches for patterns and is able to identify relationships not imagined by human decision makers.
7. Data warehouses include not just one but multiple databases that have been processed so that the warehouse's data are defined uniformly. These databases are referred to as clean data.
8. Data warehouses usually include data from outside sources (such as an industry report, the company's Security and Exchange Commission filing, or even information about competitors' products), as well as data generated for internal use.

Building a data warehouse is a monumental task. The analyst needs to gather data from a variety of sources and translate that data into a common form. For example, one database may store information about gender as "Male" and "Female," another may store it as "M" and "F," and a third may store it as "1" and "0." The analyst needs to set a standard and convert all the data to the same format.

Once the data are clean, the analyst has to decide how to summarize the data. Once summarized, the detail is lost, so an analyst has to predict the type of queries that might be asked.

Then, the analyst needs to design the data warehouse by logically organizing, and perhaps even physically clustering, the data by subject, requiring much analysis and design. The analyst needs to know a substantial amount about the business.

Typical data warehouses tend to be from 50 gigabytes to tens of terabytes in size. Because they are large, they are also expensive. Most data warehouses cost millions of dollars.

### Online Analytic Processing

First introduced in 1993 by E. F. Codd, online analytic processing (OLAP) was meant to answer decision makers' complex questions. Codd concluded that a decision maker had to look at data in a number of different ways. Therefore, the database itself had to be multidimensional. Many people picture OLAP as a Rubik's Cube of data. You can look at the data from all different sides, and can also manipulate the data by twisting or turning it so that it makes sense.

This OLAP approach validated the concept of data warehouses. It then made sense for data to be organized in ways that allowed efficient queries. Of course, OLAP involves the processing of data through manipulation, summarization, and calculation, so more than a data warehouse is involved.

### Data Mining

Data mining can identify patterns that a human is unable to detect. Either the decision maker cannot see a pattern, or perhaps the decision maker is not able to think about asking whether that pattern exists. Data mining algorithms search data warehouses for patterns using algorithms. Figure 13.27 illustrates the concept of data mining.



## CONSULTING OPPORTUNITY 13.2

### Storing Minerals for Health, Data for Mining

One of Marathon Vitamin Shops's employees, Esther See, approaches the owner, Bill Berry, about an observation she had. "I've noticed that our customers have different habits. Some come in regularly, and others are less predictable," Esther says. "When I see a regular customer, I pride myself on knowing what the customer will buy and maybe even suggest other vitamins they might like. I think I generate more sales that way. The customer is happier, too."

Esther continues, "I wish I could be better at helping out some of the customers who come in less frequently, though."

"That's a very nurturing attitude, Esther, and it helps out our store as well," Bill replies. "I know that we can benefit in other ways by getting a better handle on customer patterns. For instance, we can be sure that we have an item in stock."

Esther nods in agreement and adds, "It's not just the type of vitamin I'm talking about. Some customers prefer one brand over another. I don't know if it depends on their income level or the interests they have in leisure activities. Sports, for example."

"I see, Ms. See," Bill chuckles at his own joke, "but do you have anything in mind?"

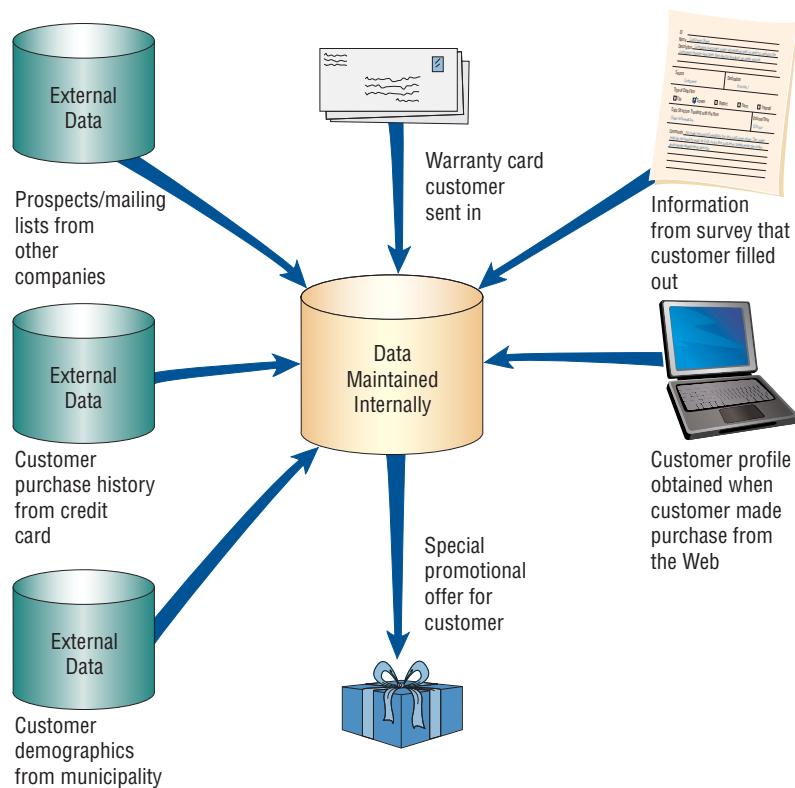
"Yes, Mr. Berry," she says more formally. "We should organize the data we have about our customers using a data warehouse concept. We can merge the data we have with data from other sources. Then we can look for patterns in our data. Maybe we can identify existing patterns and predict new trends."

Think about how you would organize a data warehouse for Marathon Vitamin Shops. What other databases would you like to merge into the data warehouse? What sort of patterns should Bill Berry be looking for? Identify these patterns by type (associations, sequences, clustering, or trends) and discuss them in a page or two.

Data mining is known by another name, knowledge data discovery (KDD). Some think that KDD differs from data mining because KDD is meant to assist decision makers in finding patterns rather than turning control over to an algorithm to find them. The decision aids available are called software; they include statistical analysis, decision trees, neural networks, intelligent agents, fuzzy logic, and data visualization.

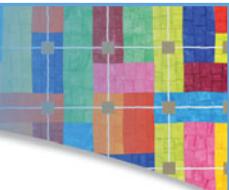
**FIGURE 13.27**

Data mining collects personal information about customers in an effort to be more specific in interpreting and anticipating their preferences.





## CONSULTING OPPORTUNITY 13.3



### Losing Prospects

**M**arket share can be a real problem,” says Ryan Taylor, director of marketing systems for a large East Coast health insurer. “One of the greatest challenges we face is how to identify good leads for our salespeople. With over 50 percent market share, we must eliminate the names of most of the prospects we buy before populating our marketing database. It is critical that we get it right because our marketing database is a critical part of our company’s arsenal of strategic information tools.”

Ryan explains to Chandler, one of your systems analysis team members, “A marketing database, or MDB for short, is a powerful, relational database that is the heart of marketing systems. Our marketing database is used to provide information for all marketing systems. They include productivity tools, such as our Sales Force Automation and our Mass Mailing Systems, which are designed to aid our salespeople in managing the sales cycle. They also include analytical tools, such as our geographic information systems (GIS) or graphical query language (GQL) tools, which are designed to provide decision support.

“The primary function of a marketing database, though, is to track information on our customers and prospects. We currently track geographic information, demographic information, and psychographic information, or, as I like to say, where they live, who they are, and how they think.

“The simplest marketing databases can be made up of just three files: Prospect Profile, Customer Profile, and Purchase and Payment History.

“Once you have designed your marketing database, the next challenge is deciding how to populate it. We currently purchase our prospect information from a list vendor. Because our company’s marketing strategy is based on mass marketing, we buy every business in our area. Because of this volume, we pay less than a dime for each prospect. If, however, a company is practicing product differentiation, their prospect base will likely be more defined. This company would likely pay a premium for more detailed data that have been carefully validated,” explains Ryan.

“We face a real challenge. If I had a dollar for every time a rep complained to me about the address on a prospect being wrong, I

could retire and move to Florida,” Ryan quips. “I’m expected to identify which prospects are bad. That’s not too hard if you only have a thousand of them, but what do you do when you have over a quarter of a million?”

Ryan continues, “Because we use these data frequently for large mailings, it is very important for us to ensure that the names and addresses on that file are as accurate as possible. For example, they should conform to postal standards and should not be duplicates.

“We achieve this through a technique called data hygiene. How’s that for a geeky term? Data hygiene is usually accomplished with specialized software, which is used to determine the validity of an address. This software matches the database address to its own internal database of valid streets and number ranges in a given city or zip code.”

Ryan resumes, “One of the other data challenges faced by marketers is eliminating duplicate records in the marketing database. There are two types of duplicates we look for: internal duplicates, which are the existence of multiple records of the same customer or prospect, and external duplicates, which represent our inability to eliminate customers from our prospect data.

“Internal duplicates create reporting problems and increase mailing costs. External duplicates are even worse; they are both costly and embarrassing,” Ryan explains. “One of the most embarrassing things for a sales representative is to make a prospecting call only to find out that the business is already our customer. The customer is generally left feeling like only a number in one of our computers. It creates a poor impression and wastes valuable time and resources.”

In two paragraphs, describe some techniques Ryan could use to help identify internal and external duplicates in his company’s marketing database. Describe how you would build a marketing database to minimize duplicates (use a paragraph). Are there operational methods that might cut down on this problem? List them. Who else in the organization could help with this process? Provide a brief list. In a paragraph, recommend methods to Chandler and your other systems analysis team members that can be used to help enlist and secure the assistance of other relevant organizational members.

The types of patterns decision makers try to identify include associations, sequences, clustering, and trends. Associations are patterns that occur together at the same time. For example, a person who buys cereal usually buys milk to go with the cereal. Sequences, on the other hand, are patterns of actions that take place over a period of time. For example, if a family buys a house this year, they will most likely buy durables (a refrigerator, or washer and dryer) next year. Clustering is the pattern that develops among a group of people. For example, customers who live in a particular zip code may tend to buy a particular car. Finally, trends are patterns that are noticed over a period of time. For example, consumers may move from buying generic goods to premium products.

The concept of data mining came from the desire to use a database for a more selective targeting of customers. Early approaches to direct mail included using zip code information as a way to determine what a family’s income might be (assuming a family must generate sufficient

income to afford to live in the prestigious Beverly Hills zip code 90210 or some other affluent neighborhood). It was a way (not perfect, of course) to limit the number of catalogs sent.

Data mining takes this concept one step further. Assuming past behavior is a good predictor for future purchases, a large amount of data is gathered on a particular person from credit card purchases. The company can identify what stores we shop in, what we have purchased, how much we paid for an item, and when and how frequently we travel. Data are also entered, stored, and used for a variety of purposes when we fill out warranties, apply for a driver's license, respond to a free offer, or apply for a membership card at a video rental store. Moreover, companies share these data and often make money on the sale of them as well.

American Express has been a leader in data mining for marketing purposes. American Express will send you discount coupons for new stores or entertainment when it sends you a credit card bill, having determined that you have shopped in similar stores or attended similar events. General Motors offers a MasterCard that allows customers to accumulate bonus points toward the purchase of a new car, and then sends out information about new vehicles at the most likely time that a consumer would be interested in purchasing a new car.

The data mining approach is not without problems, however. First, the costs may be too high to justify data mining, something that may only be discovered after huge setup costs have been accrued. Second, data mining has to be coordinated so that various departments or subsidiaries do not all try to reach the customer at the same time. In addition, customers may think their privacy has been invaded and resent the offers that are coming their way. Finally, customers may think profiles created solely on the basis of their credit card purchases present a highly distorted image of who they are.

Analysts should take responsibility for considering the ethical aspects of any data mining projects that are proposed. Questions about the length of time profile material is kept, the confidentiality of it, the privacy safeguards included, and the uses to which inferences are put should all be asked and considered with the client. The opportunities for abuse are apparent and must be guarded against. For consumers, data mining is another push technology, and if consumers do not want to be pushed, the data mining efforts will backfire.

## SUMMARY

How to store data is often an important decision in the design of an information system. There are two approaches to storing data. The first approach is to store data in individual files, one file for each application. The second approach is to develop a database that can be shared by many users for a variety of applications as the need arises.

An understanding of data storage requires a grasp of three realms: reality, data, and metadata. An entity is any object or event for which we are willing to collect and store data. Attributes are the actual characteristics of these entities. Data items can have values and can be organized into records that can be accessed by a key. Metadata describe the data and can contain restrictions about the value of a data item (such as numeric only).

Examples of conventional files include master files, table files, transaction files, work files, and report files. Databases typically are constructed with a relational structure. Legacy systems can have hierarchical or network structures, however.

Normalization is the process that takes user views and transforms them into less complex structures called normalized relations. There are three steps in the normalization process. First, all repeating groups are removed. Second, all partial dependencies are removed. Finally, the transitive dependencies are taken out. After these three steps are completed, the result is the creation of numerous relations that are of third normal form (3NF).

The entity-relationship diagram may be used to determine the keys required for a record or a database relation. The three guidelines to follow when designing master tables or database relations are that (1) each separate data entity should create a master table (do not combine two distinct entities within one table); (2) a specific data field should exist only on one master table; and (3) each master table or database relation should have programs to Create, Read, Update, and Delete.

The process of retrieving data may involve as many as eight steps: (1) choosing a relation, (2) joining two relations together, (3) projecting (choosing) columns, (4) selecting relevant rows, (5) deriving new attributes, (6) sorting or indexing rows, (7) calculating totals and performance measures, and finally (8) presenting the results to the user.

Denormalization is a process that takes the logical data model and transforms it into a physical model that is efficient for tasks that are most needed. Data warehouses differ from traditional databases in many ways; one is that they store denormalized data, which is organized around subjects. Data warehouses allow easy access via data mining software, called software, which searches for patterns and identifies relationships not imagined by human decision makers.



## HYPERCASE® EXPERIENCE 13

**“I** hear very good things about your team from the people in Management Systems. You even got some hard-earned praise from Tom Ketcham who isn't easy to please these days. Even *he* is seeing some possibilities. I think you'll pull us together yet . . . unless we all go off in different directions again. I'm just teasing you. I told you to think about whether we are a family, a zoo, or a war zone. Now's the time to start designing systems that fit us. You've been here long enough now to form those opinions. I hope they're favorable. I think our famous Southern hospitality coupled with my noticeably British sense of humor should help influence you, don't you? I was so busy persuading you that we're worth the effort that I almost forgot to tell you: Tom and Snowden have agreed to think about moving toward a database of some sort. Would you have this ready in the next two weeks? Tom is at a conference in Minneapolis, but when he returns you should have some database ideas worked up for Snowden and him to discuss. Keep at it.”

### HYPERCASE Questions

1. Assume your team members have used the Training Unit Client Characteristics Report to design a database table to store the relevant information contained on this report, with the following result:
2. Apply normalization to the table your team has developed to remove repeating groups. Display your results.
3. Remove transitive dependencies from your table and show your resulting database table.

Table name: CLIENT TABLE

Column Name	Description
CLIENT ID (primary key)	Mnemonic made up by users, such as STHSP for State Hospital
CLIENT NAME	The actual, full client name
ADDRESS	The client's address
CONTACT	The name of the contact person
PHONE NUMBER	The phone number of the contact person
CLASS	The type of institution (Veteran's Administration hospital, clinic, other)
STAFF-SIZE	Size of client staff (number)
TRAINING LEVEL	Minimum required expertise level of the staff (as defined by the class)
EQUIP-QTY	The number of medical machines that the client has
EQUIP TYPE	The type of medical machines (e.g., X-ray, MRI, CAT)
EQUIP MODEL-YR	The model and year of each medical machine

Data mining involves using a database for more selective targeting of customers. Assuming that past behavior is a good predictor for future purchases, companies collect data about a person from past credit card purchases, driver's license applications, warranty cards, and so on. Data mining can be powerful, but it may be costly and it needs to be coordinated. In addition, it may infringe on consumer privacy or even a person's civil rights.

### KEYWORDS AND PHRASES

attribute	database administrator
bubble diagram	database management system (DBMS)
clean data	delete anomaly
concatenated key	denormalization
conventional file	domain integrity
CRUD (Create, Read, Update, and Delete)	entity
data element	entity integrity constraint
data item	entity-relationship (E-R) diagram
data mining	entity subtype
data model diagram	first normal form (1NF)
data storage	hierarchical data structure
data warehouse	information retrieval
database	logical view

master file	report file
network data structure	retrieval
normalization	second normal form (2NF)
object identifier (OID)	secondary key
online analytical processing (OLAP)	siftware
partial dependencies	special characters
physical view	table file
primary key	third normal form (3NF)
reality, data, and metadata	transaction file
record	transitive dependencies
referential integrity	unnormalized relation
relational data structure	update anomaly
relationship	work file
repeating group	

## REVIEW QUESTIONS

1. What are the advantages of organizing data storage as separate files?
2. What are the advantages of organizing data storage using a database approach?
3. What are the effectiveness measures of database design?
4. List some examples of entities and their attributes.
5. What is the difference between a primary key and an object identifier?
6. Define the term *metadata*. What is the purpose of metadata?
7. List types of commonly used conventional files. Which of these are temporary files?
8. Name the three main types of database organization.
9. Define the term *normalization*.
10. What is removed when a relation is converted to the first normal form?
11. What is removed when a relation is converted from 1NF to 2NF?
12. What is removed when a relation is converted from 2NF to 3NF?
13. List the three entity constraints. In a sentence, describe the meaning of each entity constraint.
14. Describe the four anomalies that may occur when creating database tables.
15. List the eight steps for retrieving, presorting, and presenting data.
16. What does join do? What is projection? What is selection?
17. Define denormalization.
18. Explain the differences between traditional databases and data warehouses.
19. Define what siftware does when used in data mining.

## PROBLEMS

1. Given the following file of renters:

Record Number	Last Name	Apartment Number	Rent	Lease Expires
41	Warkentin	102	550	4/30
42	Buffington	204	600	4/30
43	Schuldt	103	550	4/30
44	Tang	209	600	5/31
45	Cho	203	550	5/31
46	Yoo	203	550	6/30
47	Pyle	101	500	6/30

- a. Show an example of projection.
- b. Show an example of selection.
- c. Show two different examples of sorting rows.
- d. Show an example of calculating totals.

2. The following is an example of a grade report for two students at the University of Southern New Jersey:

*USNJ Grade Report Spring Semester 2010*

*Name: I. M. Smarte*

*Major: MIS*

*Student: 053-6929-24*

*Status: Senior*

<i>Course Number</i>	<i>Course Title</i>	<i>Professor</i>	<i>Professor's Department</i>	<i>Grade</i>
MIS 403	Systems Analysis	Diggs, T.	MIS	A
MIS 411	Conceptual Foundations	Barre, G.	MIS	A
MIS 420	Human Factors in IS	Barre, G.	MIS	B
CIS 412	Database Design	Menzel, I.	CIS	A
DESC 353	Management Models	Murney, J.	MIS	A

*USNJ Grade Report Spring Semester 2010*

*Name: E. Z. Grayed*

*Major: MIS*

*Student: 472-6124-59*

*Status: Senior*

<i>Course Number</i>	<i>Course Title</i>	<i>Professor</i>	<i>Professor's Department</i>	<i>Grade</i>
MIS 403	Systems Analysis	Diggs, T.	MIS	B
MIS 411	Conceptual Foundations	Barre, G.	MIS	A

Draw a data model diagram with associations for the user view.

3. Convert the user view in Problem 2 to a 3NF relation. Show each step along the way.
4. What problem might arise when using a primary key of course number for the data in Problem 2? (*Hint:* Think about what would happen if the Department Name [not shown in the data] changes.)
5. Draw an entity-relationship diagram for the following situation: Many students play many different sports. One person, called the head coach, assumes the role of coaching all these sports. Each of the entities has a number and a name. (Make any assumptions necessary to complete a reasonable diagram. List your assumptions.)
6. The entity-relationship diagram you drew in Problem 5 represents the data entities that are needed to implement a system for tracking students and the sports that they play. List the tables that are needed to implement the system, along with primary, secondary, and foreign keys that are required to link the tables.
7. Draw an entity-relationship diagram for the following situation: A commercial bakery makes many different products. These products include breads, desserts, specialty cakes, and many other baked goods. Ingredients such as flour, spices, and milk are purchased from vendors. Sometimes an ingredient is purchased from a single vendor, and other times an ingredient is purchased from many vendors. The bakery has commercial customers, such as schools and restaurants, that regularly place orders for baked goods. Each baked good has a specialist that oversees the setup of the bakery operation and inspects the finished product.
8. List the tables and keys that are needed to implement the commercial bakery system.
9. Draw an E-R diagram for the ordering system in Figure 13.24.
10. Draw a data flow diagram for placing an order. Base your data flow diagram on the E-R diagram.
11. Create an entity-relationship diagram for a genealogy software package called “PeopleTree” to keep track of ancestors. Assume that each person will be on a Person table and that one person may have one biological father and mother as well as an adopted mother and father. The mothers and fathers must be stored on the Person table as well. Each person should have only one birthplace, stored on the Place table. Many people may be born in the same place.
12. Define the primary key used for the Person and Place tables.

13. GaiaOrganix is an organic food wholesale co-op linking producers and consumers. GaiaOrganix negotiates purchases by grocery and other stores from farmers who raise a variety of crops, such as fruits, vegetables, and grain. Each farmer may produce a number of crops, and each crop may be produced by a number of farmers. To provide the highest level of fresh products, the produce is shipped directly from the farm to the store. Each store may purchase from many farms, and each farm may sell to many stores. Draw an entity-relationship diagram in the third normal form showing the relationship between the producer (farms) and the retailer (stores).
14. ArticleIndex.com is a company that produces indexes of magazine and periodical articles for a given discipline. A Web user should be able to enter an article topic or authors and receive a detailed list of all the articles and periodicals in which the topic was found. Each article may have many authors, and each author may write many articles. An article may be found in only one periodical, but each periodical will usually contain many articles. Each article may have many topics, and each topic may be in many articles. Draw an entity-relationship diagram in the third normal form for the articles, authors, periodicals, and topics.
15. Identify the primary and foreign keys for the entity-relationship diagram created in Problem 14.

## GROUP PROJECT

1. Gregg Baker orders tickets for two concerts over the Web. His orders are processed, exact seat locations are assigned, and the tickets are mailed separately. One of the sets of tickets gets lost in the mail. When he calls the service number, he does not remember the date or the seat numbers, but the ticket agency was able to locate his tickets quickly because the agency denormalized the relation. Describe the ticket ordering system by listing the data elements that are kept on the order form and the shipping form. What information did Gregg give the ticket agency to retrieve the information?

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## EPISODE 13

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

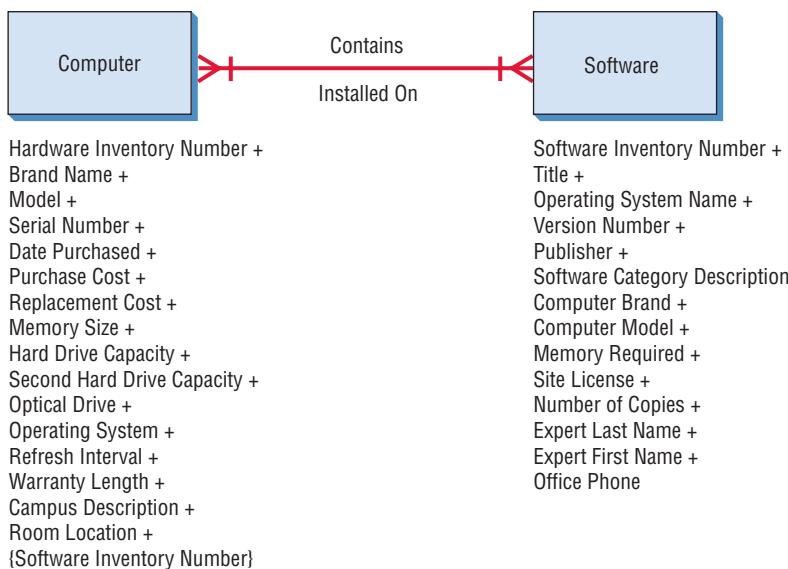
## Back to Data Basics

After numerous interviews, prototypes, data flow diagrams, data dictionary entries, and UML diagrams have been completed, Anna and Chip both start work on the entity-relationship model. “I’ll be responsible for creating the Microsoft Access table relationships,” Anna promises. Chip volunteers to complete an entity-relationship diagram. “Let’s compare the two diagrams for accuracy and consistency when we’re done,” Anna suggests, and so they do.

Figure E13.1 shows the entity-relationship diagram for the computer inventory system. Visible Analyst calls each of the rectangles an entity. Each entity represents a database table of information stored in the system, corresponding to a data store on the data flow diagram or an entity class on a sequence or class diagram. Each of the diamond rectangles represents an associative entity representing a relationship between the data entities. A rectangle with an oval in it represents an associative entity that cannot exist without the connecting entity. These are usually repeating elements. Microsoft Visio uses rectangles to represent both an associative and an attributive entity.

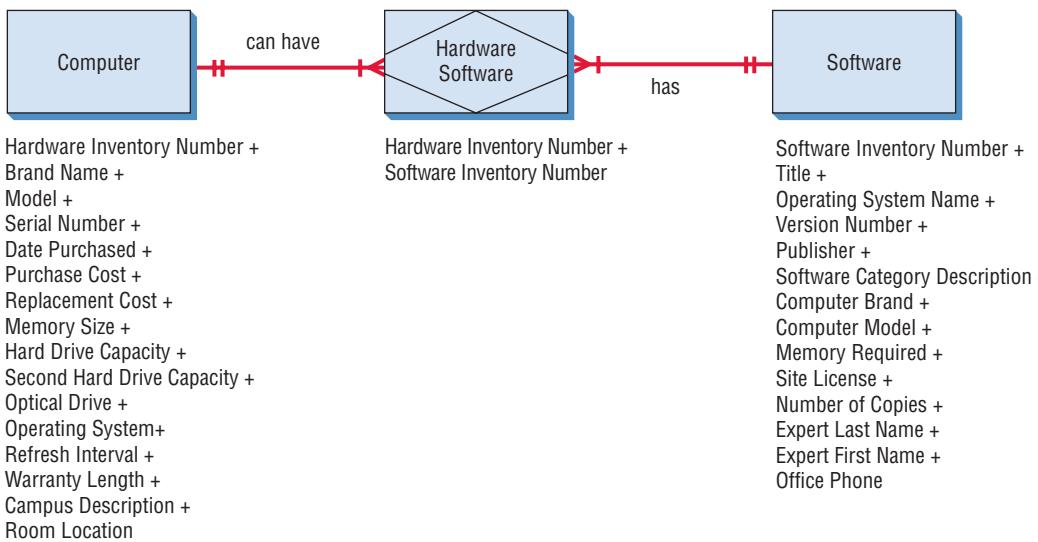
“I’ve created the entity-relationship diagram, starting with the simplest portions of the system,” Chip tells Anna. “The first data entities created are SOFTWARE and COMPUTER. The relationship is that software is installed on the computer. Next I determined the cardinality of the relationship. Because one software package could be installed on many computers, this relationship is one-to-many. Each computer may also have many different software packages installed on it so that it also provides a one-to-many relationship. Because there is a one-to-many relationship for each of the data entities, the full relationship between them becomes many-to-many.”

Chip continues by saying, “This first view is far from normalized. Notice that the SOFTWARE INVENTORY NUMBER is a repeating element on the HARDWARE entity. I will have to create several entities for each of them.” A bit later Chip reviews his work with Anna. The SOFTWARE INVENTORY NUMBER has been removed and placed in a relational entity. Refer to the entity-relationship diagram illustrated in Figure E13.2. “This places the data in the first normal form,” remarks Chip. “Also, there are no elements that are dependent on only a part of the key, so the data are also in the second normal form. There are, however, elements that are not part of the entity that is represented on the diagram, and they will have to be removed. For example, look at the OPERATING SYSTEM and CAMPUS BUILDING. These elements are not a part of the computer hardware but are installed on the computer or the computer is installed in a campus room. They should have their own entity. That makes it easier to change the version of an operating system. Rather than having to change the version of the operating system on many of the COMPUTER records, it would only have to be changed once.”



**FIGURE E13.1**

Unnormalized entity-relationship diagram for the computer system. The many-to-many relationship will have to be defined as an associative entity.

**FIGURE E13.2**

The computer system's entity-relationship diagram in the first normal form.

Anna agrees, remarking, "That's really a good assessment of the situation. It will make implementing the Microsoft Access tables easier."

Chip continues to work on the entity-relationship diagram. After a few hours he exclaims, "I think it's done. Would you take a look at the final version?" The final version is shown in Figure E13.3. All the entities and relationships have been described in the repository.

Anna reviews the final version and exclaims, "It looks great! You are right in moving the OPERATING SYSTEM and CAMPUS BUILDING to their own entities. Good idea, as the building is not a part of the computer. Also, the SOFTWARE EXPERT is definitely not a part of the SOFTWARE entity. How about the SOFTWARE CATEGORY?"

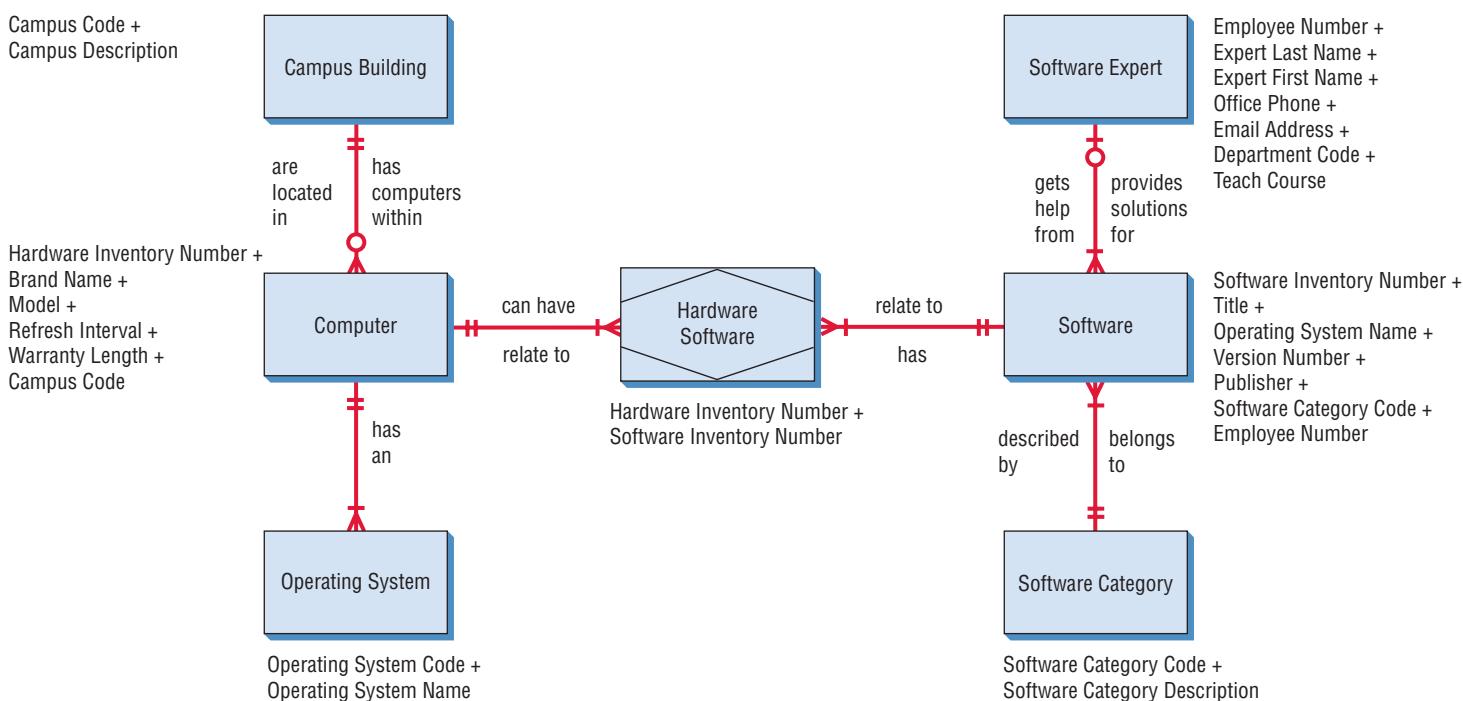
"I moved the SOFTWARE CATEGORY into its own entity to save room on the master files when they are constructed," Chip answers. "It is really a table of codes, and it makes it easy to change the category without changing all of the software records. Also, we are storing a small code, rather than a lengthy description on each software record. Why don't you double check the various keys on the diagram? Each related entity, on the many end, should have a foreign key that matches the primary key of the entity on the one end."

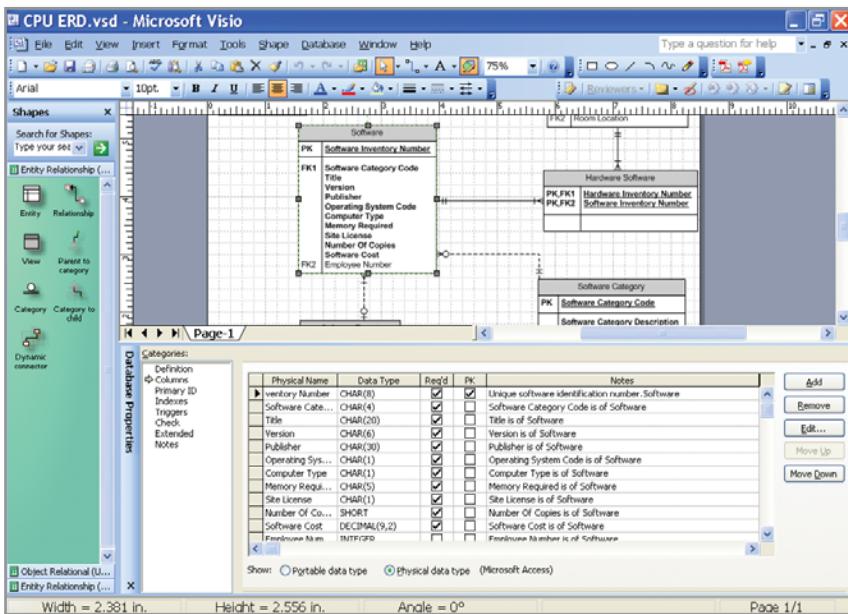
Anna examines the diagram for a while and remarks, "It looks good to me. Perhaps we should define the repository entries."

"Take a look at this repository entry." Chip opens the entity-relationship diagram, Figure E13.4, and double clicks on the COMPUTERS entity, displaying its repository entry. The primary key (the Microsoft

**FIGURE E13.3**

Final entity-relationship diagram for the computer system.



**FIGURE E13.4**

The CPU normalized entity-relationship diagram displayed in Microsoft Visio with the Software repository definition.

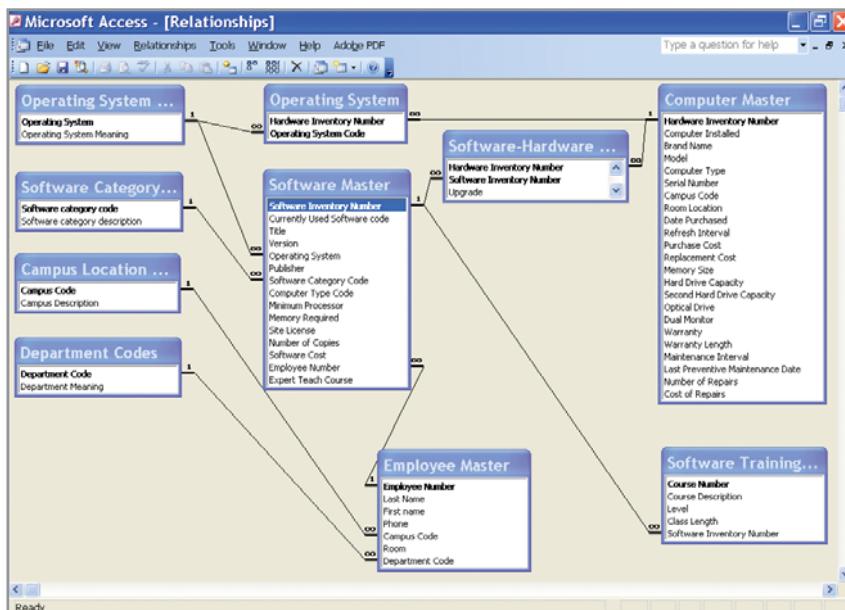
Visio and Visible Analyst [pk] notation in front of the HARDWARE INVENTORY NUMBER element in the composition area), foreign keys (the FK1, FK2, and so on), and several alternate keys ([Ak1], [Ak2], and [Ak3]) have been defined. After spending time examining the diagram as well as the repository entries and analysis reports, both Anna and Chip are satisfied that the relationships between the data have been accurately portrayed. Next they decide how to design the database from the diagrams.

The HARDWARE/SOFTWARE relation is analyzed first. Because there is a many-to-many relationship between these two data entities, it may be implemented by using three database tables:

1. A HARDWARE MASTER table.
2. A SOFTWARE MASTER table.
3. A HARDWARE/SOFTWARE RELATIONSHIP table, which would contain the key fields for the HARDWARE and SOFTWARE master tables for all software installed on all machines. An autosequence primary key would work as well, as long as the foreign keys were also included in the table.

"I guess it's my turn to work on the relationships," says Anna as she takes a copy of the entity-relationship diagram. "I'll modify the Microsoft Access tables from the prototyping sessions."

Anna starts by setting up the primary keys for each of the tables. When the tables are in their final form, she creates the relationships between them. The Microsoft Access relationships diagram is illustrated in Figure E13.5. Rectangles on the diagram represent the database tables and correspond to the various entity

**FIGURE E13.5**

A Microsoft Access RELATIONSHIPS diagram. Note the infinity symbols representing the many end of a relationship.

types found on the entity-relationships diagram. Notice that the cardinality is represented by “1” and the infinity symbol. The primary key fields are listed as the first field of each rectangle; they are also displayed in boldface type. Foreign keys are shown attached to the other end of the relationship line, if the foreign key is visible in the table rectangle. Keys are dragged from one table to another to establish a relationship, and a dialog box appears to determine properties of the relationship.

### EXERCISES



- E-1. Use Microsoft Visio or Visible Analyst to view the unnormalized and first normal form entity-relationship diagrams for the computer system. Double click on the entities to view the repository information (in both Microsoft Visio and Visible Analyst). In Microsoft Visio the repository entry is in an area on the bottom of the display. You may have to drag the border separating the diagram from the repository upward. Click the Columns entry in the Categories area on the left side of the repository to view the entity attributes). The diagram name is COMPUTER SYSTEM – UNNORMALIZED.
- E-2. Use Microsoft Visio or Visible Analyst to view the entity-relationship diagram for the computer system. Double click on the entities to view the repository information (in both Microsoft Visio and Visible Analyst). The diagram name is COMPUTER.
- E-3. Add the VENDOR entity to the diagram. The vendor warrants the computers, and the relationship between VENDOR and COMPUTER is that one VENDOR can warrant many COMPUTER(s). Add primary keys. Microsoft Visio will automatically create foreign keys. In Visible Analyst, select Key Synchronization from the Repository menu.
- E-4. Add the MAINTENANCE entity to the diagram. Maintenance repairs are performed on computers, and the relationship between MAINTENANCE and COMPUTER(s) is such that one COMPUTER may have many MAINTENANCE records. Use the repository to define MAINTENANCE ORDER NUMBER. Set this attribute as the primary key for MAINTENANCE entity and generate the foreign key.
- E-5. Describe the SOFTWARE CATEGORY entity in the repository. Include the elements found on the entity-relationship diagram below SOFTWARE CATEGORY in the **Composition** area.
- E-6. Describe the MAINTENANCE entity in the repository. The elements are as follows:
- MAINTENANCE ORDER NUMBER.
  - HARDWARE INVENTORY NUMBER.
  - MAINTENANCE DATE.
  - TYPE OF MAINTENANCE.
  - COST OF MAINTENANCE.
  - MAINTENANCE COVERED BY WARRANTY.
- E-7. Describe the VENDOR entity. The elements are as follows:
- VENDOR NUMBER.
  - VENDOR NAME.
  - STREET.
  - CITY.
  - STATE.
  - ZIP CODE.
  - TELEPHONE NUMBER.
  - DATE LAST ORDER SENT.
  - TOTAL AMOUNT PURCHASED FROM VENDOR.
  - TOTAL NUMBER OF ORDERS SENT TO VENDOR.
- E-8. Each computer may have more than one operating system, and each operating system may be installed on more than one computer. Add an associative entity called COMPUTER OPERATING SYSTEM between COMPUTER and OPERATING SYSTEM. Include the primary and foreign keys in the repository in either Microsoft Visio or Visible Analyst.
- E-9. Explain in a paragraph the relationship between a foreign key and a primary key, and why it is necessary to have them on separate entities when there is a relationship between the entities.

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

# CHAPTER 14

## Human–Computer Interaction

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand human–computer interaction (HCI).
2. Design a variety of user interfaces.
3. Design effective dialog for HCI.
4. Understand the importance of user feedback.
5. Articulate HCI implications for designing ecommerce Web sites.
6. Formulate queries that permit users to search the Web.



Throughout the book your awareness of human–computer interaction (HCI) and its importance to your task as a systems analyst has grown. While awareness is important, by now you recognize that you need to master the concepts surrounding HCI as well as become proficient at assessing human information requirements and incorporating your findings into your designs. Furthermore, the European Union (EU) and the United States have come forth with specific guidelines for usability. These guidelines mandate making Web sites and electronic services accessible to the able-bodied and disabled alike.

This chapter fills in some of the details about HCI and working with users. It also gives you some experience in applying HCI concepts that you have been learning to help in your design of human–computer interfaces; feedback, ecommerce Web sites, and Web queries.

### UNDERSTANDING HUMAN–COMPUTER INTERACTION

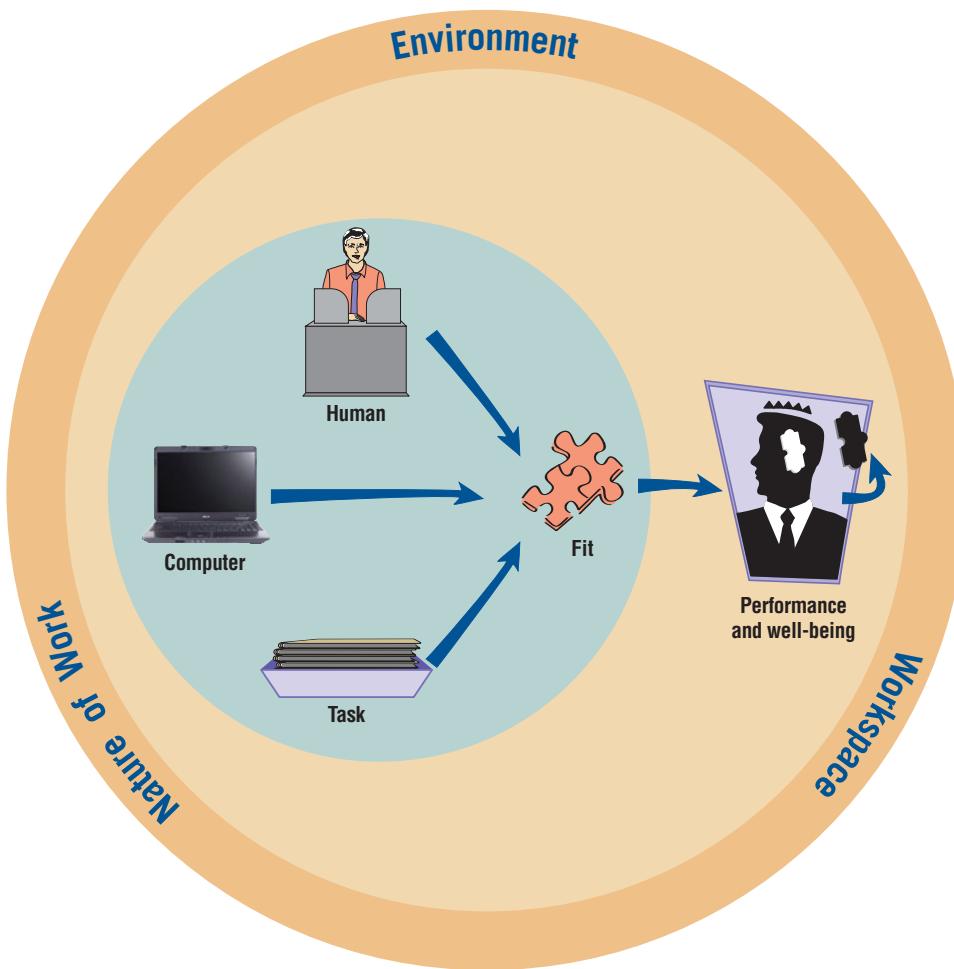
Designing for HCI means “Ensuring system functionality and usability, providing effective user interaction support, and enhancing a pleasant user experience.” Furthermore, “The overarching goal is to achieve both organizational and individual user effectiveness and efficiency. To reach these goals, managers and developers need to be knowledgeable about the interplay among users, tasks, task contexts, information technology (IT), and the environments in which systems are used” (Carey et al., 2004, p. 358).

We can ensure that our systems are user centered, so that they appropriately include users’ needs as well as organizational needs by understanding HCI concepts, considering interfaces in the light of HCI issues, and applying standard design concepts to computers in new ways because of an HCI approach.

Knowledge about the interplay among users, tasks, task contexts, IT, and the environments in which the systems are used comprises the basis of HCI. The main tactic of HCI in systems analysis and design is to repeatedly elicit feedback from users about their experiences with prototyped designs

**FIGURE 14.1**

The “fit” among the human, computer, and task affects performance and well-being.



(which could be screens, forms, interfaces, and the like), refining the design based on the suggested changes, and trying them with users again until the design is acceptable and until it is frozen by the analyst.

### How Fit Affects Performance and Well-Being

Let's begin our exploration of HCI with some useful definitions that are commonly shared among those working in the field.

**FIT.** A good fit between the HCI elements of the human, the computer, and the task that needs to be performed leads to performance and well-being, as shown in Figure 14.1. Just as it is important that new shoes comfortably fit the shape of your foot, hold up during the activity you will be doing (such as running), and are made of a material (such as leather) that is durable and cost-effective, so too is it important that the fit among the user, computer, and task all correspond.

Analysts want the best fit in their design. You want to make the best possible use of people in designing a computerized task that is intended to meet an organizational objective. Better fit is meant to result in better performance and greater overall well-being for the human involved in the system.

Fortunately, humans' capacity to learn better ways to work also influences the fit. We would never try running a marathon with a shoe right out of the box, without first getting our foot used to it by breaking it in. By the same token, users can be trained to develop a better fit by learning their tasks and computers thoroughly. Training continues to be an important way to improve fit.

**TASK.** In the foregoing chapters you have learned many methods to help you understand, document, and graphically depict the tasks that people currently perform in the organization. You have also learned methods to help you design new tasks that will help people reach their objectives with the new systems you are creating. As you recall, tasks can be structured and routine, or they can be ill defined and without apparent structure. Complex tasks that require

human, system, and task interaction are supported by ecommerce and Web systems, ERP systems, and wireless systems inside and outside the organization.

**PERFORMANCE.** The definition of the word *performance* in the HCI context is also key. In this case, the term *performance* refers to a combination of the efficiency involved in performing a task and the quality of the work that is produced by the task. For example, if analysts are using high-level software or a CASE tool to create data flow diagrams in which they are proficient, we would predict that the quality of the data flow diagrams produced would be high. The performance is also efficient, because the analysts are using an automated tool with which they are familiar. They can work rapidly, with good results. The task fits the objective, which is to create high-quality data flow diagrams to document a system. The efficiency of producing such diagrams with a CASE tool, which can then be used to store, retrieve, communicate, and modify the UML diagrams, is excellent, compared to alternatives such as using a drawing tool unrelated to a data dictionary or drafting diagrams by hand, neither of which offer such features.

**WELL-BEING.** At this point, we can introduce the concept of well-being, which is a concern for a human's overall comfort, safety, and health; in sum, it is their physical as well as psychological state. Does using a CASE tool for producing UML diagrams or DFDs on a computer serve the analyst's well-being? Yes, because the task fits well with the analyst, the software, the objective, and the computer. Notice that the analysts are working in an environment where they are physically comfortable, are psychologically stimulated to be creative, and can be productive; also, each analyst's work is valued by peers and clients, as well as valued monetarily by the employing organization.

Psychological attitudes (the affective component) are also important. How users feel about themselves, their identities, their work life, and performance can all be gauged through assessing their attitudes. As an analyst taking an HCI perspective, you are concerned about how humans' attitudes color the way they feel about technology and their tasks, and whether their attitudes hinder or enhance their experience.

### The Technology Acceptance Model and Attitude

The technology acceptance model (TAM), as proposed by Davis in 1989 and later refined and improved by Davis and others, basically is a way for analysts to organize their thinking about whether users will accept and use information technology. It can be used to shape training following system development, but it can also be used early on in the development process to gather user reactions to prototypes. Changing systems early in the development process increases the likelihood of their adoption and use.

There are many theoretical components and a good deal of research to argue the intricacies of TAM. Practically speaking, you need to be aware that there is a large body of research on the acceptance and use of technology in the information systems field and that TAM is one of the most popular subjects. TAM draws its power from examining the perceived usefulness of the system to increase one's job performance and the belief about how easy the system will be to use when a user sits down to accomplish a task. So we have the two keys: **perceived usefulness** and **perceived ease of use**. Both can be used to understand how users intend to interact with a proposed system. Some researchers add an explicit attitude dimension to their idea of the technology acceptance model that helps them think more specifically about what psychological states will shape the way users accept or reject the use of the information systems they design.

Attitudes toward computers include user satisfaction with HCI, as well as users' overall satisfaction with the system. These are generally ascertained through special user satisfaction surveys and are often used following implementation to estimate the overall success or failure of a systems project. When you attempt to characterize attitudes toward computers, you may be surprised by all the possible human responses that are conveyed. Most of the HCI research looks at a variety of user attitudes, including satisfaction, anxiety, enjoyment, and playfulness in approaching technology.

The technology acceptance model also points out the importance of whether users find a system useful and are thus motivated to use it. Since this is an important HCI concern, we can measure whether the information technology is found to be useful by examining whether the system provides support for an organizational member's individual tasks. We can also measure whether there are important tasks that a user of the new system could *not* perform prior to its implementation. Our measurements can also determine whether the system extends a user's capabilities (for example, increasing the ability to perform higher-level analysis quickly or

performing an on-the-spot translation of a financial report into another language complete with currency conversions). Part of the usefulness criterion in HCI can also be measured by ascertaining whether users find it rewarding to use the system by conducting postimplementation interviews and observations.

## USABILITY

*Usability* is a term that is defined differently depending on which branch of science you are investigating. For our purposes in exploring usability through an HCI lens, we will try to focus on usability as a way for designers to evaluate the systems and interfaces they create with an eye toward addressing as many HCI concerns as we can as thoroughly as possible. Usability studies (according to [www.useit.com](http://www.useit.com)) are all about finding out what works in the world and what doesn't. The ISO has created usability standards that you can explore on [www.usabilitynet.org/tools/r\\_international.htm](http://www.usabilitynet.org/tools/r_international.htm). The standards cover the use of the product (effectiveness, efficiency, and satisfaction in a particular context of use), the user interface and interaction, the process used to develop the product, and the capability of an organization to apply user-centered design.

Nielsen and Mack (1994) and Nielsen, Molich, Snyder, and Farrell (2001) have published usability heuristics (or rules of thumb) based on thousands of usability tests of interfaces and, later, tests of ecommerce Web sites. They include visibility of system status, match between the system and the real world, user control and freedom, consistency and standards, error prevention, reconnection rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help that users recognize, diagnosis and recovery from errors, and help and documentation. Some of these are already familiar to you from the input and output design chapters.

Figure 14.2 shows a usability survey to administer directly to users who have personally interacted with a prototype. It asks users outright about some important usability and ergonomic dimensions. Another approach is to write up use case scenarios for the system. These are helpful in examining usability concerns.

### Designing for the Cognitive Styles of Individual Users

One important consideration is that data, particularly data used for decision making, are made available in different forms so that users with different cognitive abilities can make sense of them. Some users may prefer to examine tables and make decisions, some prefer graphs, and others want to read narrative text.

It is also imaginable that the same person wants different types of presentations at different times. For example, suppose a manager wants to compare inventory held at different stores in a region. A graph can present the data very effectively. A column chart can use colors to show when a store is near its stockout level, and it can also show the relative amount of stock by allowing the user to visually compare the height of the bars directly.

Suppose now that the same decision maker wants information about a particular store in a given month. The graphical depiction may have been set up to show the stores from highest to lowest inventory on a month-by-month basis. The user may prefer to return to the table that lists stores alphabetically, with the months listed chronologically. As you can see, the same person may want to see the same data in very different ways.

**PIVOT TABLES.** Pivot tables allow users to arrange data in a table in any way they choose. An example of a pivot table template created in Microsoft Excel is shown in Figure 14.3. The user would take an item from the pop-up box called “Pivot Table Field List,” such as **Product**, drag it over to the table template, and drop it in one of the blank areas. In this example, the user drags and drops **Product** into the area on the left entitled “Drop Row Fields Here.” The user drops **Sales** into the largest area that says “Drop Data Items Here.”

Finally the user takes the item called **Quarter** and drops it into the area called “Drop Column Fields Here.” The result is a table that shows each of the products in alphabetical order and its sales for each of the four quarters we have data for, followed by the grand total for the year. This table is shown in Figure 14.4.

Of course, the user could have done the opposite, that is, drag the item **Quarter** to the leftmost column and the **Product** to the area that says “Drop Column Fields Here.” That operation, however, would have produced a table with many columns (one for each product) and only five rows (one for each quarter plus a row for the total). The resulting table would have been difficult to read.

**Usability Survey**

Please fill this out after you complete your interaction with the prototype. Circle a number as you respond to each question. Please hand your survey to the analyst when you have completed it. Thank you for this important feedback.

Prototype being evaluated \_\_\_\_\_ Version \_\_\_\_\_ Date \_\_\_\_/\_\_\_\_/\_\_\_\_

		Very Poor	Average	Very Good
<b>Physical/Safety Concerns</b>				
1.	How well were you able to read the display or form?	1 1 1	2 2 2	3 3 3
2.	If audio was used, were you able to hear it?			4 4 4
3.	Did you consider the system safe to use?			5 5 5
<b>Usability Concerns</b> How well did the system:				
4.	Help you cut down on making errors?	1 1 1	2 2 2	3 3 3
5.	Allow you to recover from an error if you made one?			4 4 4
6.	Help you use it easily?			5 5 5
7.	Help you remember how to use it?			4 4 4
8.	Make it easy to learn how to use it?			5 5 5
<b>Pleasing and Enjoyable Attributes</b>				
9.	Was the system attractive?			
10.	Was the system engaging (you wanted to use it)?	1 1 1	2 2 2	3 3 3
11.	Do you trust it as a system?			4 4 4
12.	Was it satisfying to use?			5 5 5
13.	Was it enjoyable to use?			4 4 4
14.	Was the system entertaining?			5 5 5
15.	Was the system fun to use?			4 4 4
<b>Usefulness Attributes</b> How well did the system:				
16.	Support your individual task or tasks?			
17.	Help you to extend your capabilities?	1 1 1	2 2 2	3 3 3
18.	Make itself rewarding to use?			4 4 4
19.	Permit you to do tasks that the other system would not allow you to do?			5 5 5

**FIGURE 14.2**

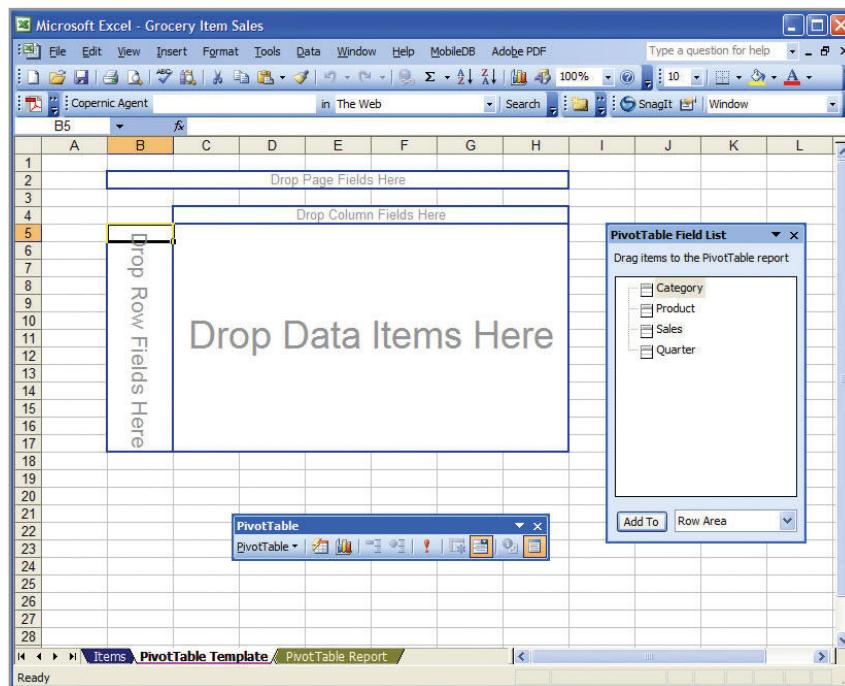
A form may be used to survey users of prototypes on key usability and ergonomic factors. (Categories based on Zhang, Carey, Te’eni, and Tremaine, 2005, table of HCI concerns, p. 522.)

Many different tables are possible just by rearranging these four variables. If the user dragged the variable **Category** over to the area that says “Drop Column Fields Here,” the columns would have been categories of products, rather than the quarters, and the resulting table would have clearly shown which of the items belonged in each category and produced subtotals for each category. If **Category** was dragged to the area at the very top of the template that says “Drop Page Fields Here,” then each category would have its own table beginning on a separate page.

Pivot tables are useful because they grant users greater control over how they look at data in different ways within a table. We can examine this same concept for graphs in the next section.

**FIGURE 14.3**

A pivot table template can make it easier for users to see information displayed in different ways.



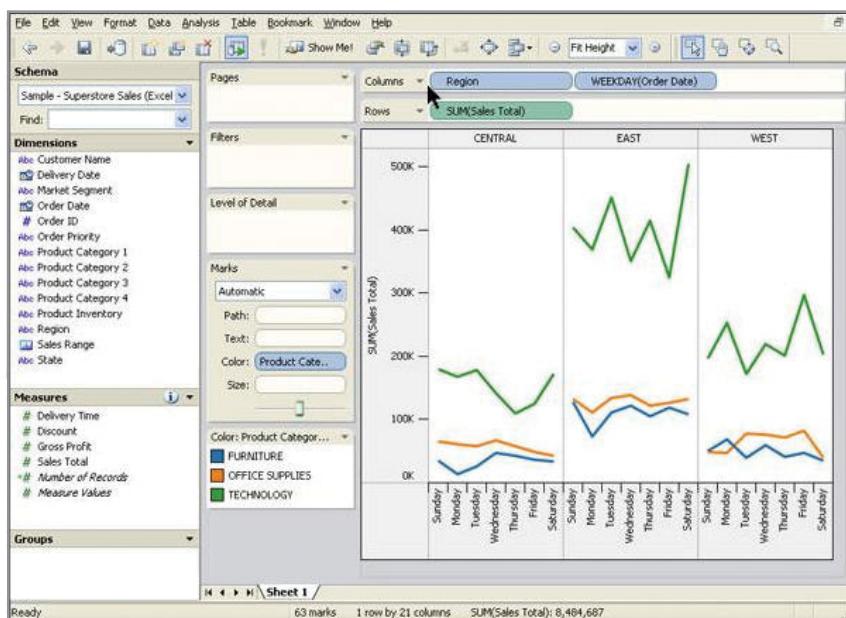
**VISUAL ANALYSIS OF DATABASES.** Innovative visual displays of data have existed for quite some time, even as early as the eighteenth century. Barriers to widespread use of visual displays included lack of imagination, the inability to draw graphs and charts in a cost-effective manner, and a lack of appreciation for such displays. The consumer of information must be able to interpret the information in the diagram or it adds little value.

Software that enables the user to visually examine a database or spreadsheet is available. One example is Tableau Software's product ([www.tableausoftware.com](http://www.tableausoftware.com)). Using an approach similar to the pivot tables we saw in Microsoft Excel, Tableau allows the user to drag and drop variables onto either a row or a column, and they appear on a graph. In Figure 14.5, the **Region** and **Weekday** were designated as columns and the **SUM (Sales Total)** was designated as a row. Each

**FIGURE 14.4**

After the user drags the items Product, Quarter, and Sales to the template, the table looks like this.

Sum of Sales							Quarter
Product	Qtr 1	Qtr 2	Qtr 3	Qtr 4	Grand Total		
Alice Mutton	2667.6	4013.1	3900	6000.15	16580.85		
Aniseed Syrup	544	600	140	440	1724		
Boston Crab Meat	1474.41	2272	3887.92	2162	9796.33		
Camembert Pierrot	3329.28	3989.9	10273.1	3060	20652.28		
Camaroon Tigers	1500	2362.5	7100	4987.5	15950		
Chai	705.6	878.4	1174.5	2128.5	4887		
Chang	2720.8	228	2061.5	2028.25	7038.55		
Chartreuse verte	590.4	360	1100.7	2424.6	4475.7		
Chef Anton's Cajun Seasoning	225.28	2970	1337.6	682	5214.88		
Chef Anton's Gumbo Mix			288.22	85.4	373.62		
Chocolate	744.6	162.56	68.85	306	1282.01		
Côte de Blaye	25127.36	12806.1	7312.12	1317.5	46563.08		
Escargots de Bourgogne		266	1393.9	417.38	2076.28		
Filo Mix	187.6	742	226.8	911.75	2068.15		
Flotemysost	4454.8	174.15	2541.29	2472.5	9642.74		
Geitost	294	242.5	99.5	150	786		
Genen Shouyu		176.7	1298.12		1474.82		
Gnocchi di nonna Alice	6931.2	9868.6	6771.6	9032.6	32604		
Gorgonzola Telino	487	2993.12	1458.75	2681.87	7620.74		
Grandma's Boysenberry Spread			1750	750	2500		
Gravad lax	208	421.2			629.2		
Guarana Fantástica	529.2	467.55	219.37	337.5	1553.62		
Gudbrandsdalsost	2649.6	1267.2	4473	5652	14041.8		

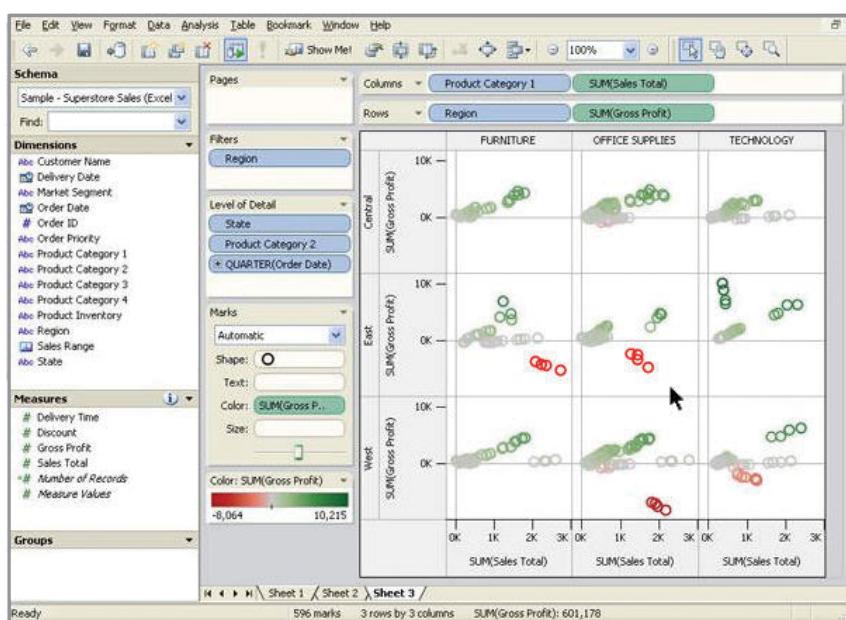


**Product Category** was then graphed (with “furniture” in blue, “office supplies” in orange, and “technology” in green).

The graph demonstrates that technology sales were higher than the other categories, but in particular technology sales were much higher than either furniture or office supplies in the East. The user was easily able to see this because the **Region** was singled out as one of the separators by dragging it to the area as a column.

Tableau is a well-designed software package because it goes much further than other applications in extending user capabilities to perform their tasks through the use of pivot table techniques. The developers also realized that users might want to cluster the data into what they consider a meaningful group. Users may then continue analysis by examining one of the groups further.

Figure 14.6 examines the **SUM (Gross Profit)** from each **Product Category** from our example. This graph uses color to indicate a profit (green) or a loss (red). In fact, the intensity of the color indicates the amount of profit or loss.



**FIGURE 14.5**

This table, showing the daily sales by category and by region, was produced using Tableau.

*Source:* Courtesy of [www.tableausoftware.com](http://www.tableausoftware.com).

**FIGURE 14.6**

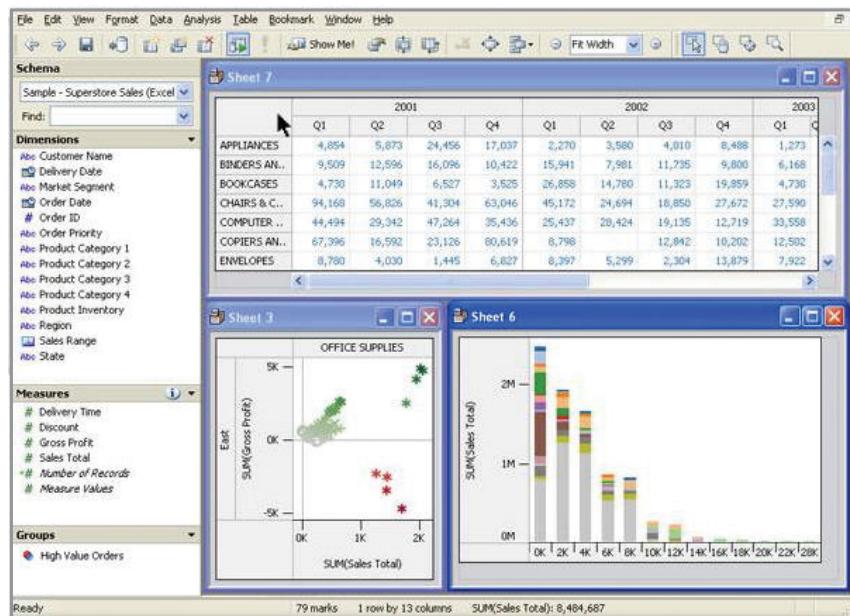
Products yielding losses are highlighted in bright red on this scatter plot, created using Tableau.

*Source:* Courtesy of [www.tableausoftware.com](http://www.tableausoftware.com).

**FIGURE 14.7**

When different graphs or tables can be displayed on the same page, the page resembles a dashboard.

Source: Courtesy of [www.tableausoftware.com](http://www.tableausoftware.com).



This graph can be used to explore the situation more deeply by selecting the three clusters of circles that are bright red, isolating them, and then looking at the data for those observations in more detail. Users can examine graphs or simply look at the observations in a table. Once again, they have control over how the information is presented and thus control their task for best cognitive fit.

Another example from Tableau, presented in Figure 14.7, shows that this software can also create a dashboard (explained in Chapter 11). Here a table, a scatter plot, and a column chart are all shown on the same page. Visual analysis tools like this support visual thinking and extend the user's cognitive capabilities to do so. An appropriate visual display will increase the chances of making an appropriate decision.

### Physical Considerations in HCI Design

In Chapters 11, 12, and 13 you learned the basis for sound design of screens, forms, Web sites, and databases. This included the special use of fonts, color, and layout design to communicate to users and to help them do the right thing with the input and output they encountered. To examine the underlying reasons for much of the design you learned, it is useful to look at human sensory capabilities and limitations that will inform our design. In keeping with the HCI philosophy, an analyst should be able to compensate, overcome, or replace human senses to a varying extent.

**VISION.** As you become a systems analyst, you are becoming accustomed to designing screens and reports for sighted people. The use of color, fonts, graphics, software, and PowerPoint presentations for displays and printed reports as input and output were detailed in Chapters 11 and 12. However, from an HCI perspective, you will also want to think in terms of limitations on human vision. Factors such as length of the distance from display to the person performing a task; the angle of the display in relation to the person viewing it; the size and uniformity of the characters; the brightness, contrast, balance, and glare of the screen; and whether a display is blinking or stable can all be designed to standards established through ISO and other national and international groups.

**HEARING.** Humans also have limits to the amount of stress their senses can withstand. Noisy laser printers, phone conversations, and shredders can lead to overload on human hearing. Office workers can wear noise-canceling headphones or get a personal music player like an iPod, but these solutions may have the effect of isolating a person from the organizational setting and may even diminish their capability to perform the task at hand. As an analyst you will need to consider noise when you design office systems.

**TOUCH.** When using an HCI perspective to evaluate the usefulness of keyboards and other input devices, we can rate the human-computer fit as well as the dimensions examining the

human–computer–task fit. Keyboards have been ergonomically designed to provide the correct feedback for the person doing data entry. Users know by the firmness of the key under their finger that the keystroke has been entered. Although keyboards can be silenced, they are often designed with a click of feedback that is emitted when a key is hit. Keyboards also include slightly raised bumps on what are called home keys, often the *f* and the *j* keys, which orients users to where their fingers are positioned on the keyboard, enabling them to look at the screen or type from a printed page on their desk without continually glancing at the keyboard.

Although the popular QWERTY keyboard that we most often use with computers today was originally designed to slow down typists so that mechanical keys of the day would not become entangled, this layout has proved to be quite an efficient way to enter data. In fact, since users do so well with this familiar interface, it is difficult to conduct experiments comparing the efficiency of QWERTY keyboards with other innovative keyboards.

Designing for data entry using numeric keypads as the human entry device also provides a decision point for designers. Notice that numbers on your mobile phone are ordered differently than numbers on a numeric keypad or calculator. Your phone may be arranged with the numbers 1, 2, and 3 on the top row. When you look at a calculator layout or a numeric keypad on your keyboard, you will see 7, 8, and 9 on the top row instead. Research now points to the superiority of the calculator layout when the user is doing a lot of data entry. However, the phone digit layout is supposed to be better for locating a number. As a designer, you are constantly examining the fit between the human, the computer, and the tasks set by the organization.

### Considering Human Limitations, Disabilities, and Design

All humans have limitations in their physical capabilities. Some are immediately visible, others are not. When designing from an HCI perspective, you start realizing that limitations are often discussed in terms of disabilities. The application of HCI to supporting and enhancing the physical capabilities of humans is one of the most promising application areas. Strides in biomedical engineering mean that there is research to support the blind or those with low vision, those who are deaf or have impaired hearing, and people with limited mobility.

There are also improvements in the technical supports available to those who face difficulties in cognitive processing, including persons suffering with symptoms of autism, dyslexia, and attention deficit disorder. As a systems analyst you will be subject to the legal provisions of the country in which you are working. For instance, if you are designing for workplaces in the United States, you may want to access the obligations of an employer under the Americans with Disabilities Act at [www.eeoc.gov/types/ada.html](http://www.eeoc.gov/types/ada.html). There you will find definitions of who is considered disabled, which states in part, “An individual with a disability is a person who: has a physical or mental impairment that substantially limits one or more major life activities; has a record of such impairment; or is regarded as having such an impairment.”

An employer in the United States is expected to make reasonable accommodation to employ a disabled person, which includes “Making existing facilities used by employees readily accessible to and usable by persons with disabilities; job restructuring, modifying work schedules, reassignment to a vacant position; acquiring or modifying equipment or devices, adjusting or modifying examinations, training materials, or policies, and providing qualified readers or interpreters.”

A qualified employee or application is an individual who, “with or without reasonable accommodation, can perform the essential functions of the job in question.” An employer is required to make reasonable accommodation to the known disability of a qualified applicant or employee if it would not impose an undue hardship on the operation of the business. Undue hardship is defined as “an action requiring significant difficulty or expense when considered in light of factors such as an employer’s size, financial resources, and the nature and structure of its operation. An employer is not required to lower quality or production standards to make an accommodation.”

One of the best ways to ensure the broadest possible accommodation is to begin designing from an HCI perspective. That way, your foremost concern will always be assisting a user in accomplishing a task, set by the organization, with the use of technology. When accommodations for disabled people are necessary, there are many sources to examine and many assistive devices to consider.

For people who are blind or who have low vision, there are braille keyboards as well as special speech software that reads Web pages and other documents aloud. There are also screen magnifiers that fit over a display to magnify the entire screen.



## CONSULTING OPPORTUNITY 14.1

### School Spirit Comes in Many Sizes

**M**att Scott manages the student-alumni clothing department for a large bookstore in Saratoga Springs.

"Our clothing sales depend not only on whether our sports teams win or lose, but the overall well-being of our students and alums. If they are proud of their university, and want to show their school spirit, they'll buy up everything on our racks," exclaims Matt. "But don't underestimate the weather as a factor," he adds. "If the weather turns cold in October, you'll see a surge in people buying warm sweaters, pullovers, and gloves."

"Our store serves the major three universities in our area," Matt goes on to state. "First, there is Hyde Park, what we call 'the football school.' They have about 17,000 students going there. They have high demand for school-branded clothing, particularly in the fall. Then, of course, there's Pierce University. Pierce thinks it's part of the Ivy League, so the students like to buy crew and Lacrosse shirts. They have about 7,500 students. Then there is St. David's, with about 3,000 students. They are devoted to their basketball team. They really have faith in them. You'll see sales pick up in the second semester, particularly during 'March Madness.'"

Mr. Scott continues, admitting, "I thought about asking the students what to stock, but an email survey is out of the question. I get spammed a lot, so I mostly don't bother with email. Unfortunately, the lead time for getting official branded sportswear into the store is really long, and we run the risk of stocking out. But we try to never run out."

You've been asked to design a set of tables and graphs that will help analyze the sales of Matt Scott's school clothing. Start by list-

ing about 20 different items of school-branded clothing for men and women fans, including items such as hooded sweatshirts, T-shirts, baseball caps, sweatbands, running shorts, and so on. Many of them feature fanciful embroidered designs depicting their mascots in menacing or endearing poses. Hyde Park has their Golden Retrievers; Pierce has their much beloved bird, the Puffins; and St. David's cheers with their Dragons.

Put the items into categories. Then think about what the data would look like. Does it make sense for Matt to look at the data weekly, monthly, or by semester? Will he want to look back five years to see if there were any trends? Set up tables identifying the rows and columns and the content of the main cells. Suggest several tables so that Matt can analyze them in different ways.

Now construct graphs that analyze the same data. Using some of the examples found in this book, suggest the type of graphs and show the data so that different users with different styles can make some decisions regarding the trend of sales over the last few years. Remember to compare the schools as well. Suggest the appropriate graphs from column, line, scatter plots, or even pie charts.

Also suggest three or four specific changes you would make to allow someone who has low vision to be able to read the graphs more easily. Magnification is one way to change a graph, but may not be the best approach.

Consider the size of the schools since this may become the most important factor when determining how Matt Scott should adjust his ordering for David's, Hyde, and Pierce.

For people who lack certain perceptual sensitivity (incorrectly called color blindness), you can work at testing the colors you are choosing for screens or forms to make certain that they can be easily distinguished from each other. Particular problems occur telling the difference between red and green, for instance. Always design the screen or form with alternative cues, such as icons, written text, or audio cues that reinforce the content. For instance, if a hyperlink that has been clicked on turns blue to show it has been followed, you can also add another icon to the display to indicate that it has been followed or create a separate sidebar list that shows which Web sites have been visited. These are better alternatives than relying solely on color to convey your message.

For users who experience impaired hearing, you can make sure that the documents and screens you design include access to written versions of the audio material. Alternatively, you might design tasks where headphones can be successfully used.

If you are designing computer tasks for those with limited mobility, you can think of speech input rather than keyboarding. Additionally, new advances in biomedical engineering permit mobility-impaired users to move the cursor on the screen by breathing into a tube or by directing the cursor to the desired spot on the screen by looking at that spot or even, in some highly specialized interfaces, by thinking about where the cursor should move.

#### Implementing Good HCI Practices

The ideal is to invite a usability specialist to serve on the systems development team with the other team members. However, many systems groups are quite small, and not many professionals are

### Guidelines for the HCI Approach to Systems Design

- Examine the task to be done and consider the fit among the human, computer, and task.
- Identify what obstacles exist for users in their attempts to accomplish their assigned tasks.
- Keep in mind the perceived usefulness and perceived ease of use from TAM.
- Consider usability. Examine the usage environment by creating use case scenarios that depict what is going on between users and the technology.
- Use the information you have gained beforehand to figure out the physical and organizational environmental characteristics. Design with prototyping to accommodate diverse users and users with disabilities.

### FIGURE 14.8

The HCI approach to systems design emphasizes the fit among the human, computer, and task.

available who are involved in the practice of usability per se; so even if you make this recommended change to your project, the odds are that the position will go unstaffed or understaffed. However, don't let that discourage you. You can take some simple steps that will positively influence the outcome of your systems project. Figure 14.8 provides a list of guidelines for taking an HCI approach to systems design.

Although we have been discussing the system in the abstract, it is important to recognize that the interface *is* the system for most users. However well or poorly designed, it stands as the representation of the system and, by reflection, your competence as a systems analyst. A well-designed interface improves the fit among the task, the technology, and the user.

Your goal must be to design interfaces that help users and businesses get the information they need in and out of the system by addressing the following objectives:

1. Matching the user interface to the task.
2. Making the user interface efficient.
3. Providing appropriate feedback to users.
4. Generating usable queries.
5. Improving the productivity of computer users.

## TYPES OF USER INTERFACE

In this section, several different kinds of user interfaces are described, including natural-language interfaces, question-and-answer interfaces, menus, form-fill interfaces, command-language interfaces, graphical user interfaces (GUIs), and a variety of Web interfaces for use on the Internet. The user interface has two main components: presentation language, which is the computer-to-human part of the transaction, and action language, which characterizes the human-to-computer portion. Together, both concepts cover the form and content of the term *user interface*.

### Natural-Language Interfaces

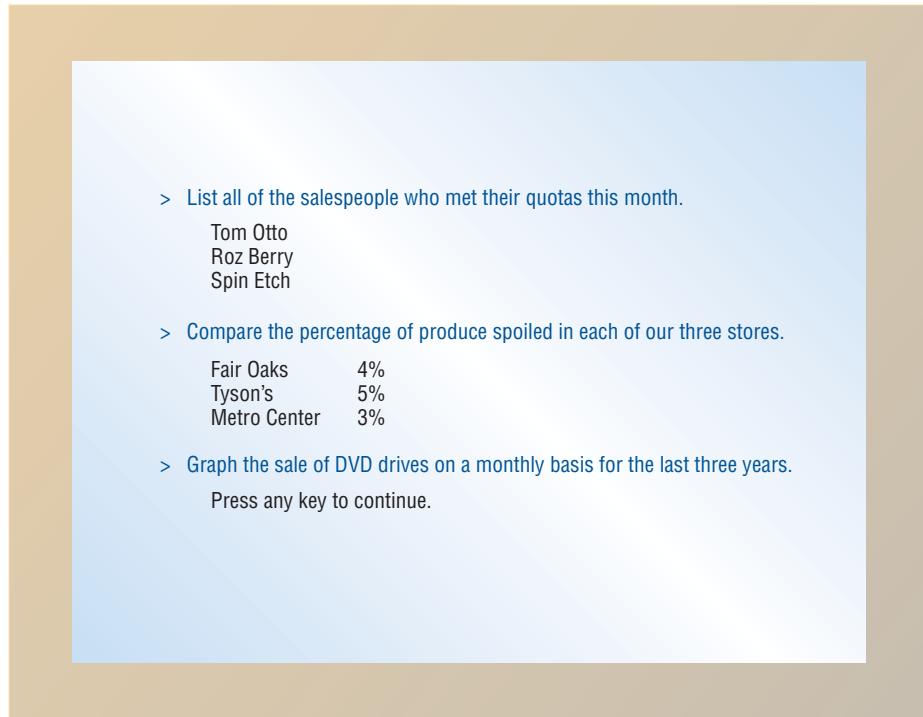
Natural-language interfaces are perhaps the dream and ideal of inexperienced users, because they permit them to interact with the computer in their everyday, or natural, language. No special skills are required of the user, who interfaces with the computer using natural language.

The display depicted in Figure 14.9 lists three natural-language questions from three different applications. Notice that interaction with each seems very easy. For instance, the first sentence seems straightforward: "List all of the salespeople who met their quotas this month."

The subtleties and irregularities residing in the ambiguities of English produce an extremely exacting and complex programming problem. Attempts at natural-language interfacing for particular applications in which any other type of interface is infeasible (say, in the case of a user who is disabled) are meeting with some success; however, these interfaces are typically expensive. Implementation problems and extraordinary demand on computing resources have so far kept natural-language interfaces to a minimum. The demand exists, though, and many programmers and researchers are working diligently on such interfaces. It is a growth area, and it therefore merits continued monitoring.

**FIGURE 14.9**

Natural-language interfaces.



### Question-and-Answer Interfaces

In a question-and-answer interface, the computer displays a question to the user on the display. To interact, the user enters an answer (via a keyboard stroke or a mouse click), and the computer then acts on that input information in a preprogrammed manner, typically by moving to the next question.

A type of question-and-answer interface called a dialog box is shown in Figure 14.10. A dialog box acts as a question-and-answer interface within another application, in this case a PERT

**FIGURE 14.10**

A dialog box: one type of question-and-answer interface.

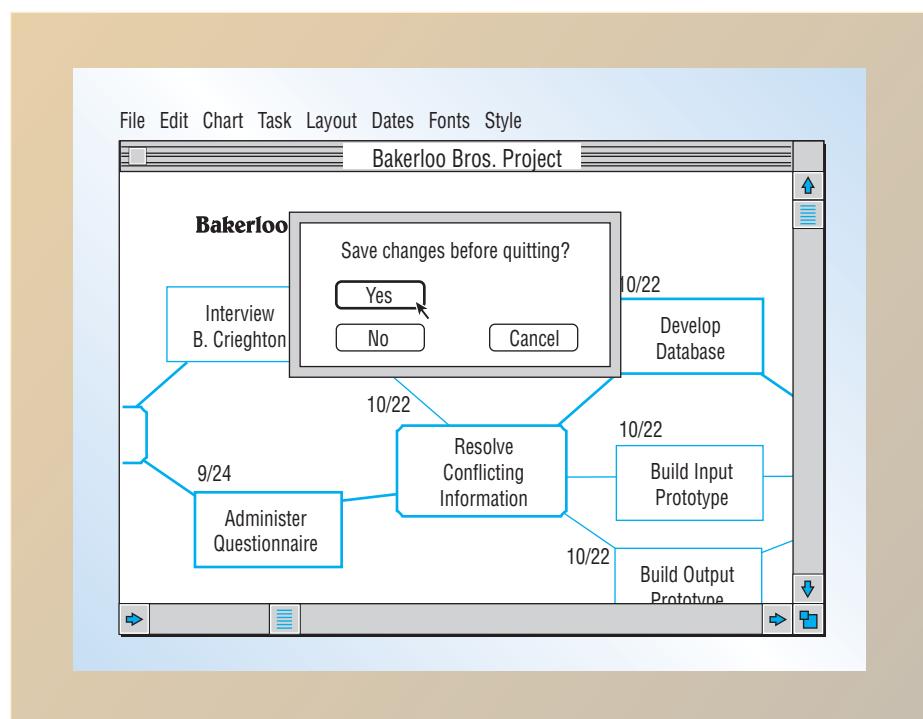


chart for a systems analysis project for the Bakerloo Brothers. Notice that the rounded rectangle for “Yes” is highlighted, indicating that it is the most likely answer for this situation. The main interface for this application need not necessarily be question and answer. Rather, by incorporating a dialog box, the programmer has included an easy-to-use interface within a more complicated one.

Wizards used to install software are a common example of a question-and-answer interface. The user responds to questions about the installation process, such as where to install the software or features. The wizard can also ask questions and respond to the user’s answers with more questions designed to narrow the scope of the problem. This is a typical way of setting up a technical support interface in order to winnow down problems and do more accurate troubleshooting.

## Menus

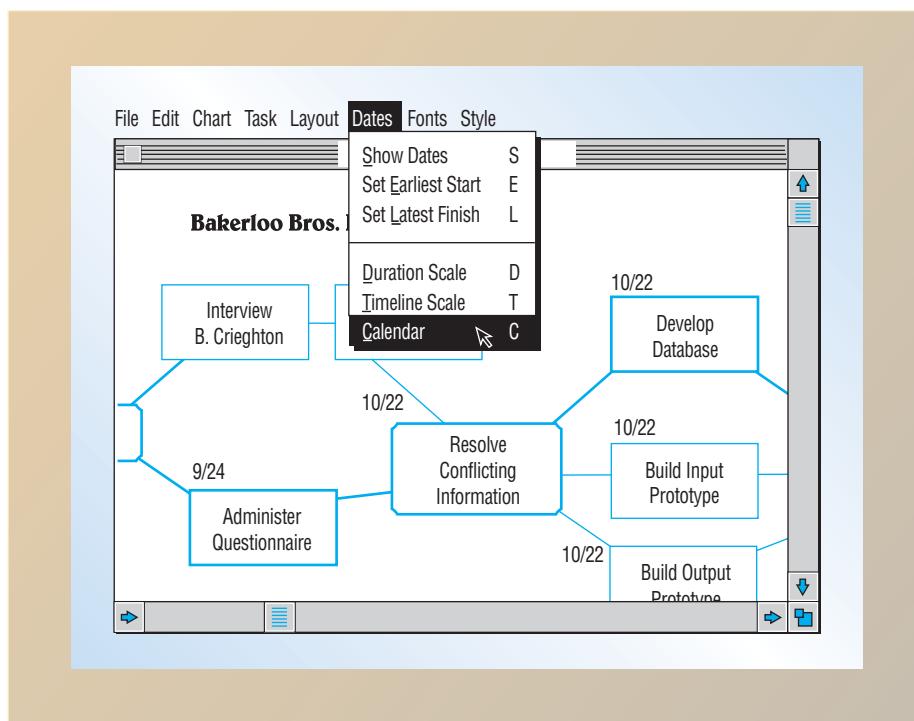
A menu interface appropriately borrows its name from the list of dishes that can be selected in a restaurant. Similarly, a menu interface provides the user with an onscreen list of available selections.

In responding to the menu, a user is limited to the options displayed. The user need not know the system but does need to know what task should be accomplished. For example, with a typical word processing menu, users can choose from the Edit, Copy, or Print options. To utilize the menu best, however, users must know which task they desire to perform.

Menus are not hardware dependent. Variations abound. Menus can be set up to use keyboard entry, light pen, touch screen, or mouse. Selections can be identified with a number, letter, or keyword, or users can click on a selection with a mouse. Consistency is important in designing a menu interface.

Menus can also be put aside until the user needs them. Figure 14.11 shows how a pull-down menu is used while constructing a PERT diagram for a systems analysis project being completed for the Bakerloo Brothers. The user puts the pointer on **Dates** and pulls it down. Then the user puts the pointer on **Calendar**, selecting the option to display the project on a conventional monthly calendar.

Menus can be nested within one another to lead a user through options in a program. Nested menus allow the screen to appear less cluttered, which is consistent with good design. They also allow users to avoid seeing menu options in which they have no interest. Nested menus can also move users quickly through the program.



**FIGURE 14.11**

A pull-down menu is there when the user needs it.



## CONSULTING OPPORTUNITY 14.2

### I'd Rather Do It Myself

“I can get Mickey to download any data I need from the Web or our server to my PC,” DeWitt Miwaye, an upper-level manager for Yumtime Foods (a Midwest food wholesaler), tells you. “Getting data is no problem. What I don’t want are a lot of reports. I’d rather get into the data myself.”

Miwaye goes on to tell you that as an executive, he doesn’t use his PC as often as he’d like, maybe only three times a month, but he has some very specific ideas about what he’d like to do with it.

“I’d like to be able to make some comparisons myself. I could compare the turnover rate for all 12 of our warehouses. I’d also like to see how effectively the capacity of each of our warehouses is being used. Sometimes I’d like to be able to graph the comparisons or see a chart of them over time.”

In three paragraphs, compare three different types of interfaces that Miwaye could use. Then recommend one interface for his use that takes into account his infrequent use of the PC, his enjoyment of working with raw data, and his desire to see data displayed in a variety of ways.

GUI menus are used to control PC software and have the following guidelines:

1. The main menu bar is always displayed.
2. The main menu uses single words for menu items. Main menu options always display secondary drop-down menus.
3. The main menu should have secondary options grouped into similar sets of features.
4. The drop-down menus that display when a main menu item is clicked often consist of more than one word.
5. Secondary options perform actions or display additional menu items.
6. Menu items in gray are unavailable for the current activity.

An object menu, also called a pop-up menu, is displayed when the user clicks on a GUI object with the right mouse button. These menus contain items specific for the current activity, and most are duplicate functions of main menu items.

Experienced users may be irritated by nested menus. They may prefer to use a single-line command entry to speed things up. Other users might use the shortcut abbreviations or key combinations such as Alt >. I >. P > C, which inserts a picture that is clip art in a Microsoft Office document.

### Form-Fill Interfaces (Input/Output Forms)

Form-fill interfaces consist of onscreen forms or Web-based forms displaying fields containing data items or parameters that need to be communicated to the user. The form often is a facsimile of a paper form already familiar to the user. This interface technique is also known as a form-based method and input/output forms.

Figure 14.12 shows a form-fill interface. A pull-down menu for **Part No.** automatically enters a **Description** and **Unit Price** for the item. When the user tabs to the **Quantity** field and enters the number of items being purchased, the software automatically calculates the **Extended Price** by multiplying **Quantity** by **Unit Price**.

Forms for display screens are set up to show what information should be input and where. Blank fields requiring information can be highlighted with inverse or flashing characters. The cursor is moved by the user from field to field by a single stroke of an arrow key. This arrangement allows movement one field backward or one field forward by clicking the appropriate arrow key. It provides the user good control over data entry. Web-based forms afford the opportunity to include hyperlinks to examples of correctly filled-out forms or to further help and provide examples.

Form input for displays can be simplified by supplying default values for fields and then allowing users to modify default information if necessary. For example, a database management system designed to show a form for inputting checks may supply the next sequential check

Part No.	Description	Quantity	Unit Price	Extended Price
OS23561	Note pads, 4 in. x 6 in., box of 25	10	9.95	99.50
OS93851	Clear tape, 12mmx33mm, box of 100	3	19.99	59.97
OS83955	Hi-Liter, assorted colors, box of 12	2	8.56	17.12
				0.00
				0.00
				0.00
				0.00
				0.00

**FIGURE 14.12**

An example of the form-fill interface.

number as a default when a new check form is exhibited. If checks are missing, the user changes the check number to reflect the actual check being input.

Input for display screen fields can be alphanumerically restricted so that, for example, users can enter only numbers in a field requesting a Social Security number, or they can input only letters where a person's name is required. If numbers are input where only letters are allowed, the computer may alert the user via audio output that the field was filled out incorrectly.

The chief advantage of the input/output form interface is that the printed version of the filled-in form provides excellent documentation. It shows field labels as well as the context for entries. In addition, Web forms can return incomplete forms to the user with an explanation of what data must be entered to complete the transaction. Often, fields with missing data are marked with a red asterisk. Web-based documents can be sent directly to billing if a transaction is involved, or they can go directly to a real-time database if a survey is being submitted. Web-based forms push the responsibility for accuracy to the user and make the form available for completion and submission on a 24-hour, 7-day-a-week, worldwide basis.

There are few disadvantages to input/output forms. The main drawback is that users experienced with the system or application might become impatient with input/output forms and might want more efficient ways to enter data.

### Command-Language Interfaces

A command-language interface allows the user to control the application with a series of key-strokes, commands, phrases, or some sequence of these three methods. The simple syntaxes of command languages are considered to be close to natural language.

Two application examples of command language are shown in Figure 14.13. The first shows a user who asks to use a file containing data on all salespeople, then asks the computer to display all last names and first names for all salespeople whose current sales (CURSALES) are greater than their quotas. In the second example, a user asks to use a file called GROCER, and then directs the computer to calculate the spoilage (SPOILS) by subtracting produce sold from produce bought. After that is done, the user asks to go back to the top of the file and to print out (LIST) the file.

The command language has no inherent meaning for the user, and that fact makes it dissimilar to the other interfaces discussed so far. Command languages manipulate the computer as a tool by allowing the user to control the dialog. Command language affords the user more overall flexibility and control. When the user employs command language, the command is executed by the system immediately. Then the user may proceed to give it another command.

Command languages require memorization of syntax rules that may prove to be obstacles for inexperienced users. Experienced users tend to prefer command languages, possibly because of their faster completion time.



## CONSULTING OPPORTUNITY 14.3

### Don't Slow Me Down

“I’ve seen ‘em all,” Carrie Moore tells you. “I was here when they got their first computer system. I guess I’ve sort of made a career of this,” she says cheerfully, pointing to the large stack of medical insurance claim forms she has been entering into the computer system. As a systems analyst, you are interviewing Carrie, a data entry operator for AbundaCare (a large medical insurance company), about changes being contemplated in the computer system.

“I’m really fast compared with the others,” she states as she nods toward the six other operators in the room. “I know, because we have little contests all the time to see who’s the fastest, with the fewest errors. See that chart on the wall? That shows how much we enter and how quickly. The gold stars show who’s the best each week. Performance measures are my friends.”

“I don’t really mind if you change computers. Like I say, ‘I’ve seen ‘em all.’” She resumes typing on her keyboard as she contin-

ues the interview. “Whatever you do, though, don’t slow me down. One of the things I’m most proud of is that I can still beat the other operators. They’re good too, though,” Carrie adds.

Based on this partial interview with Carrie Moore, what type of user interface will you design for her and the other operators? Assume that even though the new system is improved, it will still require massive amounts of data entry from a variety of medical insurance forms sent in by claimants.

Compare and contrast interfaces such as natural language, question and answer, menus, input/output forms, and Web-based form-fill documents in two paragraphs. Then choose and defend one alternative. What qualities possessed by Carrie and the other operators—and the data they will be entering—shaped your choice? Make a list of them. Is there more than one feasible choice? Why or why not? Respond in a paragraph.

### Graphical User Interfaces

The key to graphical user interfaces (GUIs) is the constant feedback on task accomplishment that they provide to users. Continuous feedback on the manipulated object means that changes or reversals in operations can be made quickly, without incurring error messages.

The creation of GUIs poses a challenge, because an appropriate model of reality or an acceptable conceptual model of the representation must be invented. Designing GUIs for use on intranets, extranets, and on the Web requires even more careful planning. Most users of Web sites are unknown to the developer, so design must be clear-cut. The choice of icons, language, and hy-

**FIGURE 14.13**

Command-language interfaces.

```
USE SALESPLI  
DISPLAY ALL LNAME, FNAME FOR CURSALES > QUOTA  
  
USE GROCER  
REPLACE ALL SPOILS WITH PBOUGHT - PSOLD  
GOTO TOP  
LIST
```



## CONSULTING OPPORTUNITY 14.4

### That's Not a Lightbulb

From your preliminary analysis, it appears that a substantial reduction in errors will be realized if salesclerks at Bright's Electric (which sells electrical parts, bulbs, and fixtures to wholesale customers) adopt an online system. The new system would allow salesclerks to withdraw a part from inventory (and thereby update inventory), return a part to inventory, check on the inventory status, and check on whether a part is backordered. Currently, to update inventory, sales clerks fill out a three-part form by hand. The customer gets one, inventory keeps one, and at the end of the day the originals are deposited in the front office.

The next morning, the first thing the lone office worker does is enter the data from the forms into the computer. Errors occur when she enters the wrong part numbers or quantities. Additional time is consumed when inventory workers hunt for a part they think might be in stock but is not. Updated inventory sheets are available to the salesclerks around noon, but by that time they have already taken from inventory twice the number of parts that will be taken out after noon. Clearly, a well-designed online system would help reduce these errors and also help with inventory control.

The owner, Luis Bright, has entertained the idea of an online system and dropped it several times over the last five years. The chief reason is that the salesclerks, who would be the heaviest users of the system, do not think the systems analysts they've talked to can create a really useful system.

M. T. Sockette, the salesclerk who has been with Bright's the longest, is the most vocal, telling you, "We know the parts, we know our customers. What we could do with a computer here would be great. The guys they've brought in here to get it going, though . . . I mean, they say things like, 'You can step right up and type one 60-watt General Electric CFL lightbulb into the computer.'

"To us, that's not a lightbulb, it's a GE60WCFL. All of us know the part numbers here. We pride ourselves on it. Typing in all that junk will take all day."

After talking to Mr. Bright, you decide to implement an online system. You have talked to M. T. and the others and reassured them that the system will use the part numbers they're familiar with and will save them time. Although they're skeptical, you've persuaded them to give it a try.

What type of user interface will you design for the sales clerks? Before you come to your solution, do a careful analysis in three paragraphs that compares and contrasts various user interfaces—natural language, question and answer, menus, input/output forms, command language, and Web-based form-fill documents—for their suitability at Bright's. Then choose one interface and explain in a paragraph why you find this one the most appropriate based on what you know about Bright's salesclerks and their current system. Draw a prototype of a display that will be part of your solution. Describe in a paragraph how you will test its usability with the sales clerks.

perlinks becomes an entire set of decisions and assumptions about what kinds of users the Web site is hoping to attract. The designer must also adhere to conventions that users now expect to encounter on Web sites.

### Other User Interfaces

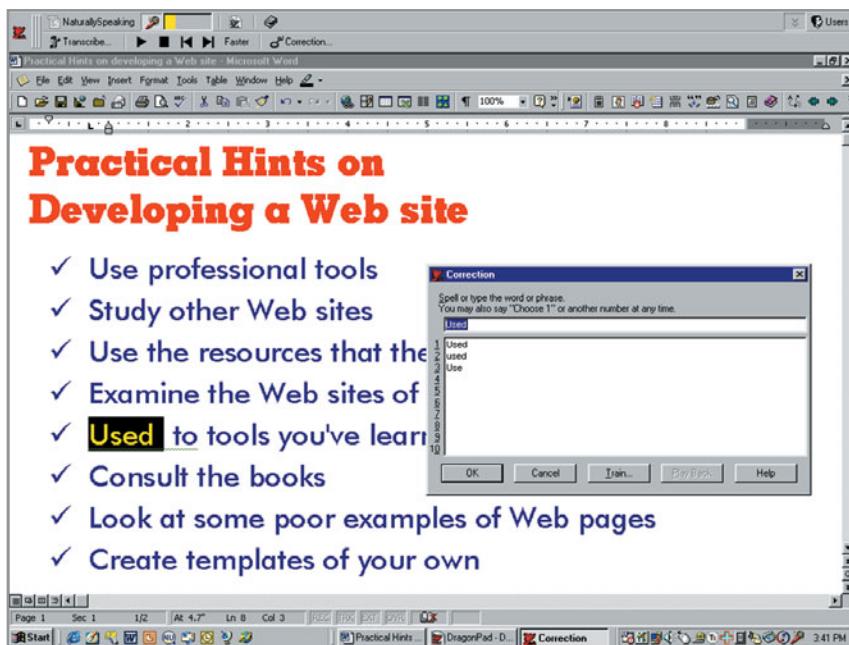
Other less common user interfaces are growing in popularity. They include pointing devices such as the stylus, touch-sensitive screens, and speech recognition and synthesis. Each of these interfaces has its own special attributes that uniquely suit it to particular applications.

The stylus (a small pointed stick that resembles a pen) is used with handwriting recognition software for mobile phones (acting as PDAs—personal digital assistants) and PC devices. They have been a success because they integrate many functions and are easy to use. Additionally, they are portable and sell for a comparatively low price. There has been an explosion of fun and useful applications written for these mobile devices, including popular programs for restaurant reviews such as Zagat, popular utilities such as "To Do" lists for work and personal use, and for popular games such as Sudoku. Data entry is also facilitated with a docking cradle so that data can be synchronized with your PC.

A tablet PC is a notebook computer with a stylus or touch-sensitive display. It can be equipped with built-in Wi-Fi or Bluetooth communication. Touch-sensitive displays allow a user to use a finger to activate the display. Touch-sensitive displays are useful in public information displays, such as maps of cities and their sights posted in hotel lobbies or car rental facilities. They can also be used to explain dioramas in museums and to locate camping facilities in state parks. Touch-sensitive displays require no special expertise from users, and the screen is self-contained, requiring no special input device that might be broken or stolen. Touch sensitive screens (also

**FIGURE 14.14**

Using software such as Dragon NaturallySpeaking by Nuance, a user can speak commands to their computer. In this example, the user corrects a word by pulling up a menu of alternative words that sound the same.



called simply touch screens or touch pads) for mobile phones such as the iPhone and the BlackBerry are making this alternative user interface familiar to users and widely used. Current research is examining how to make pressure-sensitive touch pads commercially viable. These interfaces can be used with both large and small touch screens and are practical for applications such as virtual painting or sculpting, a simulated mouse, and for musical instruments such as a piano keyboard where the intensity of the pressure applied is critical to the output.

With voice recognition, the user speaks to the computer, and the system is able to recognize an individual's vocal signals, convert them, and store the input. Voice recognition inventory systems are already in operation, and automobiles now feature voice input systems that respond to a driver's voice commands to navigate, change the radio station, or use the Bluetooth phone that has been paired with the vehicle.

An advantage of voice recognition systems is that they can speed data entry enormously, and free the user's hands for other tasks (for example, driving). Speech input adds still another dimension to the PC. It is now possible to add equipment and software that allows a PC user to speak commands such as "open file" or "save file" to avoid using the keyboard or mouse. Users with limited mobility or impaired sight can benefit from voice recognition systems. In the example shown in Figure 14.14, the user corrects a word by pulling down a menu of alternative words that sound the same.

When evaluating interfaces, keep some standards in mind:

1. The necessary training period for users should be acceptably short.
2. Early in their training, users should be able to enter commands without thinking about them or without referring to a help menu or manual. Keeping interfaces consistent throughout applications can help in this regard.
3. The interface should be seamless so that errors are few and those that do occur are not occurring because of poor design.
4. The time that users and the system need to bounce back from errors should be short.
5. Infrequent users should be able to relearn the system quickly.

Many different interfaces are available, and it is important to realize that an effective interface goes a long way toward addressing key HCI concerns. Users should want to use the system, and they should find it attractive, effective, and pleasing to use.

## GUIDELINES FOR DIALOG DESIGN

Dialog is the communication between the computer and a person. Well-designed dialog makes it easier for people to use a computer and lessens their frustration with the computer system.

Recall the elements of the TAM (technology acceptance model) indicating that perceived usefulness and perceived ease of use will lead first to an intention to use the system and eventually to using it. There are several key points for designing good dialog. They include the following:

1. Meaningful communication, so that the computer understands what people are entering and people understand what the computer is presenting or requesting.
2. Minimal user action.
3. Standard operation and consistency.

## Meaningful Communication

The system should present information clearly to the user. This means having an appropriate title for each display, minimizing the use of abbreviations, and providing clear user feedback. Inquiry programs should display code meanings as well as data in an edited format, such as displaying slashes between the month, day, and year in a date field or commas and decimal points in an amount field. User instructions should be supplied regarding details, such as available function key assignments. In a graphical user interface, the cursor may change shape depending on the work being performed.

Users with less skill in using the computer or doing their tasks with a computer require more communication. Web sites must display more text and instructions to guide the user through the site. Intranet sites may have less dialog, because there is a measure of control over how well trained users are. Internet graphics should have pop-up text or roll-over descriptions when images are used as hyperlinks, because there may be uncertainty in interpreting their meaning, especially if the site is used internationally. Notice that EU guidelines for the display of Web graphics requires that all images be labeled, so that visually impaired users will be able to hear written descriptions announced through special software. Status line information for GUI screens is another way of providing instructions for users.

Easy-to-use help screens should be provided. Many PC help screens have additional topics that may be directly selected using highlighted text displayed on the first help screen. These hyperlinks are usually in a different color, which makes them stand out in contrast to the rest of the help text. Remember to use icons or text in addition to color coding in order to reach the largest number of users. Many GUIs incorporate tool tip help, displaying a small help message identifying the function of a command button when the cursor is placed over it. The other side of communication is that the computer should understand what the user has entered. Hence, all data entered on the screen should be edited for validity.

## Minimal User Action

Keying is often the slowest part of a computer system, and good dialog will minimize the number of keystrokes required. You can accomplish this goal in a number of different ways:

1. **Keying codes, such as airport codes when making a flight reservation, instead of whole words on entry screens.** Codes are also keyed when using a command-language interface, such as a two-letter state postal abbreviation. On a GUI screen, the codes may be entered by selecting descriptions of the codes from a pull-down list of available options. This helps to ensure accuracy, since the code is stored as a value of the drop-down list, as well as helping to provide meaningful communication since descriptions that are familiar to the user are selected. An example would be selecting a Canadian province and having the two-character postal code stored.
2. **Entering only data that are not already stored on files.** For example, when changing or deleting item records, only the item number should be entered. The computer responds by displaying descriptive information that is currently stored on the item file. Another example is when a user logs on to a Web site, the user ID is used to find related records, such as a customer record, outstanding bills, orders, and so on.
3. **Supplying the editing characters (for example, slashes as date field separators).** Users should not have to enter formatting characters such as leading zeros, commas, or a decimal point when entering a dollar amount; nor should they have to enter slashes or hyphens when entering a date. In general, Web sites are an exception to this rule, since Web forms

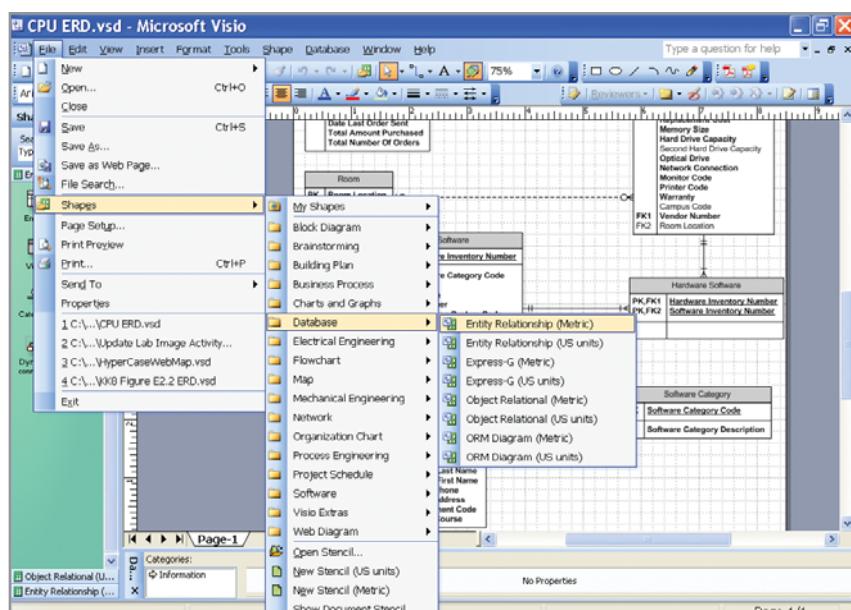
do not include slashes or decimal points. Some Web forms use a series of entry fields with editing characters between them, such as parentheses around an area code.

4. **Using default values for fields on entry screens.** Defaults are used when a user enters the same value in a screen field for the majority of the records being processed. The value is displayed, and the user may press the Enter key to accept the default or overtype the default value with a new one. GUIs may contain check boxes and radio buttons that are selected when a Web form or dialog box opens. Context-sensitive menus appear when an object is clicked with the right mouse button. These menus contain options specific to the object under the mouse.
5. **Designing an inquiry (or change or delete) program so that the user needs to enter only the first few characters of a name or item description.** The program displays a list of all matching names, and, when the user chooses one, the matching record is displayed.
6. **Providing keystrokes for selecting pull-down menu options.** Often, these options are selected using a mouse, followed by keying. Users must move their hands from the keyboard to the mouse and back. As users become familiar with the system, shortcut keystrokes provide a faster method for manipulating the pull-down menus, because both hands remain on the keyboard. This helps users become efficient at their tasks. On a PC or Mac, keystrokes usually involve pressing a function key or the Alt key followed by a letter. Figure 14.15 is an example of nested pull-down menus.
7. **Use radio buttons and drop-down lists to control displays of new Web pages or to change Web forms.** For example, when a radio button is clicked, a drop-down list may change to reflect the radio button choice. A radio button may be clicked and a form may change according to the choice. A drop-down list may change or a radio button may be clicked to move to a new Web page. Drop-down lists are often provided on a Web page for quick navigation; selecting a new Web page from the drop-down list takes the viewer to that page.
8. **Provide cursor control for Web forms and other displays so that the cursor moves to the next field when the right number of characters has been entered.** An example would be when a user enters an area code for a U.S. telephone number, and, following the entry of three characters, the cursor then moves to the local phone number field. Entering software registration key codes is another example. The codes are often in groups of four or five letters and, when the first field is filled, the cursor moves to the next field and so on. The analyst should examine every field to see whether automatic cursor control should occur.

Any combination of these eight approaches can help the analyst decrease the number of keystrokes required by the user, thereby speeding up data entry and minimizing errors.

**FIGURE 14.15**

Example of nested pull-down menus with shortcut keys from Microsoft Visio Professional.





## CONSULTING OPPORTUNITY 14.5

### Waiting to Be Fed

“Yeah, we were sold a package all right. This one right here. Don’t get me wrong, it gets the work done. We just don’t know when.”

You are talking with Owen Itt, who is telling you about the sales unit’s recent purchase of new software for its networked PCs that allows the input of sales data for each of its 16 salespeople, provides output showing comparison data for them, and projects future sales based on past sales records.

“We’ve had some odd experiences with this program, though,” Owen continues. “It seems slow or something. For instance, we’re never sure when it’s done. I type in a command to get a file and nothing happens. About half a minute later, if I’m lucky, the display I want might come up, but I’m never sure. If I ask it to save sales data, I just get a whirring sound. If it works, I’m returned to where

I was before. If it doesn’t save data, I’m still returned to where I was before. It’s confusing, and I never know what to do. There’s nothing on the display screen that tells me what to do next. See the little manual that came with it? It’s dog-eared because we have to keep thumbing through it trying to figure out what to do next. Or we go online to try to get some help, but their technical assistance is just about nonexistent. It takes way too much time, too.”

Based on what you’ve heard in the interview, take this opportunity to supplement the software by designing some onscreen feedback for Owen and his sales team. The feedback should address all of Owen’s concerns, and follow the guidelines for giving feedback to users, and the guidelines for designing good displays. Draw a prototype of the displays you think are necessary to address the problems Owen lists.

### Standard Operation and Consistency

The system should be consistent throughout its set of different displays and in the mechanisms for controlling the operation of the displays throughout different applications. Consistency makes it easier for users to learn how to use new portions of the system once they are familiar with one component. You can achieve consistency by:

1. Locating titles, date, time, and operator and feedback messages in the same places on all displays.
2. Exiting each program by the same key or menu option.
3. Canceling a transaction in a consistent way, such as using the **esc** key.
4. Obtaining help in a standardized way, such as using a function key.
5. Standardizing the colors used for all displays or Web pages.
6. Standardizing the use of icons for similar operations when using a graphical user interface.
7. Using consistent terminology in a display screen or Web site.
8. Providing a consistent way to navigate through the dialog.
9. Using consistent font alignment, size, and color on Web pages.

### FEEDBACK FOR USERS

All systems require feedback to monitor and change behavior. Feedback usually compares current behavior with predetermined goals and gives back information describing the gap between actual and intended performance.

Because humans themselves are complex systems, they require feedback from others to meet psychological and cognitive processing needs discussed earlier in this chapter. Feedback also increases human confidence. How much feedback is required is an individual characteristic.

When users interface with machines, they still need feedback about how their work is progressing. As designers of user interfaces, systems analysts need to be aware of the human need for feedback and build it into the system. In addition to text messages, icons can often be used. For example, displaying an hourglass while the system is processing encourages the user to wait a while rather than repeatedly hitting keys to get a response.

Feedback to the user from the system is necessary in seven distinct situations. Feedback that is ill timed or too plentiful is not helpful, because humans possess a limited capacity to process information. Web sites should display a status message or some other way of notifying the user that the site is responding and that input is either correct or in need of further information.

### Types of Feedback

**ACKNOWLEDGING ACCEPTANCE OF INPUT.** The first situation in which users need feedback is to learn that the computer has accepted the input. For example, when a user enters a name on a line, the computer provides feedback to the user by advancing the cursor one character at a time when the letters are entered correctly. A Web example would be a Web page displaying a message that “Your payment has been processed. Your confirmation number is 1234567. Thank you for using our services.”

**RECOGNIZING THAT INPUT IS IN THE CORRECT FORM.** Users need feedback to tell them that the input is in the correct form. For example, a user inputs a command, and the feedback states “READY” as the program progresses to a new point. A poor example of feedback that tells the user that input is in the correct form is the message “INPUT OK,” because that message takes extra space, is cryptic, and does nothing to encourage the input of more data. When placing an order on the Web or making a payment, a confirmation page often displays, requesting that the user review the information and click a button or image to confirm the order or payment.

**NOTIFYING THAT INPUT IS NOT IN THE CORRECT FORM.** Feedback is necessary to warn users that input is not in the correct form. When data are incorrect, one way to inform the user is to generate a window that briefly describes the problem with the input and explains how the user can correct it, as shown in Figure 14.16.

Notice that the message concerning an error in inputting the subscription length is polite and concise but not cryptic, so that even inexperienced users will be able to understand it. The subscription length for the online newsletter is entered incorrectly, but the feedback does not dwell on the user’s mistake. Rather, it offers options (13, 26, or 52 weeks) so that the error can be corrected easily. On a GUI screen, feedback is often in the form of a message box with an **OK** button on it.

Web messages have a variety of formats. One method is to return a new page with the message on the side of the field containing the error. The new Web page may have a link for additional help. This method works for all Web sites, and the error detection and formatting of the new page are controlled by the server. Another method uses JavaScript to detect the error and display a message box on the current screen with details about the specific error. An advantage of this method is that the Web page does not have to be sent to the server, and the page is more responsive. Disadvantages are that, if JavaScript is turned off, the error will not be detected, and only

**FIGURE 14.16**

Feedback informs the user that input was not in the correct form and lists options.

The screenshot shows a web-based subscription form titled "SOA Online Newsletter Subscription List". The form consists of several input fields and a message box. At the top, there are three text input fields: "First Initial" with value "M", "Middle Initial" with value "C", and "Last Name" with value "HURST". Below these are two rows of two input fields each: "Number" with value "3349" and "Street" with value "SOUTH STREET", followed by "Apartment" (empty). The next row contains "City" with value "LINCOLN" and "State" with value "NE", followed by "Zip Code" with value "68506". At the bottom of the form are two more input fields: "Subscription Length in Weeks" with value "14" and "Method of Payment" with value "CHK". A red-bordered box contains a message: "The subscription length you entered is not currently being offered. Please choose either 13, 26, or 52 weeks."

one error is displayed at a time. There must also be a way of detecting the error on the server. A second disadvantage is that JavaScript may not detect errors that involve reading database tables, such as verifying a credit card number. This may be offset by using Ajax, which can send the number to the server and return an error to the Web page. Remember, however, that some users intentionally turn off their JavaScript capability; so analysts need to follow a variety of tactics when communicating errors.

Web pages may also use JavaScript to detect multiple errors and display text messages on the page. Caution must be used so that the error messages are bold enough for the user to notice. A small red line of text may go unnoticed. A message box or audible beeps may be used to alert the users that one or more errors have occurred.

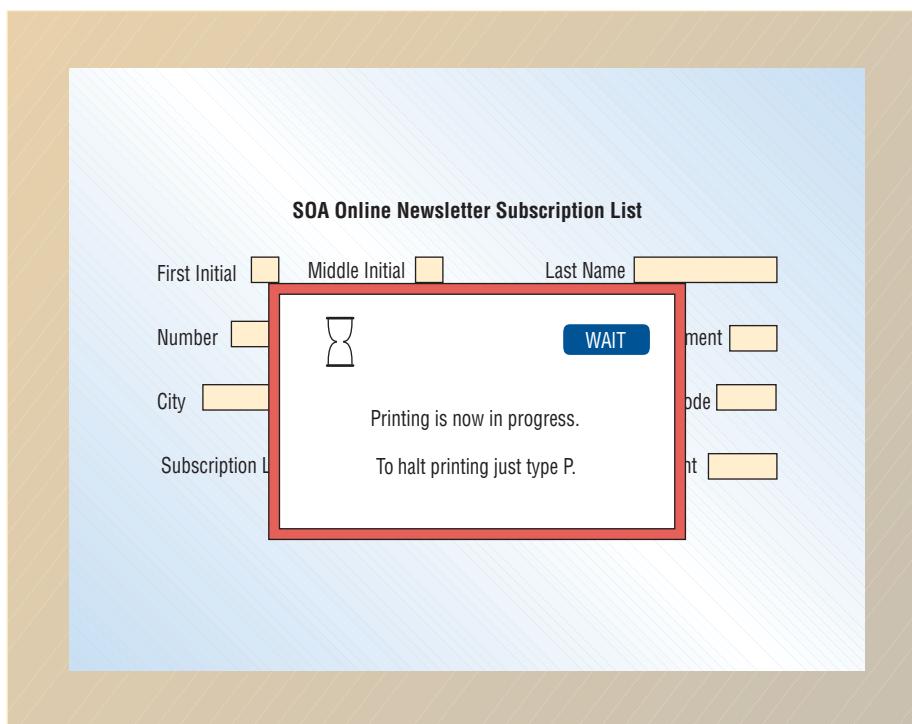
The analyst must decide whether to detect and report errors when a Submit button or link is clicked, called batch validation, or detect errors one at a time, such as when a user enters a month of 14 and leaves the field. The second method is a riskier approach since poor coding may put the browser into a loop, and the user will have to shut down the browser.

So far, we have discussed visual feedback in text or iconic form, but many systems have audio feedback capabilities as well. When a user inputs data in the incorrect form, the system might beep instead of providing a window. But audio feedback alone is not descriptive, so it is not as helpful to users as onscreen instructions. Use audio feedback sparingly, perhaps to denote urgent situations. The same advice also applies to the design of Web sites, which may be viewed in an open office, where sounds carry and a coworker's desktop speakers are within earshot of several other people.

**EXPLAINING A DELAY IN PROCESSING.** One of the most important kinds of feedback informs the user that there will be a delay in processing his or her request. Delays longer than 10 seconds or so require feedback so that the user knows the system is still working.

Figure 14.17 shows a display providing feedback in a window for a user who has just requested a printout of the electronic newsletter's subscription list. The display shows a sentence reassuring the user that the request is being processed, as well as a sign in the upper right corner instructing the user to "WAIT" until the current command has been executed. The display also provides a way to stop the operation if necessary.

Sometimes during delays, while new software is being installed, a short tutorial on the new application is run, which is meant to serve as a distraction rather than feedback about the installation. Often, a list of files that are being copied and a status bar are used to reassure the user that



**FIGURE 14.17**

Feedback tells the user that there will be a delay during printing.

the system is functioning properly. Web browsers usually display the Web pages that are being loaded and the time remaining.

It is critical to include feedback when using Ajax to update Web forms. Because a new Web page does not load, the user may not be aware that data are being retrieved from the server that will change the current Web page. When a drop-down list is changing, a message, such as “Please wait while the list is being populated,” informs the user that the Web page is changing.

Timing feedback of this sort is critical. Too slow a system response could cause the user to input commands that impede or disrupt processing.

**ACKNOWLEDGING THAT A REQUEST IS COMPLETED.** Users need to know when their request has been completed and new requests may be input. Often a specific feedback message is displayed when an action has been completed by a user, such as “Employee record has been added,” “Customer record has been changed,” or “Item number 12345 has been deleted.”

**NOTIFYING THAT A REQUEST WAS NOT COMPLETED.** Feedback is also needed to let the user know that the computer is unable to complete a request. If the display reads “Unable to process request. Check request again,” the user can then go back and check to see if the request has been input correctly rather than continue to enter commands that cannot be executed.

**OFFERING THE USER MORE DETAILED FEEDBACK.** Users need to be reassured that more detailed feedback is available, and they should be shown how they can get it. Commands such as Assist, Instruct, Explain, and More may be employed. Or the user may type a question mark or click on an appropriate icon to get more feedback. Using the command Help as a way to obtain further information has been questioned, because users may feel helpless or caught in a trap from which they must escape. This convention is in use, and its familiarity to users may overcome this concern.

When designing Web interfaces, hyperlinks can be embedded to allow the user to jump to the relevant help screens or to view more information. Hyperlinks are typically highlighted with underlining, italics, or a different color. Hyperlinks can be graphics, text, or icons.

## Including Feedback in Design

If used correctly, feedback can be a powerful reinforcer of users’ learning processes, serve to improve user performance with the system, increase motivation to produce, and improve the fit among the user, the task, and the technology.

**A VARIETY OF HELP OPTIONS.** Feedback on personal computers has developed over the years. “Help” originally started as a response to the user who pressed a function key, such as F1; the GUI alternative is the pull-down help menu. This approach was cumbersome, because end users had to navigate through a table of contents or search via an index. Next came context-sensitive help. Users could simply click on the right mouse button, and topics or explanations about the current screen or area of the screen would be revealed. A third type of help on personal computers occurs when the user places the arrow over an icon and leaves it there for a couple of seconds. At this point, some programs pop up a balloon similar to those found in comic strips. This balloon explains a little bit about the icon function.

The fourth type of help is a wizard, which asks the user a series of questions and then takes action accordingly. Wizards help users through complicated or unfamiliar processes such as setting up network connections or booking an airline seat online. Most users are familiar with wizards through creating a PowerPoint presentation or choosing a style for a word processing memo.

Besides building help into an application, software manufacturers offer online help (either automated or personalized with live chat) or help lines (most customer service telephone lines are not toll free, however). Some COTS software manufacturers offer a fax-back system. A user can request a catalog of various help documents to be sent by fax, and then can order from the catalog by entering the item number with a touch-tone phone.

Finally, users can seek and find support from other users through software forums. This type of support is, of course, unofficial, and the information thus obtained may be true, partially true, or misleading. The principles regarding the use of software forums are the same for those mentioned later on in Chapter 16, where folklore and recommendation systems are discussed. Approach any software fixes posted on bulletin boards, blogs, discussion groups, or chat rooms with wariness and skepticism.

Besides informal help on software, vendor Web sites are extremely useful for updating drivers, viewers, and the software itself. Most online computer publications have some sort of “driver watch” or “bug report” that monitors the bulletin boards and Web sites for useful programs that can be downloaded. Programs will forage vendor Web sites for the latest updates, inform the user of them, assist with downloads, and actually upgrade user applications.

## SPECIAL DESIGN CONSIDERATIONS FOR ECOMMERCE

Many of the user interface design principles you have learned concerning feedback also extend to designing ecommerce Web sites. A few extra considerations shown in this section can give your Web interface designs improved functionality.

### Soliciting Feedback from Ecommerce Web Site Customers

Not only do you need to give users feedback about what is happening with an order, but you need to elicit feedback as well. Most ecommerce Web sites have a **Feedback** button. There are two standard ways to design what users will experience when they click on the **Feedback** button.

The first way is to launch the user’s email program with the email address of the company’s contact automatically entered into the **To:** field. This method prevents typing errors and facilitates ease in contacting the organization. The user does not need to leave the site to communicate with it. These messages, however, raise expectations that they will be answered just as regular mail or phone calls are. Research indicates that 60 percent of organizations with this type of email contact feature on their sites do not have anyone assigned to reply to the email messages received. Thus, the business is losing valuable feedback, allowing customers to harbor the impression that they are communicating, and engendering ill will when no response is received. If you design this type of feedback opportunity, you also need to design procedures for the organization to reply to email from the Web site. Some designers handle this problem by creating systems to automatically return an email reply, which generates a unique case or incident number, provides further instructions on how to proceed (hyperlinks to FAQ pages perhaps), or offers phone numbers to help lines that are unavailable to the general public.

The second type of design for garnering feedback from customers using an ecommerce Web site is to take users to a blank message template when they click on **Feedback**. Some Web creation tools permit you to create and insert a feedback form into your site easily. This form might begin with a header that states “Company X Feedback” and then “You can use the form below to send suggestions, comments, and questions about the X site to our Customer Service team.”

Fields can include First Name, Last Name, Email Address, Regarding (a subject field that supplies a drop-down menu of the company’s product or service selections, asking the user to “Please make a selection”), an “Enter Your Message Here.” section (a free-form space where users can type in their message), and the standard **Submit** and **Clear** buttons at the bottom of the form. Using this type of form permits the analyst to have the user data already formatted correctly for storage in a database. Consequently, it makes the data entered into a feedback form easier to analyze in the aggregate.

Thus, the analyst does more than just design a response to individual email. The analyst helps the organization capture, store, process, and analyze valuable customer information in a manner that makes it more likely that the company will be capable of spotting important trends in customer response, rather than simply reacting to individual queries.

### Easy Navigation for Ecommerce Web Sites

Many authors speak of what is known as “intuitive navigation” for ecommerce Web sites. Users need to know how to navigate the site without having to learn a new interface and without having to explore every inch of the Web site before they can find what they want. The standard for this type of navigational approach is called one-click navigation.

There are four ways to design easy, one-click navigation for an ecommerce site: (1) creating a rollover menu, (2) building a collection of hierarchical links so that the home page becomes an outline of the key topic headings associated with the Web site, (3) placing a site map on the home page and emphasizing the link to it (this would also be placed on every other page on the site), and (4) placing a navigational bar on every inside page (usually at the top or on the left side of the page) that repeats the categories used on the entry screen.



## CONSULTING OPPORTUNITY 14.6

### When You Run a Marathon, It Helps to Know Where You're Going

**M**arathon Vitamin Shops was successful in getting its Web site up and running. The Web developers put the company's entire catalog online and included a choice of skins (or personas as they are called in the Firefox browser) so that each type of customer would enjoy using the Web site. (See Consulting Opportunities 1.1 and 12.3 for more details.)

The analysts are meeting with owner Bill Berry and some employees to evaluate customer feedback as well as give their own reactions to the new Web site. They are meeting in a large conference room, where they have a computer with Internet access and a projector. As they sit down at the table, the entry screen for the Web site is projected at the front of the room. "The Web site has attracted lots of attention, but we want to give the customers even more so that they keep coming back," says Bill, gesturing to the screen.

He continues, "It's not like we're closing our retail stores or anything. In fact, it's just the opposite. When customers notice we're on the Web, they're eager to locate the store in their community. They want to be able to walk into a store and talk to a trained expert rather than buying everything over the Internet. We need to tell people how to get there."

"We think we can improve the site by adding special enhancements and features," says Al Falfa, a member of the systems team who originally developed and implemented the ecommerce Web site.

"Yes," says Ginger Rute, one of the other members of the systems development team, as she nods in agreement. "The university uses a mapping facility from MapQuest, and Home Depot uses maps from Microsoft."

Vita Ming, another member of the original systems development team, speaks up enthusiastically, saying, "We know of a couple good message board services and chat rooms we can build into our Web site. We think they can improve the stickiness of the site, making people stay on the site longer and also making them want to return."

"That's a great idea," says Jin Singh, one of the technologically savvy Marathon employees. "We can let customers talk with

one another, tell each other about a product they liked, and so on. We could even let them start their own blogs."

Vita continues by moving to the computer keyboard and saying, "Let me show you some good sites." As she types in the first URL, the group sees the site projected. "They use chat systems from ichat and Multicity.com," she continues.

"Customers also need to search for more information about a product or manufacturer," Al adds. "Let's make it easier for them. Let's look at [www.cincinnati.com](http://www.cincinnati.com) for an example. They use Google to search for information."

After listening intently, Bill speaks up. "Medical information could also be useful" he says. "I've noticed that [www.medpool.com](http://www.medpool.com) has medical news from acquiremedia. I've seen people on the treadmills at my health and fitness center watching the financial channels while they exercise."

"While we're at it, why don't we add news and financial information to the Web site?" Ginger asks. "I notice that a company called [Moreover.com](http://Moreover.com) appears often as a provider."

Think about the conversation between the systems development team and the people from Marathon Vitamin shops. Some of the enhancement suggestions involved taking advantage of free services; others required payments ranging from \$1,000 to \$5,000 annually. Although some were good ideas, others may not be practical or feasible. Perhaps some of the ideas just do not make sense for the company.

For each of the following, review what you know about the mission and business activities of Marathon Vitamin Shops. Then make a recommendation regarding each option the analysts and clients have made and defend it:

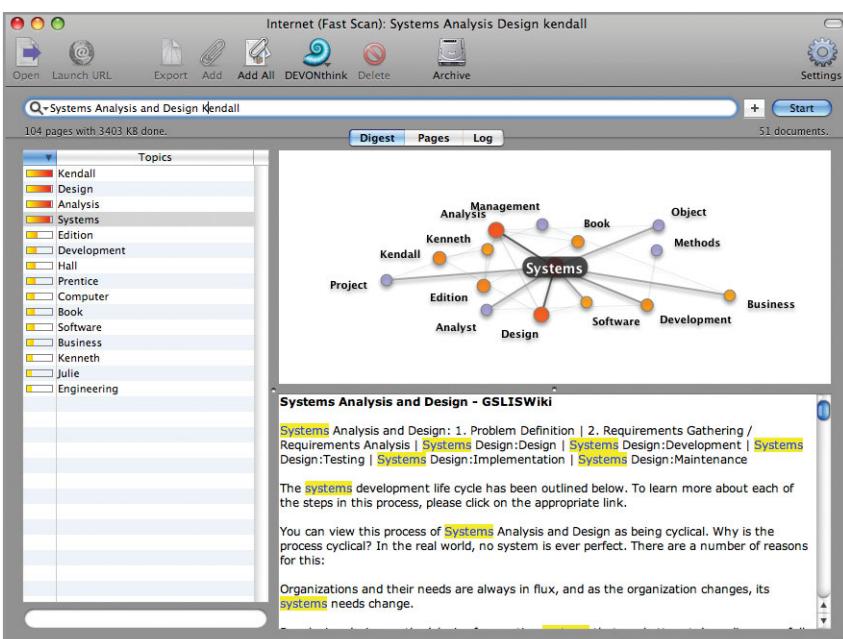
- Mashups using Google Maps.
- Chat rooms and message boards.
- Blogs.
- Search engines.
- Medical information.
- News feeds and financial markets information.

**ROLLOVER MENUS.** A rollover menu (or rollover button) can be created with cascading styles with JavaScript and HTML divisions. The rollover menu appears when the customer using the Web site moves the cursor over a link.

**HIERARCHICAL LINKS.** Creating an outline of the content of the site through the presentation of a table of contents on the home page is another way to speed navigation of the site. This design, however, imposes severe constraints on the designer's creativity, and sometimes simply presenting a list of topics does not adequately convey the strategic mission of the organization to the user.

**SITE MAP.** Designing and then prominently displaying the link to a site map is a third way to improve navigational efficiency. Remember to include the link to the site map on the home page and on every other page as well.

## MAC APPEAL



Megasearch engines that obtain results from multiple search engines, aggregate the results, and display them in a more useful way than any single search engine can have been available for a long time. There is a unique application on the Mac platform that goes one step further.

That application is DEVONagent, software that uses both general and specialized search engines to get results, then gives the user the option to view the results in a graphical topic map. Another option is to view the results in a relevance-ranked list.

Analysts will find DEVONagent to be useful if they understand and make use of the graphical topic map. It is also useful if complex searches are required (i.e., if standard searches do not dig deep enough to find the exact information needed). It is also useful for searches that need to be repeated often.

**FIGURE 14.MAC**  
DEVONagent from DEVONtechnologies.

**NAVIGATION BAR.** Finally, you can design navigation bars that are consistently displayed on the home page as well as at the top and on the left of all other pages that comprise the site. Once you have established (during the information requirements phase) the most useful and most used categories (usually categories such as “Our Company,” “Our Products,” “Buy Now,” “Contact Us,” “Site Map,” and “Search”), remember to include them on all pages.

**OTHER NAVIGATION OPTIONS.** Including a search function is another option. Include adding a search engine such as Google to your site. Simple search functions work well for small, manageable sites, but as a site grows large, advanced search functions that include Boolean logic (discussed later in this chapter) are needed.

Creating flexibility in the way users navigate the Web is also important. An expert Web site designer would try to incorporate many different ways to look up information on a particular subject. Figure 14.18 shows a Web page from DinoTech. For example, a user interested in an international IT career can find out information from the DinoTech Web site in three different ways.

**FIGURE 14.18**

An example of a Web page that allows users to navigate to the desired page in different ways.



If they are interested in working in Argentina, they can click on the Argentine flag, click on the name of the country, or click on the map representing Argentina.

Designing a Web site with navigation for users with different cognitive processing or interests is desirable. It is even possible that the same user may use all three of these methods at different times. All of these add to the usability of a Web site.

The main priority in navigation is, however, that, whatever you do, you must make it extremely easy for users to return to a previous page and make it somewhat easy to return to the place where they entered the client's site. Your main concern is keeping customers on the Web site. The longer customers are on the site, the greater the chance is that they will purchase something. So make sure that, if users navigate to a link in your client's Web site, they can easily find their way back. Doing these things will ensure the stickiness of the Web site. Do not create any barriers to the customer who wants to return to the client's Web site.

## MASHUPS

An application programming interface (API) is a set of small programs and protocols used like building blocks for building software applications. When two or more APIs are used together they form a mashup. Many mashups are open source, so developers can use an API from a site like Google Maps and combine it with an API that contains other data, resulting in a new Web site that creates an entirely new application.

Bogozo Real Estate, for example, combines Craigslist real estate data with Google Maps. This new application allows a user to see properties displayed on a map, view the location of neighborhood schools, and in the specific case of New York City, see an overlay of a New York City subway map to help buyers find a place convenient to the subway system.

A large corporation that has many retail outlets in a region may want to make it easier for customers to find their retail stores. They may want to hire a company like Blipstar, which provides a service that allows companies to upload information about retail stores. Blipstar geocodes them and places them on a Google map. The company then puts a link to this information on its own Web site, so customers can simply enter their zip or postal code and let the mashup display the location of the nearest retail store.

Mashups are becoming a new way to present information. Expect to see many useful mashup applications soon. Look for them at [www.programmableweb.com](http://www.programmableweb.com).

## DESIGNING QUERIES

When users ask questions of or communicate with the database, they are said to query it. Six different types of queries are among the most common. Your careful attention to query design can

EARNINGS-HISTORY		EMPLOYEE NAME	DEPARTMENT	S/H	YEAR-2006	YEAR-2007	YEAR-2008	YEAR-2009
72845	Waters	Outside Sales	S	48,960	51,400	49,050	52,900	
72888	Dryne	Outside Sales	S	42,200	44,700	48,020	50,580	
73712	Fawcett	Distribution	H	43,500	45,500	46,780	47,100	
80345	Well, Jr.	Marketing	S	65,000	71,000	75,000	78,000	
84672	Piper	Maintenance	H	40,560	42,340	43,520	44,910	
'60	Acquia	Accounting	H	38,755	40,040	41,380	42,540	

**FIGURE 14.19**

It is possible to perform six basic types of queries on a table that contains entities, attributes, and values.

help reduce users' time spent in querying the database, help them find the data they want, and result in a smoother user experience overall.

## Query Types

The questions we pose concerning data from our database are referred to as queries. There are six basic query types. Each query involves three items: an entity, an attribute, and a value. In each case, two of these are given, and the intent of the query is to find the remaining item. Figure 14.19 will be used to illustrate all the query examples.

**QUERY TYPE 1.** The entity and one of the entity's attributes are given. The purpose of the query is to find the value. The query can be expressed as follows:

What is the value of a specified attribute for a particular entity?

Sometimes it is more convenient to use notation to formulate the query. This query can be written as

$$V \leftarrow (E, A)$$

where  $V$  stands for the value,  $E$  for entity, and  $A$  for attribute, and the variables in parentheses are given.

The question

What did employee number 73712 make in year 2009?

can be stated more specifically as

What is the value of the attribute YEAR-2009 for the entity EMPLOYEE NUMBER 73712?

The record containing employee number 73712 will be found, and the answer to the query will be \$47,100.

**QUERY TYPE 2.** The intent of the second query type is to find an entity or entities when an attribute and value are given. Query type 2 can be stated as follows:

What entity has a specified value for a particular attribute?

Because values can also be numeric, it is possible to search for a value equal to, greater than, less than, not equal to, greater than or equal to, and so on. An example of this type of query is as follows:

What employee(s) earned more than \$50,000 in 2009?

The notation for query type 2 is

$$E \leftarrow (V, A)$$

In this case, three employees made more than \$50,000, so the response will be a listing of the employee numbers for the three employees: 72845, 72888, and 80345.

**QUERY TYPE 3.** The purpose of this query type is to determine which attributes fit the description provided when the entity and value are given. Query type 3 can be stated as follows:

What attribute(s) has a specified value for a particular entity?

This query is useful when many similar attributes have the same property. The following example has similar attributes (specific years) that contain the annual salaries for the employees of the company:

What years did employee number 72845 make over \$50,000?

or, more precisely,

What attributes {YEAR-2006, YEAR-2007, YEAR-2008, YEAR-2009} have a value [gt] 50,000 for the entity EMPLOYEE-NUMBER = 72845?

where the optional list in braces ({} ) is the set of eligible attributes.

The notation for query type 3 is

$$A \leftarrow (V, E)$$

In this example, Waters (employee number 72845) made over \$50,000 for two years. Therefore, the response will be year 2007 and year 2009. Query type 3 is rarer than the preceding two types due to the requirement of having similar attributes exhibiting the same properties.

**QUERY TYPE 4.** Query type 4 is similar to query type 1. The difference is that the values of all attributes are desired. Query 4 can be expressed as follows:

List all the values for all the attributes for a particular entity.

An example of query type 4 is:

List all the details in the earnings history file for employee number 72888.

The notation for query type 4 is

$$\text{all } V \leftarrow (E, \text{all } A)$$

The response for this query will be the entire record for the employee named Dryne (employee number 72888).

**QUERY TYPE 5.** The fifth type of query is another global query, but it is similar in form to query type 2. Query type 5 can be stated as follows:

List all entities that have a specified value for all attributes.

An example of query type 5 is:

List all the employees whose earnings exceeded \$50,000 in any of the years available.

The notation for query type 5 is

$$\text{all } E \leftarrow (V, \text{all } A)$$

The response to this query will be 72845, 72888, and 80345.

**QUERY TYPE 6.** The sixth query type is similar to query type 3. The difference is that query type 6 requests a listing of the attributes for all entities rather than a particular entity. Query type 6 can be stated as follows:

List all the attributes that have a specified value for all entities.

The following is an example of query type 6:

List all the years for which earnings exceeded \$40,000 for all employees in the company.

The notation for query type 6 is

$$\text{all } A \leftarrow (V, \text{all } E)$$

The response will be YEAR-2007, YEAR-2008, and YEAR-2009. As with query type 3, query type 6 is not used as much as other types.

**BUILDING MORE COMPLEX QUERIES.** The preceding six query types are only building blocks for more complex queries. Expressions, referred to as Boolean expressions, can be formed for queries. An example of a Boolean expression is:

List all the customers who have zip codes greater than or equal to 60001 and less than 70000, and who have ordered more than \$500 from our catalogs or have ordered at least five times in the past year.

One difficulty with this statement is determining which operator (for example, AND) belongs with which condition; it is also difficult to determine the sequence in which the parts of the expression should be carried out. The following may help to clarify this problem:

LIST ALL CUSTOMERS HAVING (ZIP-CODE GE 60001 AND ZIP-CODE LT 70000)  
AND (AMOUNT-ORDERED GT 500 OR TIMES-ORDERED GE 5)

Now some of the confusion is eliminated. The first improvement is that the operators are expressed more clearly as GE, GT, and LT than as English phrases, such as “at least.” Second, the attributes are given distinct names, such as AMOUNT-ORDERED and TIMES-ORDERED. In the earlier sentence, these attributes were both referred to as “have ordered.” Finally, parentheses are used to indicate the order in which the logic is to be performed. Whatever is in parentheses is done first.

Operations are generally performed in a predetermined order of precedence. Arithmetic operations are usually performed first (exponentiation, then either multiplication or division, and then addition or subtraction). Next, comparative operations are performed. These operations are GT (greater than), LT (less than), and others. Finally, the Boolean operations are performed (first AND and then OR). Within the same level, the order generally goes from left to right. The precedence is summarized in Figure 14.20.

## Query Methods

Two popular query methods are query by example and structured query language.

**QUERY BY EXAMPLE.** Query by example (QBE) is a simple but powerful method for implementing queries in database systems, such as Microsoft Access. The database fields are selected and displayed in a grid, and the requested query values are either entered in the field area or below the field. The query should be able to select both rows from the table that match conditions as well as specific columns (fields). Complex conditions may be set to select records, and the user may easily specify the columns to be sorted. Figure 14.21 is an example of a query using Microsoft Access. The query design screen is divided into two portions. The top portion contains the tables selected for the query and their relationships, and the bottom portion contains the query selection grid. Fields from the database tables are dragged to the grid.

The first two rows contain the field and the table in which the field is located. The next row contains sorting information. In this example, the results will be sorted by CUSTOMER NAME. A check mark in the Show box (fourth row down) indicates that the field is to be displayed in the

Type	Level	Symbol
Arithmetic Operators	1	* *
	2	* /
	3	+ -
Comparative Operators	4	GT LT EQ NE GE LE
Boolean Operators	5	AND
	6	OR

**FIGURE 14.20**

Arithmetic, comparative, and Boolean operators are processed in a hierarchical order of precedence unless parentheses are used.



## CONSULTING OPPORTUNITY 14.7

### Hey, Look Me Over (Reprise)

You have been called back to take another look at Merman's Costume Rentals. Here is part of the database created for Annie Oaklea of Merman's (with whom you last worked in Consulting Opportunities 7.1 and 8.1). The database contains information, such as the cost of the rental, the date checked out, the date due back, and the number of days the costume has been rented since the beginning of the year (YTD DAYS OUT) (see Figure 14.C1).

Analyzing Annie's typical day in the costume rental business, you realize there are several requests she must make of the database so that she can make decisions on when to replace frequently used costumes or even when to buy more costumes of a particular type.

She also needs to remember to keep in the good graces of customers she has previously turned down for a particular costume rental, to know when to recall an overdue costume, and so on.

Formulate several queries that will help her get the information she needs from the database. (*Hint:* Make any assumptions necessary about the types of information she needs to make decisions and use as many of the different query types discussed in this chapter as you can.) In a paragraph, describe how Annie's queries would be different if she were working with a Web-based or hyper-linked system.

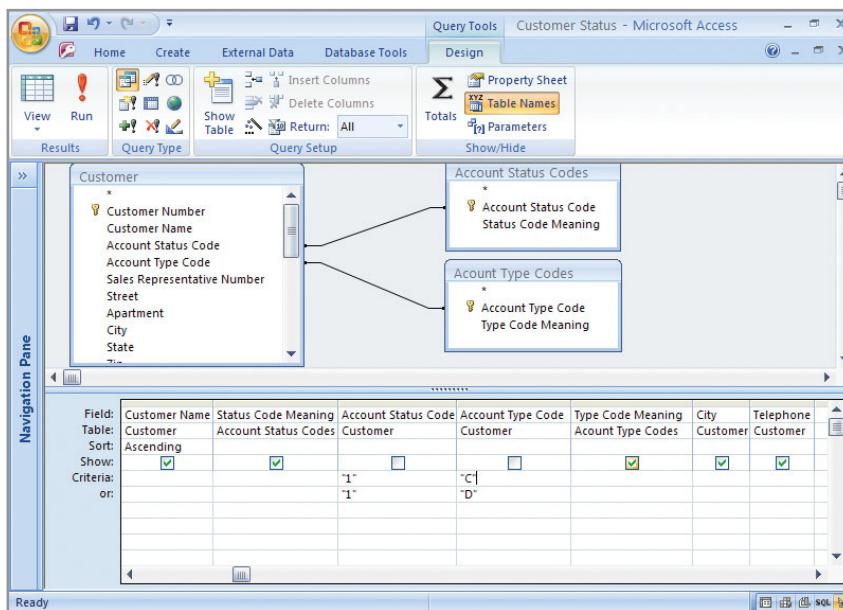
#### COSTUME-RENTAL

COSTUME NUMBER	DESCRIPTION	SUIT NUMBER	COLOR	COST OF	DATE CHECKED OUT	DUE DATE	YTD DAYS OUT	TYPE OF COSTUME	REQUESTS TURNED DOWN
0003	Lady MacBeth F, SM	01	Blue	15.00	10/15	11/30	150	Standard	2
1342	Bear F, MED	01	Dk. Brown	12.50	10/24	11/09	26	Standard	0
1344	Bear F, MED	02	Dk. Brown	12.50	10/24	11/09	115	Standard	0
1347	Bear F, LG	01	Black	12.50	10/24	11/09	22	Standard	0
1348	Bear F, LG	02	Black	12.50	11/01	11/08	10	Standard	0
1400	Goldilocks F, MED	01	Light Blue	7.00	10/24	11/09	140	Standard	0
1402	Goldilocks F, MED	02	Light Blue	7.00	10/28	11/09	10	Standard	0
1852	Hamlet M, MED	01	Dark Green	15.00	11/02	11/23	115	Standard	3
1853	Ophelia F, SM	01	Light Blue	15.00	11/02	11/23	22	Standard	0
4715	Prince M, LG	01	White/purple	10.00	11/04	11/21	145	Standard	5
4730	Frog M, SM	01	Green	7.00	11/04	11/21	175	Standard	2
7822	Jester M, MED	01	Multi	7.50	11/10	12/08	12	Standard	0
7824	Jester M, MED	02	Multi	7.50	11/09	11/15	10	Standard	0
7823	Executioner M, LG	01	Black	7.00	11/19	12/05	21	Standard	0
8645	Mr. Spock N, LG	01	Orange	18.00	09/07	09/12	150	Trendy	4
9000	Pantomime F, LG	01	Red	7.00	08/25	09/15	56	Standard	0
9001	Pantomime M, MED	01	Blue	7.00	08/25	09/15	72	Standard	0
9121	Juggler M, MED	01	Multi	7.00	11/05	11/19	14	Standard	0
9156	Napoleon M, SM	01	Blue/white	15.00	10/26	11/23	56	Standard	1

**FIGURE 14.C1**

A portion of the database from Merman's Costume Rental shop.

results. Notice that the CUSTOMER NUMBER, CUSTOMER NAME, and STATUS CODE MEANING are selected for the resulting display (other fields are displayed as well, but they do not show in the display). Notice that the ACCOUNT STATUS CODE and ACCOUNT TYPE CODE are not checked and therefore will not be in the final results. In the criteria rows, there is a *I* in the ACCOUNT STATUS CODE (indicating an active record) and a *C* and *D* (selecting a General Customer or a Discount Customer) in the ACCOUNT TYPE CODE columns. Two conditions in the same row indicate an AND condition, and two conditions in different rows repre-

**FIGURE 14.21**

Query by example using Microsoft Access.

sent an OR condition. This query specifies that the user should select both an Active Customer and either a General or Discount Customer.

The results of a query are displayed in a table, illustrated in Figure 14.22. Notice that the ACCOUNT STATUS CODE and ACCOUNT TYPE CODE do not display. They are not checked and are included in the query for selection purposes only. Instead, the code meanings are displayed, which are more useful to the user. The customer names are sequenced alphabetically.

**STRUCTURED QUERY LANGUAGE.** Structured query language (SQL) is another popular way to implement queries. It uses a series of words and commands to select the rows and columns that should be displayed in the resulting table. Figure 14.23 contains SQL code. The SELECT DISTINCTROW keyword determines which rows are to be selected. The WHERE keyword specifies the condition that the CUSTOMER NAME should be used to select the data entered in the LIKE parameter.

The screenshot shows the Microsoft Access 'Datasheet View' window. The results of a query for 'CUSTOMER STATUS' are displayed in a table:

Numb	Customer Name	Status Code Meanin	Type Code Meaning	City	Telephone
02122	Carolyn Riter	Active	Discount Customer	Arlington	(715) 222-1234
16403	Gordon Builders	Active	General Customer	Sunnyvista	(415) 458-1364
14672	Industrial Cleaning Supply	Active	General Customer	Central Valley	(805) 263-8060
19592	Masterpiece Manuscripts	Active	General Customer	Camden	(000) 000-0000
17507	Music Unlimited	Active	General Customer	New York	(212) 334-9487
19844	Nathan's House of Pets	Active	Discount Customer	Milwaukee	(312) 238-9963
09288	Ursa Optical	Active	General Customer	Seattle	(206) 351-4999
19712	Wallaby Outfitters	Active	General Customer	Oakland	(415) 336-1114

**FIGURE 14.22**

A query by example for CUSTOMER STATUS yields these results.

**FIGURE 14.23**

Structured Query Language (SQL) for the CUSTOMER NAME parameter query.

```
SELECT DISTINCTROW
Customer.[Customer Number],
Customer.[Customer Name],
Customer.City,
Customer.Telephone
FROM Customer
WHERE (((Customer.[Customer Name])
Like ([Enter a partial Customer Name] & "*")));

```

## SUMMARY

We examined human–computer interaction (HCI), a variety of interfaces, designing the user interface, designing user feedback, and designing ecommerce Web site feedback and navigation. We focused on understanding HCI to ensure the functionality and usability of computer systems we design. When analysts create a proper fit among the HCI elements of the human, the computer, and the task, it leads to improved performance and overall psychological and physical well-being of the individual.

Designs focus on developing a proper fit. Analysts can use the TAM (Technology Acceptance Model) to organize their thinking about whether users will accept technology and eventually use it, by examining perceived usefulness and perceived ease of use from the users' perspective.

Usability identifies what works for users and what does not. Physical considerations of HCI design include vision, hearing, and touch. Physical disabilities and limitations should be taken into consideration during task and interface design. A variety of user interfaces and input devices are possible. Some interfaces are particularly well suited to inexperienced users, whereas others are better suited to experienced users. Combine interfaces such as drop-down menus and graphical interfaces for increased effectiveness. The Web has posed new challenges for designers, because the user is not known.

Users' need for feedback from the system is also an important consideration. Feedback is most often visual, with text, graphics, or icons the most common. Audio feedback can also be effective.

Improve functionality of Web sites by eliciting customer feedback through automatic email feedback buttons or by including blank feedback forms on the Web site. Four important navigation design strategies improve the stickiness of ecommerce Web sites: (1) rollover menus, (2) hierarchical displays of links on the entry screen, (3) site maps, and (4) navigation bars that provide one-click navigation.

Queries are designed to allow users to extract meaningful data from the database. There are six basic types of queries, and they can be combined using Boolean logic to form more complex queries. Query by example and SQL are two common ways to query database systems.

## KEYWORDS AND PHRASES

- |  |                                     |
|--|-------------------------------------|
| application programming interface (API)  | physical considerations of HCI      |
| Boolean operators                        | psychological considerations of HCI |
| cognitive considerations of HCI          | pull-down menu                      |
| command-language interface               | query                               |
| continuous speech system                 | query by example                    |
| dialog box                               | question-and-answer interface       |
| disabilities and design                  | rollover menu                       |
| feedback                                 | site map                            |
| feedback for users                       | speech recognition and synthesis    |
| fit                                      | stickiness                          |
| form-fill (input/output form) interfaces | structured query language (SQL)     |
| graphical user interface (GUI)           | stylus                              |
| intuitive navigation                     | task                                |
| mashup                                   | technology acceptance model (TAM)   |
| menu                                     | template                            |
| natural-language interface               | touch screen                        |
| navigation bar                           | touch-sensitive screen              |
| nested menus                             | usability                           |
| one-click navigation                     | Web-based form-fill interface       |
| performance                              | wizard                              |



## HYPERCASE® EXPERIENCE 14

“I have no problem with using a mouse or any other rodent you throw my way. Really, though, whatever Snowden needs is what I try to do. Everyone is different, however. I’ve seen people here go out of their way to avoid using a computer altogether. Other people would prefer not to talk with a human. In fact, they would be as happy as a puppy chewing on a new bedroom slipper if they could use command language to interact. Most of the folks we have here are open to new things. Otherwise, they wouldn’t be here at MRE. We do pride ourselves on our creativity. I have you signed up for a meeting with people from the training group, including Tom Ketchem, Melissa Smith, and Kathy Blandford. I’ve included Ashley Heatherford who is our usability expert consultant. Melanie Corazón might be there since she wants to see if what you’re doing could be applicable to ecommerce systems. Snowden may sit in as well, if he has time. They’ll be very curious to see what kind of interface you are suggesting for them on the new project reporting system.”

### HYPERCASE Questions

1. Write a short proposal describing what type of user interface would be appropriate for the users of the project reporting

system who are in the training group. Include reasons for your decision.

2. Design a user interface using a CASE tool, such as Visible Analyst, a software package such as Microsoft Access, or paper layout forms for the training group. What are the key features that address the needs of the people in the training group?
3. Write a short proposal describing what type of user interface would be appropriate for the users of the B2B ecommerce systems Melanie Corazón described in her interview. Include reasons for your decision.
4. Design a user interface using a CASE tool, such as Visible Analyst, a software package such as Microsoft Access, or paper layout forms for the users of the B2B ecommerce systems Melanie Corazón described. What are the key features that address the needs of the people who use B2B ecommerce systems on the Web?
5. Make a bulleted list of any usability concerns Ashley might have with the interfaces you designed.



**FIGURE 14.HC1**

In HyperCase, you can see how users process information in order to create a more effective user interface.

## REVIEW QUESTIONS

1. Define HCI.
2. Explain how fit among the HCI elements of the human, the computer, and the tasks to be performed leads to performance and well-being.
3. What are the components of the term *performance* in the HCI context?
4. What is meant by the word *well-being* when used in an HCI approach?
5. What are the two variables of the Technology Acceptance Model (TAM)?
6. List five of the eleven usability heuristics for judging the usability of computer systems and ecommerce Web sites provided by Nielsen and others.
7. Describe some of the ways that a pivot table allows a user to arrange data.
8. List three physical considerations that HCI design addresses.
9. List three ways that analysts can improve task or interface design to help, respectively, a person who is visually impaired, hearing impaired, or mobility impaired.
10. What are the five objectives for designing user interfaces?
11. Define natural-language interfaces. What is their major drawback?
12. Explain what is meant by question-and-answer interfaces. To what kind of users are they best suited?
13. Describe how users use onscreen menus.
14. What is a nested menu? What are its advantages?
15. Define onscreen input/output forms. What is their chief advantage?
16. What are the advantages of Web-based fill-in forms?
17. What are the drawbacks of Web-based form-fill interfaces?
18. Explain what command-language interfaces are. To what types of users are they best suited?
19. Define graphical user interfaces. What is the key difficulty they present for programmers?
20. For what type of user is a GUI particularly effective?
21. What are the three guidelines for designing good screen dialog?
22. What are the roles of icons, graphics, and color in providing feedback?
23. List eight ways for achieving the goal of minimal operator action when designing a user interface.
24. List five standards that can aid in evaluating user interfaces.
25. What are the seven situations that require feedback for users?
26. What is an acceptable way of telling the user that input was accepted?
27. When a user is informed that his or her input is not in the correct form, what additional feedback should be given at the same time?
28. List three ways to notify a Web user that the input is not in the correct form.
29. Why is it unacceptable to notify the user that input is not correct solely through the use of audible beeping or buzzing?
30. When a request is not completed, what feedback should be provided to the user?
31. Describe two types of Web site designs for eliciting feedback from customers.
32. List four practical ways that an analyst can improve the ease of user navigation and the stickiness of an ecommerce Web site.
33. What are hypertext links? Where should they be used?
34. Describe what a mashup is.
35. List in shorthand notation the six basic query types.

## PROBLEMS

1. Manu Narayan owns several first-class hotels worldwide, including properties in Manhattan, Mumbai, and even some in suburbia. He wants to make sure that the human-computer interface is appropriate to each culture but also wants to be able to share the software among all of his hotel reservation departments. Design a nested menus interface for a check-in and checkout hotel reservation system that can be used internationally. Use numbers to select a menu item. Show how each menu would look on a standard PC display.
2. Stefan Lano needs displays that will show the musical instrument inventory in his chain of music stores that caters to musicians playing in world-class symphony orchestras in Basel, Switzerland; Buenos Aires, Argentina; Philadelphia, USA; and New York. Design a form-fill interface for the inventory control of musical instruments in all four stores that could be used on a PC display screen. Assume that English will be the interface language.
3. Design a Web-based form-fill interface to accomplish the same task as in Problem 2.
  - a. What difficulties did you encounter? Discuss them in a paragraph.
  - b. Of the two designs you did, which would you say is better suited to Mr. Lano's task? Why? List three reasons for your choice. How would you test their usability?
4. A U.K.-based travel agent, Euan Morton, LLC, would like your systems team to design a command-language interface he can use to book seats for airlines to which his firm has solid business ties, such as British Air, RyanAir, and Virgin Atlantic.

- a. Show what the interface would look like on a standard display.
- b. Make a list of commands needed to book an airline seat and write down what each command means.
5. An IT executive, Felicia Finley, from Jersey IT Innovators, Inc., has asked that you design a graphical user interface for an executive desktop to help her in her work. Use icons for file cabinets, a wastebasket, a telephone, and so on. Show how they would appear on the computer display.
6. Nick, a celebrity chef/restaurant owner from Williamsburg, New York, wants to be able to receive clear feedback on the systems used to manage his many “show place” restaurants. Design a display that provides appropriate feedback for a user whose command cannot be executed.
7. Design a screen for a payroll software package that displays information telling Nick from Problem 6 how to get more detailed feedback.
8. Design a Web-based display that shows an acceptable way to tell Nick that input to his system was accepted.
9. Design a feedback form for Nick’s restaurant customers using an ecommerce Web site.
10. Write six different queries for the file in Problem 1 in Chapter 13.
11. Write six different queries for the 3NF relation in Problem 5 in Chapter 13.
12. Design a search that will find potential competitors of a company such as World’s Trend on the Web. Assume you are the customer.
13. Search for World’s Trend’s potential competitors on the Web. (You won’t find World’s Trend itself on the Web. It is a fictional company.) Make a list of those you’ve found.

## GROUP PROJECTS

1. With your group members, create a pull-down menu for an employment agency that matches professional candidates to position openings. Include a list of keystrokes that would directly invoke the menu options using the Alt-X format. The menu has the following options:

Add employee	Delete employer
Change employee	Match employee to opening
Delete employee	Print open positions report
Employee inquiry	Print successful matches report
Position inquiry	Add position
Employer inquiry	Change position
Add employer	Delete position
Change employer	

2. In a paragraph, describe the problems your group faced in creating this menu.
3. The drag-and-drop feature is used in GUIs and allows the user to move sentences around in a word processing package. As a group, suggest how drag and drop can be used to its fullest potential in the following applications:

- a. Project management software (Chapter 3).
- b. Relational database program (Chapter 13).
- c. Display or forms designer (Chapter 12).
- d. Spreadsheet program.
- e. CASE tool for drawing data flow diagrams (Chapter 7).
- f. Fax program (Chapter 11).
- g. Personal digital assistant (PDA) calendar (Chapter 3).
- h. Illustration in a drawing package.
- i. CASE tool for developing data dictionaries (Chapter 8).
- j. Decision tree drawing program (Chapter 9).
- k. Web site for collecting consumer opinions on new products (Chapter 11).
- l. Organizing bookmarks for Web sites.

For each solution your group designs, draw the display and show movement by using an arrow.

4. Ask all the members of your group to request a search based on their leisure activities. If there are four people in your group, there will be four unique searches to perform. Now go ahead and do all the searches. Compare your results. Does the person who is involved with the activity have an advantage over the people who know less about it? Explain.
5. Look at the following mashup Web sites and describe how each of them adds value by providing a service.
  - a. Aboutairportparking.com, [www.aboutairportparking.com](http://aboutairportparking.com)
  - b. Baebo, <http://baebo.francisshanahan.com>
  - c. Global Incident Map, [www.globalincidentmap.com/home.php](http://www.globalincidentmap.com/home.php)
  - d. Hawkee Technology Social Network, [www.hawkee.com](http://www.hawkee.com)
  - e. Homethinking, [www.homethinking.com](http://www.homethinking.com)
  - f. Shopping sites at mpire, [www.mpire.com/buyer/search.page](http://www.mpire.com/buyer/search.page)
  - g. Streeteasy, [www.streeteasy.com](http://www.streeteasy.com)

6. The following two mashups have political agendas. Suggest three other mashups that attempt to change something by appealing to the public.

Health Care That Works, [www.healthcarethatworks.org/maps/nyc](http://www.healthcarethatworks.org/maps/nyc)

And also try onNYTurf, [www.onnyturf.com](http://www.onnyturf.com)

7. Try these mashups just for fun.

- a. The Geography of Seinfeld, [www.stolasgeospatial.com/seinfeld.htm](http://www.stolasgeospatial.com/seinfeld.htm)
- b. HBO: The Sopranos [www.hbo.com/sopranos/map](http://www.hbo.com/sopranos/map)
- c. PlotShot, [www.plotshot.com](http://www.plotshot.com)
- d. Flickr Sudoku, <http://flickrssudoku.com>
- e. Liveplasma, [www.liveplasma.com](http://www.liveplasma.com)

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## EPISODE 14

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Up to the Users

“Let’s take our prototypes and some new displays, reports, and forms to create the final user interface,” Anna says to Chip.

“It’s about time, isn’t it?” replies Chip. He was all too aware of the importance of designing a good interface. “I would like to keep all of the factors of the human-computer interface in mind. I think that when we are finished, we should have the users complete a usability survey.”

“Agreed!” exclaims Anna. “Let’s outline and define our guidelines.”

After talking, they set up the following display dialog guidelines:

#### 1. Well-designed displays should:

Communicate actions and intentions clearly to users.

Show options available to operators, either using text or icons. Examples are:

MAKE CORRECTIONS OR PRESS ESC TO CANCEL

ENTER HARDWARE INVENTORY NUMBER

PRESS ENTER KEY

PRESS ENTER TO CONFIRM DELETE, ESC TO CANCEL

Buttons that say OK or Cancel

Standardize use of any abbreviations.

Avoid the use of codes, substituting the code meaning.

Provide help screens for complicated portions of the dialog.

Provide tool-tip help for toolbar icons.

#### 2. Feedback should be provided to the users. Feedback includes:

Titles to show the current page.

Actions successfully completed messages, such as:

RECORD HAS BEEN ADDED

RECORD HAS BEEN CHANGED

Error messages. Examples are:

INVALID DATE

YOU MUST INCLUDE A NUMBER

SOFTWARE IS NOT ON FILE

An invalid data dialog box, with an OK button on a graphical user interface display.

Processing delay messages similar to:

PLEASE WAIT—REPORT IS BEING PRODUCED

An hourglass turning upside down on a graphical user interface.

#### 3. There should be consistency in the design, including:

Location of the brief help in the status line area. Web pages should include instructions and a clearly indicated help option.

Date and time in heading areas.

Consistent exit of all displays, such as through the use of the same action or back button on Web pages.

Standard use of icons or buttons, to display a next or previous page in a multiple-page display.

Consistent method of canceling an operation, such as through the use of the Escape key.

Standardized use of color and high-intensity display, such as all error messages appearing in red.

Standardized use of icons and images on Web pages and displays.

Standardized pull-down menus for Web pages and on other displays.

#### 4. Minimum operator actions should be required to use the system. Some examples are:

When changing or deleting records, only the record key need be specified. The system would obtain the record and display pertinent information.

When names are required as key entries, only the first few letters of the name need be entered. The program would use partial matching or Ajax for Web pages to find all matching record key names and present them for selection by the operator.

All numeric entries may omit leading zeros and commas.

As each data field is completed, the cursor should advance to the next entry field. The user should be able to tab into fields in the correct sequence.

After each option is completed, the same display, with blank entry areas, should be redisplayed until the Exit icon is clicked.

When an option is exited, the previous menu should be displayed.

Drop-down lists should be used whenever possible on Web and GUI displays.

Check boxes and radio buttons should be used to make selections whenever possible.

Default buttons should be outlined so that the user can press the Enter key to select them.

5. Data entering the system should be validated. Guidelines are:

Specific fields should be verified according to edit criteria.

As errors are detected, operators should be given a chance either to correct the error or to cancel the transaction.

When no errors have been detected in a transaction, the entry should be presented to the operator for visual confirmation. The operator should have the opportunity either to accept it or to make corrections to the data entered.

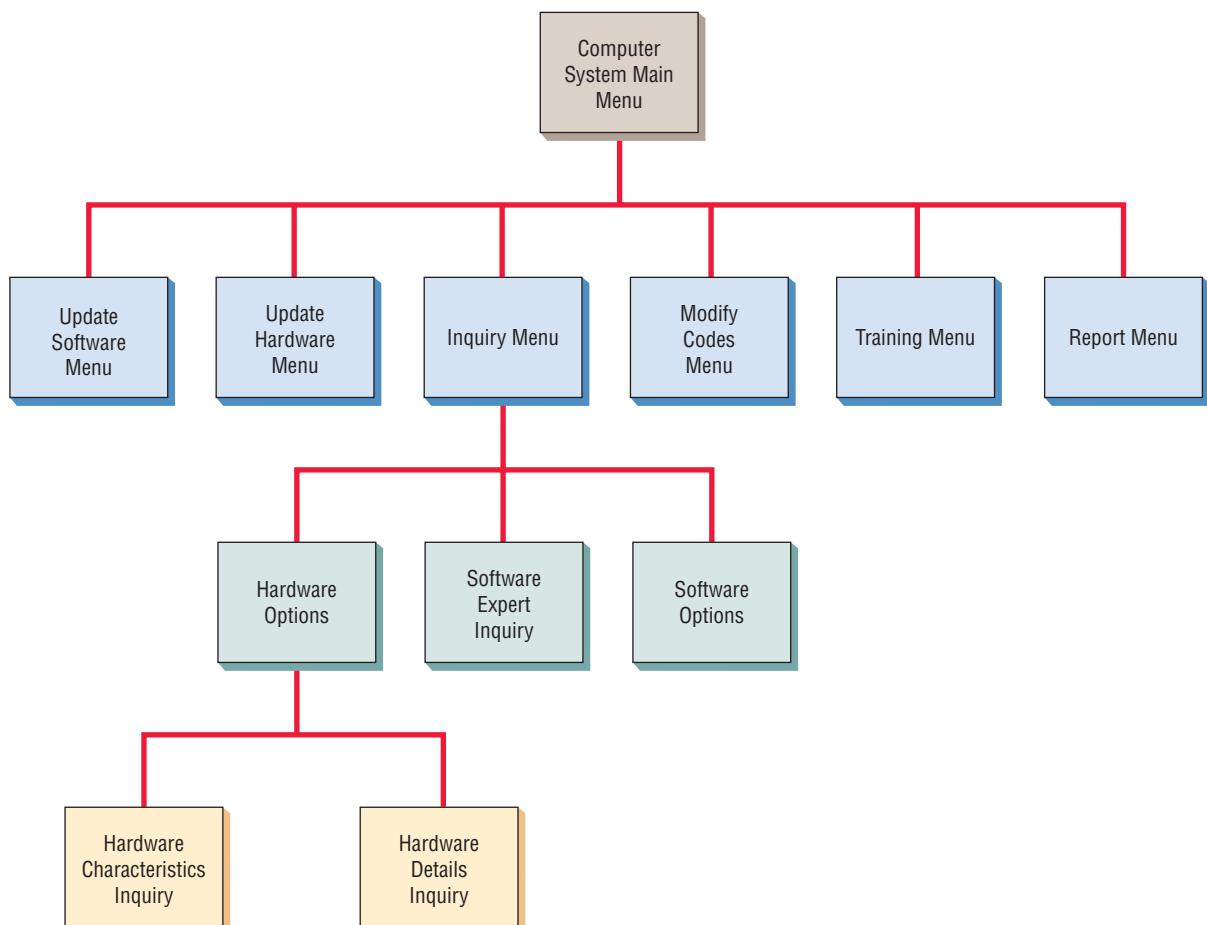
Upon examining the many displays and reports (over 30 in all in Access as well as numerous Web pages), Chip and Anna decide to split the menu into several functions. “How do we divide these various functions into a set of menus?” asked Chip.

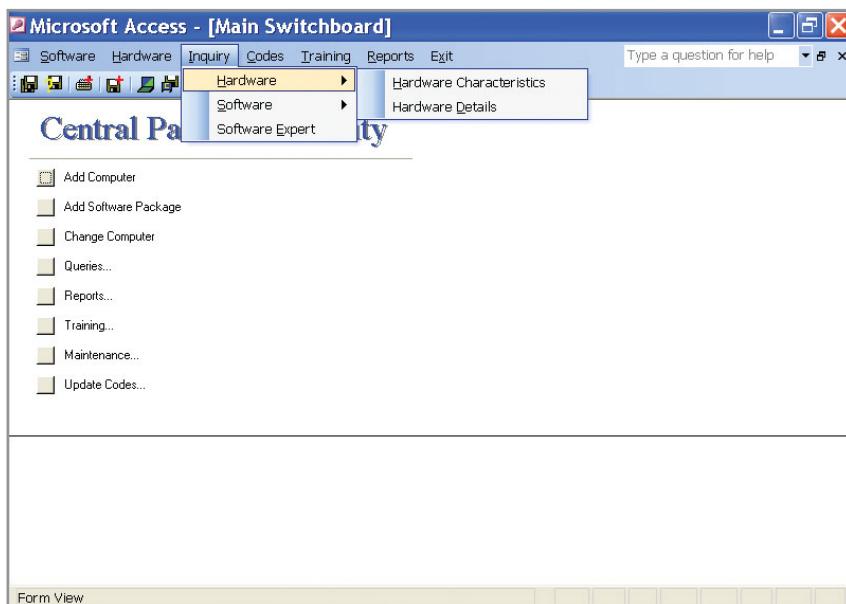
“Why don’t we use a decomposition diagram to organize the functions into a hierarchy?” replied Anna. Chip and Anna begin working on the diagram. The menu interactions will be represented in a hierarchical structure, with options shown as rectangles and the overall menu represented by the rectangle on the top. Each secondary menu will be shown beneath the primary menu, with screen programs at the lowest level. The main menu will have six main choices, as illustrated in Figure E14.1: (1) **Update Software**, (2) **Update Hardware**, (3) **Inquiry**, (4) **Modify Codes**, (5) **Training**, and (6) **Report**. Each of these options is further subdivided into smaller menus or individual functions. The Inquiry Menu is subdivided into two smaller menus, **Software Options** and **Hardware Options**, as well as an option for running the **Software Expert Inquiry**.

The rectangles on the functional decomposition diagram are implemented using a series of pull-down menu lists, which are shown in Figure E14.2. Notice that the Inquiry menu has functions corresponding to

**FIGURE E14.1**

Screen hierarchy for the computer system.



**FIGURE E14.2**

The main menu for the computer system.

the rectangles on the previous figure. A row of buttons for common functions is included below the menus. The menu functions are included as a set of buttons in the main area of the screen, and these buttons may be clicked to run corresponding programs. It was decided that the **Add Computer**, **Add Software Package**, and **Change Computer** programs would be run directly from the main menu. Clicking the other buttons causes selection dialog boxes to display, with choices for selecting programs.

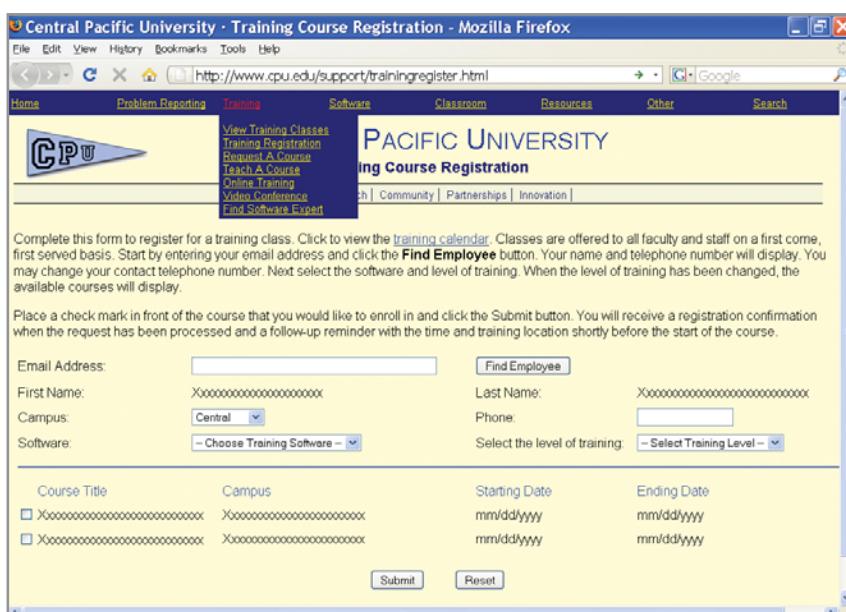
"We are also including drop-down menus for the Web pages," comments Anna. "These use a *z*-index to place them in front of the Web page. They drop down when the mouse hovers them, and they disappear when the mouse moves off of them."

"Sometimes that can be annoying," remarks Chip. "The Web page is constantly flashing menus when the mouse is moved over the page."

"We can put a delay so that the drop-down happens when the mouse hovers for more than a brief second," says Anna thoughtfully.

"These menus should be consistent for the set of Web pages and forms," muses Chip. "We can use the same code and styles on a number of Web pages."

After some thoughtful deliberation, the design of the Web menus is complete. Figure E14.3 illustrates the final menu.

**FIGURE E14.3**

CPU Web menu showing drop-down options displaying in front of the main Web page.

"Here's what I think the guidelines for the update programs should be," Anna tells Chip. "The key focus is on accuracy, with comprehensive editing for each data field. Add programs will display an entry page and allow either hardware or software records to be created. After all entries are complete, a user should double-check the data and click the **Add Software Record** button. Any data that are already in the system should be implemented using drop-down lists. There are also buttons to undo changes, move to different records, print the record, save the changes, and exit the page. A record could be added only if the primary key for the record does not already exist."

"Delete displays must have a simple, primary key entry, such as the COURSE DESCRIPTION in the DELETE SOFTWARE COURSE display." Anna continues. "The DELETE SOFTWARE COURSE display uses a Find button (the binoculars) to help locate the desired record. The corresponding record is read and the information is displayed. Users click the Delete button and are prompted to confirm the delete. If the user clicks the Escape key or Cancel, the delete action is canceled. How does all that sound?" she asks Chip.

"So far, so good," he replies. "Anything about onscreen change displays?"

"Yes. They have a primary key for the record entered and the matching record read. Record information is to be displayed that allows the operator to overtype the data with changes. All changes are to be validated with full editing. When all change fields are valid, the user must click a button to save the changes. Is that clear enough for the user?" Anna asks.

"I think it's very good," Chip acknowledges. "I think we've got a good start on designing our user interfaces."

## EXERCISES



- E-1. Use Microsoft Access to view the menu options for the computer system.



- E-2. Examine the HARDWARE INQUIRY. Explain the inquiry type using the value, entity, and attribute (*V, E, A*) notation.



- E-3. In a paragraph, explain why a data entry display should emphasize accuracy, whereas an inquiry display emphasizes how fast results may be displayed.

- E-4. Modify and print the hierarchy chart representing the **Update Hardware** menu. The file name in Microsoft Visio is Update Hardware. Add rectangles to represent the following menu options:

CHANGE COMPUTER  
DELETE COMPUTER RECORD  
UPDATE INSTALLED COMPUTER



- E-5. Use the Program Structure diagram of Microsoft Visio or the **Functional Decomposition** diagram in Visible Analyst to draw a hierarchy chart representing the options found on the **Update Software** menu. Start with the top rectangle representing the **Update Software** menu.

ADD SOFTWARE PACKAGE  
CHANGE SOFTWARE RECORD  
DELETE SOFTWARE RECORD  
UPGRADE SOFTWARE PACKAGE

- E-6. Chip and Anna realize that the menu that has been designed is for the users involved in the installation and maintenance of computer hardware and software. This menu would not be suitable for general faculty and staff members, because they should not have the ability to update the records. Design a menu, either on paper or using software with which you are familiar, that would provide the general user with the ability to perform inquiries and reports.

- E-7. Discuss in a paragraph why the users would need to move to another page (by pressing the **Next Record** button) to display the correct record for the SOFTWARE LOCATION inquiry.



- E-8. Design the SOFTWARE DETAILS inquiry display. The entry field is SOFTWARE INVENTORY NUMBER, and all software information, with the exception of EXPERT and MACHINES INSTALLED ON, should be displayed. Refer to the Visible Analyst SOFTWARE DETAILS data flow repository entry or the repository Web page.



- E-9. When scheduling classrooms for student use, Cher Ware needs to know all the software packages in a given room. She would like to enter the CAMPUS LOCATION and the ROOM on an inquiry display. The fields would be TITLE, VERSION, SITE LICENSE, and NUMBER OF COPIES.

Design the SOFTWARE BY ROOM inquiry, which is described as a data flow in the repository Web page or the Visible Analyst repository.

**E-10.** Every so often, Hy Perteks receives a request for help concerning a given software package. Staff members and students need to perform advanced options or transfer data to and from different packages, and they are having difficulties. Hy would like to enter the software TITLE and VERSION NUMBER. The resulting display would show the SOFTWARE EXPERT NAME and his or her CAMPUS LOCATION and ROOM NUMBER. Design the screen for the LOCATE SOFTWARE EXPERT inquiry. Describe the logic and files needed to produce the inquiry. Use value, entity, and attribute (V, E, A) notation for this inquiry. The details for this inquiry are included in the Visible Analyst SOFTWARE EXPERT data flow repository entry or the repository Web page.



**E-11.** Hy receives a number of requests for training classes. He would like to plan training and place the upcoming classes on the intranet so that faculty would have an adequate amount of lead time to schedule a class. Design the SOFTWARE TRAINING CLASSES inquiry. The details may be found in the repository Web page or the Visible Analyst data flow repository entry called SOFTWARE TRAINING CLASSES.



The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

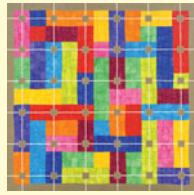
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# Designing Accurate Data Entry Procedures

## LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Understand the uses of effective coding to support users in accomplishing their tasks.
2. Design effective and efficient data capture approaches for people and systems.
3. Recognize how to ensure data quality through validation.
4. Articulate accuracy advantages of user input on ecommerce Web sites.



Making sure that users are able to enter data into the system accurately is of utmost importance. It is by now axiomatic that the quality of data input determines the quality of information output. The systems analyst can support accurate data entry through the achievement of four broad objectives: (1) creating meaningful coding for data, (2) designing efficient data capture approaches, (3) assuring complete and effective data capture, and (4) assuring data quality through validation.

The quality of data is a measurement of how consistently correct the data are within certain preset limits. Effectively coded data facilitate accurate data entry by humans through cutting down on the sheer quantity of data, and thus the time required to enter the information.

When users enter data efficiently, data entry is meeting predetermined performance measures that give the relationship between the time spent on entry and the number of data items entered. Effective coding, effective and efficient data capture and entry, and ensuring data quality through validation procedures are all data entry objectives covered in this chapter.

## EFFECTIVE CODING

One of the ways that data can be entered more accurately and efficiently is through the knowledgeable employment of various codes. The process of putting ambiguous or cumbersome data into short, easily entered digits or letters is called coding (not to be confused with program coding).

Coding aids the systems analyst in reaching the objective of efficiency, because data that are coded require less time for people to enter, and thus reduce the number of items entered. Coding can also help in the appropriate sorting of data at a later point in the data transformation process. In addition, coded data can save valuable memory and storage space. In sum, coding is a way of being eloquent but succinct in capturing data. Besides providing accuracy and efficiency, codes should have a purpose that supports users. Specific types of codes allow us to treat data in a particular manner. Human purposes for coding include the following:

1. Keeping track of something.
2. Classifying information.
3. Concealing information.

**FIGURE 15.1**

Using a simple sequence code to indicate the sequence in which orders enter a custom furniture shop.

Order #	Product	Customer
5676	Rocking Chair/with Leather	Arthur Hook, Jr.
5677	Dining Room Chair/Upholstered	Millie Monice
5678	Love Seat/Upholstered	J. & D. Pare
5679	Child's Rocking Chair/Decals	Lucinda Morely

4. Revealing information.
5. Requesting appropriate action.

Each of these purposes for coding is discussed in the following sections, along with some examples of codes.

### Keeping Track of Something

Sometimes we want merely to identify a person, place, or thing just to keep track of it. For example, a shop that manufactures custom-made upholstered furniture needs to assign a job number to a project. The salesperson needs to know the name and address of the customer, but the job shop manager or the workers who assemble the furniture need not know who the customer is. Consequently, an arbitrary number is assigned to the job. The number can be either random or sequential, as described in the following subsection.

**SIMPLE SEQUENCE CODES.** The simple sequence code is a number that is assigned to something if it needs to be numbered. It therefore has no relation to the data themselves. Figure 15.1 shows how a furniture manufacturer's orders are assigned an order number. With this easy reference number, the company can keep track of the order in process. It is more efficient to enter job "5676" than "that brown and black rocking chair with the leather seat for Arthur Hook, Jr."

Using a sequence code rather than a random number has some advantages. First, it eliminates the possibility of assigning the same number. Second, it gives users an approximation of when the order was received.

Sequence codes should be used when the order of processing requires knowledge of the sequence in which items enter the system or the order in which events unfold. An example is found in the situation of a bank running a special promotion that makes it important to know when a person applied for a special, low-interest home loan, because (all other things being equal) the special mortgage loans will be granted on a first-come, first-served basis. In this case, assigning a correct sequence code to each applicant is important.

**ALPHABETIC DERIVATION CODES.** At times it is undesirable to use sequence codes. The most obvious instance is when you do *not* wish to have someone read the code to figure out how many numbers have been assigned. Another situation in which sequence codes may not be useful is when a more complex code is desirable to avoid a costly mistake. One possible error would be to add a payment to account 223 when you meant to add it to account 224, because you entered an incorrect digit.

The alphabetic derivation code is a commonly used approach in identifying an account number. The example in Figure 15.2 comes from a mailing label for a magazine. The code becomes the account number. The first five digits come from the first five digits of the subscriber's zip code, the next three are the first three consonants in the subscriber's name, the next four numbers are from the street address, and the last three make up the code for the magazine. The main purpose of this code is to identify an account.

**FIGURE 15.2**

Identifying the account of a magazine subscriber with an alphabetic derivation code.

Code	Explanation of Code
68506KND7533TVG	<p>99999XXX9999XXX</p> <p>Abbreviation of magazine</p> <p>Four digits of street address</p> <p>First three consonants in last name</p> <p>First five digits of zip code</p>

A secondary purpose is to print mailing labels. When designing this code, the zip code is the first part of the account number. The subscriber records are usually updated only once a year, but the primary purpose of the records is to print mailing labels once a month or once per week. Having the zip code as the first part of a primary key field means that the records do not have to be sorted by zip code for bulk mailing, because records on a file are stored in primary key sequence. Notice that the expiration date is not part of the account number, because that number can change more frequently than the other data.

One disadvantage of an alphabetic derivation code occurs when the alphabetic portion is small (for example, the name Po) or when the name contains fewer consonants than the code requires. The name Roe has only one consonant and would have to be derived as RXX, or derived using some other scheme. Another disadvantage is that some of the data may change. Changing one's address or name would change the primary key for the file.

### Classifying Information

Classification affords the ability to distinguish among classes of items. Classifications are necessary for many purposes, such as reflecting what parts of a medical insurance plan an employee carries, or showing which student has completed the core requirements of his or her coursework.

To be useful, classes must be mutually exclusive. For example, if a student is in class F, meaning freshman, having completed 0 to 36 credit hours, he or she should not also be classifiable as a sophomore (S). Overlapping classes would be F = 0 – 36 credit hours, S = 32 – 64 credit hours, and so on. Data are unclear and not as readily interpretable when coding classes are not mutually exclusive.

**CLASSIFICATION CODES.** Classification codes are used to distinguish one group of data with special characteristics from another. Classification codes can consist of either a single letter or a number. They are a shorthand way of describing a person, place, thing, or event.

Classification codes are listed in manuals or posted so that users can locate them easily. Many times, users become so familiar with frequently used codes that they memorize them. A user classifies an item and then enters its code directly into an online system.

An example of classification coding is the way you may wish to group tax-deductible items for the purpose of completing your income taxes. Figure 15.3 shows how codes are developed for items such as interest, medical payments, contributions, and so on. The coding system is simple: Take the first letter of each of the categories; contributions are C, interest payments are I, and supplies are S.

All goes well until we get to other categories (such as computer items, insurance payments, and subscriptions) that begin with the same letters we used previously. Figure 15.4 demonstrates what happens in this case. The coding was stretched so that we could use P for “comPuter,” N for “iNsurance,” and B for “suBscriptions.” Obviously, this situation is far from perfect. One way to avoid this type of confusion is to allow for codes longer than one letter, discussed later in this chapter under the subheading of mnemonic codes. Pull-down menus in a GUI system often use classification codes as a shortcut for running menu features, such as **Alt-F** for the **File** menu.

**BLOCK SEQUENCE CODES.** Earlier we discussed sequence codes. The block sequence code is an extension of the sequence code. Figure 15.5 shows how a business user assigns numbers to computer software. Main categories of software are browsers, database packages, and Web design. These were assigned sequential numbers in the following “blocks,” or ranges: browser, 100–199; database, 200–299; and so forth. The advantage of the block sequence code is that the data are grouped according to common characteristics, but still take advantage of the simplicity of assigning the next available number (within the block, of course) to the next item needing identification.

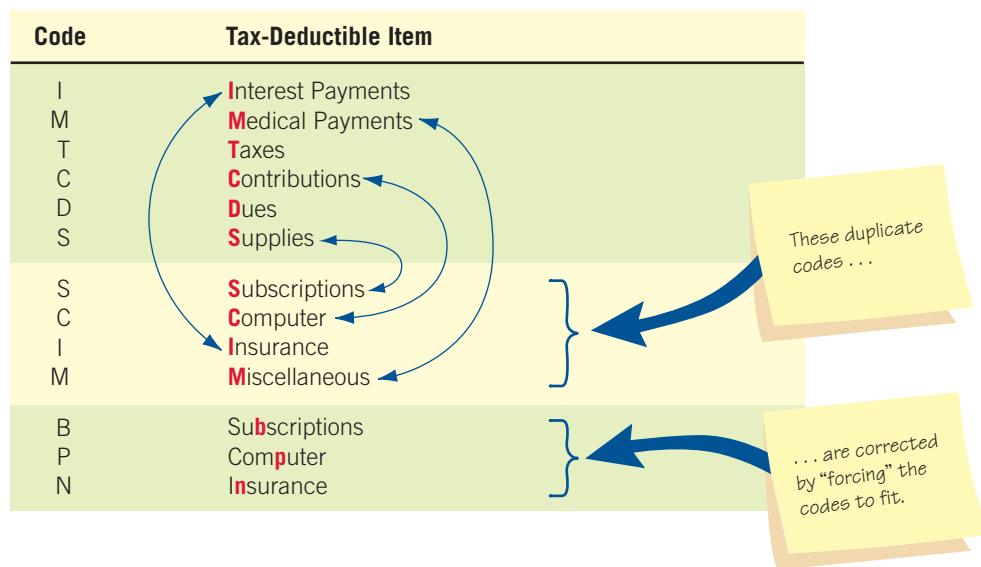
Code	Tax-Deductible Item
I	Interest Payments
M	Medical Payments
T	Taxes
C	Contributions
D	Dues
S	Supplies

**FIGURE 15.3**

Grouping tax-deductible items through the use of a one-letter classification code.

**FIGURE 15.4**

Problems in using a one-letter classification code occur when categories share the same letter.



### Concealing Information

Codes may be used to conceal or disguise information we do not wish others to know. There are many reasons why a business user may want to do that. For example, a corporation may not want information in a personnel file to be accessed by data entry workers. A store may want its salespeople to know the wholesale price to show them how low a price they can negotiate, but they may encode it on price tickets to prevent customers from finding that out. A restaurant may want to capture information about the service without letting the customer know the name of the server. Concealing information and security have become very important in the last few years. Corporations have started to allow vendors and customers to access their databases directly, and handling business transactions over the Internet has made it necessary to develop tight encryption schemes. The following subsection describes an example of concealing information through codes.

**CIPHER CODES.** Perhaps the simplest coding method is the direct substitution of one letter for another, one number for another, or one letter for a number. A popular type of puzzle called a cryptogram is an example of letter substitution. Figure 15.6 is an example of a cipher code taken from a Buffalo, New York, department store that coded all markdown prices with the words BLEACH MIND. No one really remembered why those words were chosen, but all the employees knew them by heart, and so the cipher code was successful. Notice in this figure that an item with a retail price of \$25.00 would have a markdown price of BIMC, or \$18.75 when decoded letter by letter.

### Revealing Information

Sometimes it is desirable to reveal information to specific users through a code. In a clothing store, information about the department, product, color, and size is printed along with the price

**FIGURE 15.5**

Using a block sequence code to group similar software packages.

Code	Name of Software Package	Type
100	Apple Safari	Browser
101	Mozilla Firefox	
102	Microsoft Internet Explorer	
.		
.		
200	Microsoft Access	Database
201	MySQL	
202	Oracle	
.		
.		
300	Adobe Dreamweaver	Web design
301	Freeway Pro	
302	Microsoft Web Expression	

Code	Meaning	Example of Price Ticket	Explanation
B	1	GOLDEN'S 202-395-40	Store Name
L	2	BIMC	Style Code
E	3		Coded Markdown Price
A	4		
C	5		
H	6	Size 12	Size of Garment
M	7		
I	8	\$25.00	Customer Price
N	9		
D	0		

Regular Price of Dress = \$25.00  
 Markdown Ticket Encoded BIMC = **\$18.75**

**FIGURE 15.6**

Encoding markdown prices with a cipher code is a way of concealing price information from customers.

on the ticket for each item. This information helps the salespeople and stock people locate the place for the merchandise.

Another reason for revealing information through codes is to make the data entry more meaningful for humans. A familiar part number, name, or description supports more accurate data entry. The examples of codes in the following subsection explain how these concepts can be realized.

**SIGNIFICANT-DIGIT SUBSET CODES.** When it is possible to describe a product by virtue of its membership in many subgroups, we can use a significant-digit subset code to help describe it. The clothing store price ticket example in Figure 15.7 is an example of an effective significant-digit subset code.

Code	Merchandise Described	Explanation of Code
2023954010	Red maternity dress, style 395, size 10	202 — 395 — 40 — 10 ↑           ↑           ↑           ↑ Department (Maternity)      Product (Dress Style 395)      Color (Red)      Size (Size 10)
4142191912	Beige winter coat, style 219, size 12	414 — 219 — 19 — 12 ↑           ↑           ↑           ↑ Department (Winter Coats)      Product (Coat Style 219)      Color (Beige)      Size (Size 12)

**FIGURE 15.7**

Using a significant-digit subset code helps employees locate items belonging to a particular department.

To the casual observer or customer, the item description appears to be one long number. To one of the salespeople, however, the number is made up of a few smaller numbers, each one having a meaning of its own. The first three digits represent the department, the next three the product, the next two the color, and the last two the size.

Significant-digit subset codes may consist of either information that actually describes the product (for example, the number 10 means size 10), or numbers that are arbitrarily assigned (for instance, 202 is assigned to mean the maternity department). In this case, the advantage of using a significant-digit subset code is that it makes it possible to locate items that belong to a certain group or class. For example, if the store's manager decided to mark down all winter merchandise for an upcoming sale, salespeople could locate all items belonging to departments 310 through 449, the block of codes used to designate "winter" in general.

**MNEMONIC CODES.** A mnemonic (pronounced nî-môn'-îk) is a human memory aid. Any code that helps either the data entry person remember how to enter the data or the user remember how to use the information can be considered a mnemonic. Using a combination of letters and symbols affords a strikingly clear way to code a product so that the code is easily seen and understood.

The city hospital codes formerly used by the Buffalo Regional Blood Center were mnemonic, as shown in Figure 15.8. The simple codes were invented precisely because the blood center administrators and systems analysts wanted to ensure that hospital codes were easy to memorize and recall. Mnemonic codes for the hospitals helped lessen the possibility of blood being shipped to the wrong hospital.

### Unicode

Codes allow us to reveal characters that we normally cannot input or view. Traditional keyboards support character sets that are familiar to people using Western alphabetic characters (referred to as Latin characters), but many languages, such as Greek, Japanese, Chinese, or Hebrew, do not use the Western alphabet. These languages may use Greek letters, or glyphs or symbols representing syllables or whole words. The International Standards Organization (ISO) has defined the Unicode character set, which includes all standard language symbols, and has room for 65,535 characters. You can display Web pages written in other alphabets by downloading an input method editor from Microsoft.

Glyph symbols are represented using an "&#xnnnn;" notation, in which nnnn represents a specific letter or symbol, and x means that hexadecimal notation, or base 16 numbering, is used to represent the Unicode characters. For example, &#30B3 represents the Japanese Katakana symbol *ko*. The code used for the Japanese word for hello, *konichiwa*, is &x3053;&x306B;&x3061;&x308F. In Japanese, the word looks like:

こにちわ  
ko ni chi wa  
hello

The full set of Unicode characters are grouped by language and may be found at [www.unicode.org](http://www.unicode.org).

**FIGURE 15.8**

Mnemonic codes function as memory aids by using a meaningful combination of letters and numbers.

Code	City Hospitals
BGH	Buffalo General Hospital
ROS	Roswell Park Memorial Institute
KEN	Kenmore Mercy
DEA	Deaconess Hospital
SIS	Sisters of Charity
STF	Saint Francis Hospital
STJ	Saint Joseph's Hospital
OLV	Our Lady of Victory Hospital

Code	Function
1	Delivered
2	Sold
3	Spoiled
4	Lost or Stolen
5	Returned
6	Transferred Out
7	Transferred In
8	Journal Entry (Add)
9	Journal Entry (Subtract)

**FIGURE 15.9**

Function codes compactly capture functions that the computer must perform.

## Requesting Appropriate Action

Codes are often needed to instruct either the computer or the decision maker about what action to take. Such codes are generally referred to as function codes, and they typically take the form of either sequence or mnemonic codes.

**FUNCTION CODES.** The functions that the analyst or programmer desires the computer to perform with data are captured in function codes. Spelling out precisely what activities are to be accomplished is translated into a short numeric or alphanumeric code.

Figure 15.9 shows examples of a function code for updating inventory. Suppose you managed a dairy department; if a case of yogurt spoiled, you would use the code 3 to indicate this event. Of course, data required for input vary depending on what function is needed. For example, appending or updating a record would require only the record key and function code, whereas adding a new record would require all data elements to be input, including the function code.

## General Guidelines for Coding

In the previous sections, we examined the purposes for using different types of codes when humans and machines enter and store data. Next, we examine a few heuristics for establishing a coding system. These rules are highlighted in Figure 15.10.

**BE CONCISE.** Codes should be concise. Overly long codes mean more keystrokes and consequently more errors. Long codes also mean that storing the information in a database will require more memory.

Short codes are easier for people to remember and easier to enter than long codes. If codes must be long, they should be broken up into subcodes. For example, 5678923453127 could be broken up with hyphens as follows: 5678-923-453-127. This approach is much more manageable and takes advantage of the way people are known to process information in short chunks. Sometimes codes are made longer than necessary for a reason. Credit card numbers are often long to prevent people from guessing a credit card number. Visa and MasterCard use 16-digit numbers, which would accommodate nine trillion customers. Because the numbers are not assigned sequentially, chances of guessing a credit card number are very slight.

**FIGURE 15.10**

There are eight general guidelines for establishing a coding system.

### In Establishing a Coding System, the Analyst Should:

- Keep codes concise
- Keep codes stable
- Make codes that are unique
- Allow codes to be sortable
- Avoid confusing codes
- Keep codes uniform
- Allow for modification of codes
- Make codes meaningful



## CONSULTING OPPORTUNITY 15.1

### It's a Wilderness in Here

“I can’t stand this. I’ve been looking for this hat for the last 45 minutes,” complains Davey, as he swings a coonskin cap by its tail above his head. He is one of the new warehouse workers for Crockett’s, a large retail catalog and ecommerce firm. “The catalog slip calls it a ‘Coo m5–9w/tl.’ Good thing you told me ‘Coo’ stands for coonskin. Then, of course, I thought about caps and looked over here. I found it here in this bin labeled BOYS/CAP. Wouldn’t it be easier if the catalog and Web pages matched the bins? To me, this invoice says, ‘Cookware, metallic, 5–9-piece set with Teflon.’ I’ve been stranded in the cookware sets the whole time.”

Daniel, Davey’s coworker, barely listens as he hurriedly pulls items out of bins to fill another order. “You’ll get used to it. They’ve got to have it this way so that the computers can understand the bill later. Mostly, I look at the catalog page number on the invoice, then I look it up in the book and sort of translate it to back here . . . unless I remember it from finding it before,” Daniel explains.

Davey persists, saying, “Computers are smart, though, and we have to fill so many orders. We should tell the people up in billing the names we’ve got on our bins.”

Daniel replies cynically, “Oh, sure. They’re dying to know what we think.” Then he continues in a quieter tone. “You know, we used

to have it like that, but when they got all the new computers and went to 24-hour phone and Internet orders, it all changed. They said the operators (and users) had to know more about what they were selling (or buying), so they changed their codes to be more like a story.”

Davey, surprised at Daniel’s revelation, asks, “What’s the story for the one I was working on?”

Inspecting the code on the cap’s invoice, Daniel replies, “The one you were working on was ‘Coo m5–9w/tl.’ After looking it up real fast on the computer the operator can tell the customer, ‘It’s a coonskin (Coo) cap for boys (m for male) ages 5–9 with a real tail (w/tl).’ We can’t see the forest for the trees because of their codes, but you know Crockett’s. They’ve got to make the sale.”

How important is it that the warehouse bins and invoices are coded inconsistently? Respond in a paragraph. What are some of the problems created when a code appears to be mnemonic but employees are never given an appropriate “key” to decode it? Discuss your response in two paragraphs. What changes would you make to invoice/warehouse coding for Crockett’s? Document your changes, identify the type of code you would use, and use the code in an example of a product that Crockett’s might sell. Remember to decipher it as well.

**KEEP THE CODES STABLE.** Stability means that the identification code for a customer should not change each time new data are received. Earlier, we presented an alphabetic derivation code for a magazine subscription list. The expiration date was not part of the subscriber identification code because it was likely to change.

Don’t change the code abbreviations in a mnemonic system. Once you have chosen the code abbreviations, do not try to revise them, because that makes it extremely difficult for data entry personnel to adapt.

**ENSURE THAT CODES ARE UNIQUE.** For codes to work, they must be unique. Make a note of all codes used in the system to ensure that you are not assigning the same code number or name to the same items. Code numbers and names are an essential part of the entries in data dictionaries, discussed in Chapter 8.

**ALLOW CODES TO BE SORTABLE.** If you are going to manipulate the data usefully, the codes must be sortable. For example, if you were to perform a text search on the months of the year in ascending order, the “J” months would be out of order (January, July, and then June). Dictionaries are sorted in this way, one letter at a time from left to right. So, if you sorted MMMDDYYYY where the MMM stood for the abbreviation for the month, DD for the day, and YYYY for the year, the result would be in error.

Figure 15.11 shows what would happen if a text search were performed on different forms of the date. The third column shows a problem that was part of the year 2000 (Y2K) crisis that caused some alarm and even made the cover of *Time* magazine.

One of the lessons learned is to make sure that users can do what you intend them to do with the codes you create. Numeric codes are much easier to sort than alphanumerics; therefore, consider converting to numerics wherever practical.

**AVOID CONFUSING CODES.** Try to avoid using coding characters that look or sound alike. The characters O (the letter oh) and 0 (the number zero) are easily confused, as are the letter I and the

Incorrect Sorting Using MMM-DD-YYYY	Incorrect Sorting Using MM-DD-YYYY	Incorrect Sorting (Year 2000 Problem) YY-MM-DD	Correct Sorting Using YYYY-MM-DD
Dec-25-1998	06-04-1998	00-06-11	1997-06-12
Dec-31-1997	06-11-2000	97-06-12	1997-12-31
Jul-04-1999	06-12-1997	97-12-31	1998-06-04
Jun-04-1998	07-04-1999	98-06-04	1998-10-24
Jun-11-2000	10-24-1998	98-10-24	1998-12-25
Jun-12-1997	12-25-1998	98-12-25	1999-07-04
Oct-24-1998	12-31-1997	99-07-04	2000-06-11

number 1, and the letter Z and the number 2. Therefore, codes such as B1C and 280Z are unsatisfactory.

One example of a potentially confusing code is the Canadian Postal Code, as shown in Figure 15.12. The code format is X9X 9X9, where X stands for a letter and 9 stands for a number. One advantage to using letters in the code is to allow more data in a six-digit code (there are 26 letters, but only 10 numbers). Because the code is used on a regular basis by Canadians, the code makes perfectly good sense to them. To foreigners sending mail to Canada, however, it may be difficult to tell if the second-to-last symbol is a Z or a 2.

**KEEP THE CODES UNIFORM.** To be effective and efficient for humans, codes need to follow readily perceived forms most of the time. Codes used together, such as BUF-234 and KU-3456, are poor because the first contains three letters and three numbers, whereas the second has only two letters followed by four numbers.

When you are required to add dates, try to avoid using the codes MMDDYYYY in one application, YYYYDDMM in a second, and MMDDYY in a third. It is important to keep codes uniform among as well as within programs.

**ALLOW FOR MODIFICATION OF CODES.** Adaptability is a key feature of a good code. The analyst must keep in mind that the system will evolve over time, and the coding system should be able to encompass change. The number of customers should grow, customers will change names, and suppliers will modify the way they number their products. The analyst needs to be able to forecast the predictable changes that business users will desire and anticipate a wide range of future needs when designing codes.

**MAKE CODES MEANINGFUL.** Unless the analyst wants to hide information intentionally, codes should be meaningful. Effective codes not only contain information, but they also make sense to the people using them. Meaningful codes are easy to understand, work with, and recall. The job of data entry becomes more interesting when working with meaningful codes instead of just entering a series of meaningless numbers.

**USING CODES.** Codes are used in a number of ways. In validation programs, input data is checked against a list of codes to ensure that only valid codes have been entered. In report and inquiry programs, a code stored on a file is transformed into the meaning of the code. Reports and displays should not show or print the actual code. If they did, the user would have to memorize code meanings or look them up in a manual. Codes are used in GUI programs to create drop-down lists.

### FIGURE 15.11

Plan ahead in order to be able to do something useful with data that have been entered. In this example, the person creating the codes did not realize the data would have to be sorted.

Code Format for Canadian Postal Code  
X9X 9X9

Handwritten Code	Actual Code	City, Province	Problem
L8S 4M4	L8S 4M4	Hamilton, Ontario	S looks like a 5
T3A ZE5	T3A 2E5	Calgary, Alberta	2 looks like a Z 5 looks like an S
LOS 1JO	LOS 1JO	Niagara-on-the-Lake, Ontario	Zero and Oh look alike S looks like a 5 1 looks like an l

### FIGURE 15.12

Combining look-alike characters in codes can result in errors.



## CONSULTING OPPORTUNITY 15.2

### Catching a Summer Code

Vicky takes her fingers off her keyboard and bends over her workstation to verify the letters on the invoices stacked in front of her. "What on earth?" Vicky asks aloud as she further scrutinizes the letters that encode cities where orders are to be shipped.

Shelly Overseer, her supervisor, who usually sits a couple of workstations away, is passing by and sees Vicky's consternation. "What's the matter? Did the sales rep forget to write in the city code again?"

Vicky swings around in her chair to face Shelly. "No, there are codes here, but they're weird. We usually use a three-letter code, right? Like CIN for Cincinnati, SEA for Seattle, MIN for Minneapolis, BUF for Buffalo. They're all *five*-letter codes here, though."

"Look," Vicky says, lifting the invoice to show Shelly. "CINNC, SEATT, MINNE. It'll take me all day to enter these. No kidding, it's really slowing me down. Maybe there's a mistake. Can't I just use the standard?"

Shelly backs away from Vicky's workstation as if the problem were contagious. Excusing herself apologetically, Shelly says, "It's the part-timers. They are learning sales now, and management was worried that they'd get messed up on their cities. I think it has something to do with mixing up Newark and New Orleans on the last or-

ders. So, a committee decided to make the cities more recognizable by having them add two letters. Those kids can't learn everything we know overnight, even though they try. It's just until August 19, though, when the part-timers go back to school."

As Vicky glumly turns back to her keyboard, Shelly shakes her head sympathetically and says, "I know it's a strain and it's making you feel miserable, but don't worry. You'll get over it. It's just a summer code."

What general guidelines of coding has management overlooked in its decision to use a summer code for cities? Make a list of them. What is the effect on full-time data entry personnel of changing codes for the ease of temporary help? Respond in two paragraphs. What future impact could the temporary change in codes have on sorting and retrieving data entered during the summer period? Take two paragraphs to discuss these implications. What changes can you suggest so that the part-timers don't get mixed up on codes in the short term? In a memo to the supervisor of this work group, make a list of five to seven changes in the data capture or data entry procedures that can be made to accommodate short-term hires without disrupting normal business. In a paragraph, indicate how this goal can be accomplished without marring the productivity of data entry personnel.

## EFFECTIVE AND EFFICIENT DATA CAPTURE

To ensure the quality of data users enter into the system, it is important to capture data effectively. Data capture has received increasingly greater attention as the point in information processing at which excellent productivity gains can be made. Great progress in improving data capture has been made in the last four decades, as we have moved from multiple-step, slow, and error-prone systems such as keypunching to using sophisticated systems including such things as optical character recognition (OCR), bar codes, and point-of-sale terminals.

### Deciding What to Capture

The decision about what to capture precedes user interaction with the system. Indeed, it is vital in making the eventual interface worthwhile, for the adage "garbage in, garbage out" is still true.

Decisions about what data to capture for system input are made among systems analysts and systems users. Much of what will be captured is specific to the particular business. Capturing data, inputting them, storing them, and retrieving them are all costly endeavors. With all these factors in mind, determining what to capture becomes an important decision.

There are two types of data to enter: data that *change* or *vary* with every transaction, and data that concisely *differentiate* the particular item being processed from all other items.

An example of changeable data is the quantity of supplies purchased each time an advertising firm places an order with the office supply wholesaler. Because quantities change depending on the number of employees at the advertising firm and on how many accounts they are servicing, quantity data must be entered each time an order is placed.

An example of differentiation data is the inclusion on a patient record of the patient's Social Security number and the first three letters of his or her last name. In this way, the patient is uniquely differentiated from other patients in the same system.

## Letting the Computer Do the Rest

When considering what data to capture for each transaction and what data to leave to the system to enter, the systems analyst must take advantage of what computers do best. In the preceding example of the advertising agency ordering office supplies, it is not necessary for the operator entering the stationery order to reenter each item description each time an order is received. The computer can store and access this information easily.

Computers can automatically handle repetitive tasks, such as recording the time of the transaction, calculating new values from input, and storing and retrieving data on demand. By employing the best features of computers, efficient data capture design avoids needless data entry, which in turn alleviates much human error and boredom, and permits people to focus on higher-level or creative tasks. Software can be written to ask the user to enter today's date or capture the date from the computer's internal clock. Once entered, the system proceeds to use that date on all transactions processed in that data entry session.

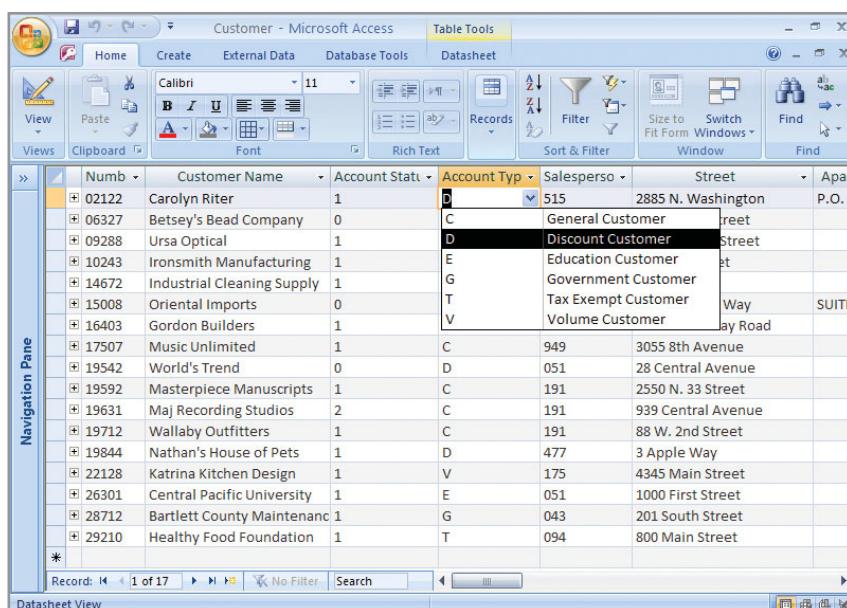
A prime example of reusing data entered once is that of the online computer library center (OCLC) used by thousands of libraries in the United States. OCLC was built on the idea that each item bought by a library should only have to be cataloged once for all time. Once an item is entered, cataloging information goes into the huge OCLC database and is shared with participating libraries. In this case, implementation of the simple concept of entering data only once has saved enormous data entry time.

The calculating power of the computer should also be taken into account when deciding what *not* to reenter. Computers are adept at long calculations, using data already entered.

For example, the person doing data entry may enter the flight numbers and account number of an air trip taken by a customer belonging to a frequent-flyer incentive program. The computer then calculates the number of miles accrued for each flight, adds it to the miles already in the customer's account, and updates the total miles accrued to the account. The computer may also flag an account that, by virtue of the large number of miles flown, is now eligible for an award. Although all this information may appear on the customer's updated account, the only new data entered were the flight numbers of the flights flown.

In systems that use a graphical user interface (GUI), codes are often stored either as a function or as a separate table in the database. There is a trade-off on creating too many tables, because the software must find matching records from each table, which may lead to slow access. If the codes are relatively stable and rarely change, they may be stored as a database function. If the codes change frequently, they are stored on a table so that they may be easily updated.

Figure 15.13 shows how a drop-down list is used to select the codes for adding or changing a record in the CUSTOMER table. Notice that the code is stored, but the drop-down list



The screenshot shows a Microsoft Access Datasheet View window titled "Customer - Microsoft Access". The table has columns: Numb, Customer Name, Account Stat., Account Typ., Salesperso, Street, and Apar. The "Account Typ." column contains a dropdown menu with options: B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V. The option "D" is currently selected. The "Salesperso" column has a dropdown menu with options: 515, 949, 051, 191, 191, 477, 175, 051, 043, 094. The option "515" is currently selected. The "Street" column has a dropdown menu with options: 2885 N. Washington Street, 3055 8th Avenue, 28 Central Avenue, 2550 N. 33 Street, 939 Central Avenue, 88 W. 2nd Street, 3 Apple Way, 4345 Main Street, 1000 First Street, 201 South Street, 800 Main Street. The option "2885 N. Washington Street" is currently selected. The "Apar" column has a dropdown menu with options: P.O. Box, Suite, Way, Bay Road. The option "P.O. Box" is currently selected. The bottom status bar shows "Record: 14 1 of 17 > < No Filter Search".

**FIGURE 15.13**

A table of codes used in a drop-down list. This list is used to select a code for adding or changing an item in a record.

displays both the code and the code meaning. This method helps to ensure accuracy, because the user does not have to guess at the meaning of the code and there is no chance of typing an invalid code.

### Avoiding Bottlenecks and Extra Steps

A bottleneck in data entry is an apt allusion to the physical appearance of a bottle. Data are poured rapidly into the wide mouth of the system only to be slowed in its “neck” because of an artificially created instance of insufficient processing for the volume or detail of the data being entered. One way a bottleneck can be avoided is by ensuring that there is enough capacity to handle the data that are being entered.

Ways to avoid extra steps are determined not only at the time of analysis, but also when users begin to interact with prototypes of the system. The fewer steps involved in inputting data, the fewer chances there are for the introduction of errors. So, beyond the obvious consideration of saved labor, avoiding extra steps is also a way to preserve the quality of data. Once again, use of an online, real-time system that captures customer data without necessitating the completion of a form is an excellent example of saving steps in data entry.

### Starting with a Good Form

Effective data capture is achievable only if prior thought is given to what the source document should contain. The data entry operator inputs data from the source document (usually some kind of form); this document is the source of a large amount of all system data. Online systems (or special data entry methods such as bar codes) may circumvent the need for a source document, but often some kind of paper form, such as a receipt, is created anyway.

With effective forms, it is not necessary to reenter information that the computer has already stored, or data such as time or date of entry that the computer can determine automatically. Chapter 11 discussed in detail how a form or source document should be designed to maximize its usefulness for capturing data and to minimize the time users need to spend entering data from it.

### Choosing a Data Entry Method

Several efficient data entry methods are available, and choosing one of them is shaped by many factors, including the need for speed, accuracy, and user training; the cost of the data entry method (whether it is materials- or labor-intensive); and the methods currently in use in the organization.

**KEYBOARDS.** Keyboarding is the oldest method of data entry, and certainly it is the one with which organizational members are the most familiar. Some improvements have been made over the years to improve keyboards. Features include special function keys to open programs, keys used to scroll and explore the Web, and keys that can be programmed with macros to reduce the number of keystrokes required. Ergonomic keyboards and infrared or Bluetooth-enabled keyboards and mice are big improvements, as well.

**OPTICAL CHARACTER RECOGNITION.** Optical character recognition (OCR) lets a user read input from a source document with an optical scanner rather than off the magnetic media we have been discussing so far. Using OCR devices can speed data input from 60 to 90 percent over some keying methods.

The increased speed of OCR comes through not having to encode or key in data from source documents. It eliminates many of the time-consuming and error-prone steps of other input devices. In doing so, OCR demands few employee skills and commensurately less training, resulting in fewer errors and less time spent by employees in redundant efforts. It also decentralizes responsibility for quality data directly to the unit that is generating it. OCR, which has become available to all, has one additional, highly practical use: the transformation of faxes into documents that can be edited.

**OTHER METHODS OF DATA ENTRY.** Other methods of data entry are also becoming more widely employed. Most of these methods reduce labor costs by requiring few operator skills or little training, they move data entry closer to the source of data, and they eliminate the need for a source document. In doing so, they have become fast and highly reliable data entry methods. The data entry methods discussed in the following subsections include magnetic ink character recognition, mark-sense forms, punch-out forms, bar codes, and data strips.

**Magnetic Ink Character Recognition** Magnetic ink characters are found on the bottom of bank checks and some credit card bills. This method is akin to OCR in that special characters are read, but its use is limited. Data entry through magnetic ink character recognition (MICR) is done through a machine that reads and interprets a single line of material encoded with ink that is made up of magnetic particles.

Some advantages of using MICR are (1) it is a reliable and high-speed method that is not susceptible to accepting stray marks (because they are not encoded magnetically); (2) if it is required on all withdrawal checks, it serves as a security measure against bad checks; and (3) data entry personnel can see the numbers making up the code if it is necessary to verify it.

**Mark-Sense Forms** Mark-sense forms allow data entry through the use of a scanner that senses where marks have been made on special forms. A common usage is for scoring answer sheets for survey questionnaires, as shown in Figure 15.14. Little training of entry personnel is necessary, and a high volume of forms can be processed quickly.

## FIGURE 15.14

A mark-sense form that can be read by a scanner speeds data entry.

One drawback of mark-sense forms is that although the readers can determine whether a mark has been made, they cannot interpret the mark in the way that optical character readers do. Stray marks on forms can thus be entered as incorrect data. In addition, choices are limited to the answers provided on the mark-sense form, forms have difficulty in capturing alphanumeric data because of the space required for a complete set of letters and numbers, and it is easy for those filling out mark-sense forms to get confused and put a mark in an incorrect position.

**Bar Codes** Bar codes typically appear on product labels, but they also appear on patient identification bracelets in hospitals and in almost any context in which a person or object needs to be checked into and out of any kind of inventory system. Bar codes can be thought of as metacodes, or codes encoding codes, because they appear as a series of narrow and wide bands on a label that encodes numbers or letters. These symbols in turn have access to product data stored in computer memory. A beam of light from a scanner or lightpen is drawn across the bands on the label either to confirm or record data about the product being scanned.

A bar-coded label, such as the one shown in Figure 15.15, includes the following elements of coding for a particular grocery product: the manufacturer identification number, the product identification number, a code to verify the scan's accuracy, and codes to mark the beginning and end of the scan.

Bar coding affords an extraordinarily high degree of accuracy for data entry. It saves labor costs for retailers because each item does not have to be individually price-marked. In addition, bar coding allows the automatic capturing of data that can be used for reordering, more accurate inventory tracking, and the forecasting of future needs. Sale prices or other changes in the meaning of the bar codes are entered into the central processor, thus saving the trouble of marking down numerous items.

One new use of bar coding is the tracking of an individual's credit card purchases for the purpose of building a consumer profile that can then in turn be used to refine marketing to that individual or type of consumer. New input devices are constantly being developed.

**RFID** Commonly known as RFID, radio frequency identification allows the automatic collection of data using RFID tags or transponders that contain a chip and an antenna. An RFID tag may or may not have its own power source. If it does not have its own power, the antenna provides just enough power from an incoming signal to power the chip and transmit a response. RFID tags can be attached to products, packages, animals, or even humans so that the item or person can be identified using a radio frequency.

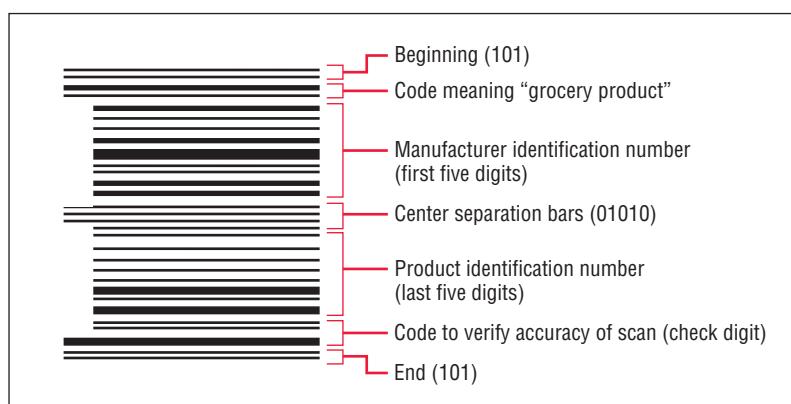
RFID tags, also called proximity cards because of their limited range, can be passive or active. Passive RFID tags have no internal power source; active tags do. Passive tags are inexpensive (less than 5¢ per tag) and are typically the size of a postage stamp. They are used in large retail stores, including Wal-Mart and Target. Wal-Mart has been actively pursuing RFID technology in improving its inventory management and supply chain processes.

Active tags are much more reliable because they have their own power supply. The U.S. Department of Defense has used these tags to minimize the costs related to logistics and increase supply chain visibility. Active tags cost only a few dollars each.

### FIGURE 15.15

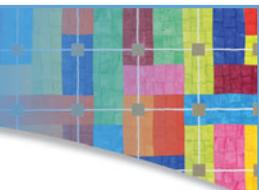
Bar coding, as shown in this label for a grocery product, affords highly accurate data entry.

Used with the permission of the Uniform Code Council, Dayton, Ohio.





## CONSULTING OPPORTUNITY 15.3



### To Enter or Not to Enter: That Is the Question

“I’ve just taken on the presidency of Elsinore Industries,” says Rose N. Krantz. “We’re actually part of a small cottage industry that manufactures toy villages for children seven years old and up. Our tiny hamlets consist of various kits that will build what children want from interlocking plastic cubes, essentials such as city hall, the police station, the gas station, and a hot dog stand. Each kit has a unique part number from 200 to 800, but not every number is used. The wholesale prices vary from \$54.95 for the city hall to \$1.79 for a hot dog stand.

“I’ve been melancholy over what I’ve found out since signing on at Elsinore. ‘Something is rotten’ here, to quote a famous playwright. In fact, the invoicing system was so out of control that I’ve been working around the clock with our bookkeeper, Gilda Stern,” Krantz soliloquizes.

“I would like you to help straighten things out,” Rose continues. “We ship to 12 distribution warehouses around the country. Each invoice we write out includes the warehouse number, 1 through 12, its street address, and the U.S. postal code (zip code).

We also put on each invoice the date we fill the order, code numbers for the hamlet kits they order, a description of each kit, the price per item, and the quantity of each kit ordered. Of course, we also include the subtotals of kit charges, shipping charges, and the total that the warehouse owes us. No sales tax is added, because they resell what we send them to toy stores in all 50 states. I want you to help us design a computerized order entry system that will be part of the invoicing system for Elsinore Industries.”

For your design of a data entry system for Elsinore, take into consideration all the objectives for data entry discussed throughout this chapter. Draw any displays necessary to illustrate your design. How can you make the order entry system efficient? Respond in a paragraph. Specify what data can be stored and retrieved and what data must be entered anew for each order. How can unnecessary work be avoided? Write a paragraph to explain why the system you propose is more efficient than the old one. How can data accuracy be ensured? List three strategies that will work with the type of data that are being entered for Elsinore Industries.

To capture the data on an RFID tag, a reader is required. The reader activates the tag so that it can be read. The reader decodes the data and the unique product code on the chip inside the tag, then passes it along to a host computer that processes the data.

One example is an electronic toll pass used in vehicles traversing toll roads. An RFID transponder can be attached to the windshield and read every time the vehicle passes through a toll booth. The toll booth’s RFID reader can also act as a writer, so a balance can be stored on the RFID chip.

The Moscow Metro was the first transportation system to use RFID smartcards in 1998. Other applications include the tracking of cattle to identify the herd of origin, which enables better tracking of mad cow disease, as well as RFID tracking in bookstores, airline baggage services, pharmaceuticals, and even patients or inmates.

RFID tags have found common use in most shipping applications. The technology will soon be used in general electronic cash transactions. They may even replace UPC codes since their advantages include security (by reducing the number of items stolen) and not requiring scanning (they can simply pass through the reader zone).

RFID is not without controversy. Privacy is a concern. An individual who pays for a tagged item by a credit card or a shoppers’ card could be identified.

The systems analyst needs to think of the users involved and their rights when considering whether this technology is suited for the application being designed.

## ENSURING DATA QUALITY THROUGH INPUT VALIDATION

So far, we have discussed ensuring the effective capturing of data onto source documents and the data’s efficient entry into the system through various input devices. Although these conditions are necessary for ensuring quality data, they alone are not sufficient.

Errors cannot be ruled out entirely, and the critical importance of catching errors during input, *prior* to processing and storage, cannot be overemphasized. The snarl of problems created by incorrect input can be a nightmare, not the least of which is that many problems take a long time to surface. The systems analyst must assume that errors in data *will* occur and must work with users to design input validation tests to prevent erroneous data from being processed and stored,

**FIGURE 15.16**

Validating input is important to ensure that most potential problems with data are eliminated early.

This Type of Validation	Can Prevent These Problems
Validating Input Transactions	Submitting the wrong data Data submitted by an unauthorized person Asking the system to perform an unacceptable function
Validating Input Data	Missing data Incorrect field length Data have unacceptable composition Data are out of range Data are invalid Data do not match with stored data

because initial errors that go undiscovered for long periods are expensive and time consuming to correct.

You cannot imagine everything that will go awry with input, but you must cover the kinds of errors that give rise to the largest percentage of problems. A summary of potential problems that must be considered when validating input is given in Figure 15.16.

### Validating Input Transactions

Validating input transactions is largely done through software, which is the programmer's responsibility, but it is important that the systems analyst know what common problems might invalidate a transaction. Businesses committed to quality will include validity checks as part of their routine software.

Three main problems can occur with input transactions: submitting the wrong data to the system, the submitting of data by an unauthorized person, or asking the system to perform an unacceptable function.

**SUBMITTING THE WRONG DATA.** An example of submitting the wrong data to the system is the attempt to input a patient's Social Security number into a hospital's payroll system. This error is usually an accidental one, but it should be flagged before data are processed.

**SUBMITTING OF DATA BY AN UNAUTHORIZED PERSON.** The system should also be able to discover if otherwise correct data are submitted by an unauthorized person. For instance, only the supervising pharmacist should be able to enter inventory totals for controlled substances in the pharmacy. Invalidation of transactions submitted by an unauthorized individual applies to privacy and security concerns surrounding payroll systems and employee evaluation records that determine pay levels, promotions, or discipline; files containing trade secrets; and files holding classified information, such as national defense data.

**ASKING THE SYSTEM TO PERFORM AN UNACCEPTABLE FUNCTION.** The third error that invalidates input transactions is asking the system to perform an unacceptable function. For instance, it would be logical for a human resources manager to update the existing record of a current employee, but it would be invalid to ask the system to create a new file rather than merely to update an existing record.

### Validating Input Data

It is essential that the input data themselves, along with the transactions requested, are valid. Several tests can be incorporated into software to ensure this validity. We consider eight possible ways to validate input.

**TEST FOR MISSING DATA.** The first kind of validity test examines data to see if there are any missing items. For some situations, *all* data items must be present. For example, a Social Security file for paying out retirement or disability benefits would be invalid if it did not include the payee's Social Security number.

In addition, the record should include both the key data that distinguish one record from all others and the function code telling the computer what to do with the data. The systems analyst needs to interact with users to determine what data items are essential and to find out whether exceptional cases ever occur that would allow data to be considered valid even if some data items were missing. For example, a second address line containing an apartment number or a person's middle initial may not be a required entry.

**TEST FOR CORRECT FIELD LENGTH.** A second kind of validity test checks input to ensure it is of the correct length for the field. For example, if the Omaha, Nebraska, weather station reports into the national weather service computer but mistakenly provides a two-letter city code (OM) instead of the national three-letter city code (OMA), the input data might be deemed invalid, and hence would not be processed.

**TEST FOR CLASS OR COMPOSITION.** The test for class or composition validity checks to see that data fields that are supposed to be exclusively composed of numbers do not include letters, and vice versa. For example, a credit card account number for American Express should not include any letters. Using a composition test, the program should not accept an American Express account number that includes both letters and numbers.

**TEST FOR RANGE OR REASONABILITY.** Validity tests for range or reasonableness are really common-sense measures of input that answer the question of whether data fall within an acceptable range or whether they are reasonable within predetermined parameters. For instance, if a user was trying to verify a proposed shipment date, the range test would neither permit a shipping date on the 32nd day of October nor accept shipment in the 13th month, the respective ranges being 1 to 31 days and 1 to 12 months.

A reasonableness test ascertains whether the item makes sense for the transaction. For example, when adding a new employee to the payroll, entering an age of 120 years would not be reasonable. Reasonableness tests are used for data that are continuous, that is, data that have a smooth range of values. These tests can include a lower limit, an upper limit, or both a lower and an upper limit.

**TEST FOR INVALID VALUES.** Checking input for invalid values works if there are only a few valid values. This test is not feasible for situations in which values are neither restricted nor predictable. This kind of test is useful for checking responses where data are divided into a limited number of classes. For example, a brokerage firm divides accounts into three classes only: class 1 = active account, class 2 = inactive account, and class 3 = closed account. If data are assigned to any other class through an error, the values are invalid. Value checks are usually performed for discrete data, which are data that have only certain values. If there are many values, they are usually stored in a table of codes file. Having the values in a file provides an easy way to add or change values.

**CROSS-REFERENCE CHECKS.** Cross-reference checks are used when one element has a relationship with another one. To perform a cross-reference check, each field must be correct in itself. For example, the price for which an item is sold should be greater than the cost paid for the item. Price must be entered, numeric, and greater than zero. The same criterion is used to validate cost. When both price and cost are valid, they may be compared.

A geographical check is another type of cross-reference check. In the United States, the state abbreviation may be used to ensure that a telephone area code is valid for that state and that the first two digits of the zip code are valid for the state.

**TEST FOR COMPARISON WITH STORED DATA.** The next test for validity of input data that we consider is one comparing it with data that the computer has already stored. For example, a newly entered part number can be compared with the complete parts inventory to ensure that the number exists and is being entered correctly.

**SETTING UP SELF-VALIDATING CODES (CHECK DIGITS).** Another method for ensuring the accuracy of data, particularly identification numbers, is to use a check digit in the code itself. This procedure involves beginning with an original numeric code, performing some mathematics to arrive at a derived check digit, and then adding the check digit to the original code. The mathematical process involves multiplying each of the digits in the original code by some predetermined weights, summing these results, and then dividing this sum by a modulus number. The modulus number is needed because the sum usually is a large number, and we need to reduce the result to a single digit. Finally, the remainder is subtracted from the modulus number, giving us the check digit.

**FIGURE 15.17**

Steps in converting a five-digit part number to a six-digit number containing a check digit.

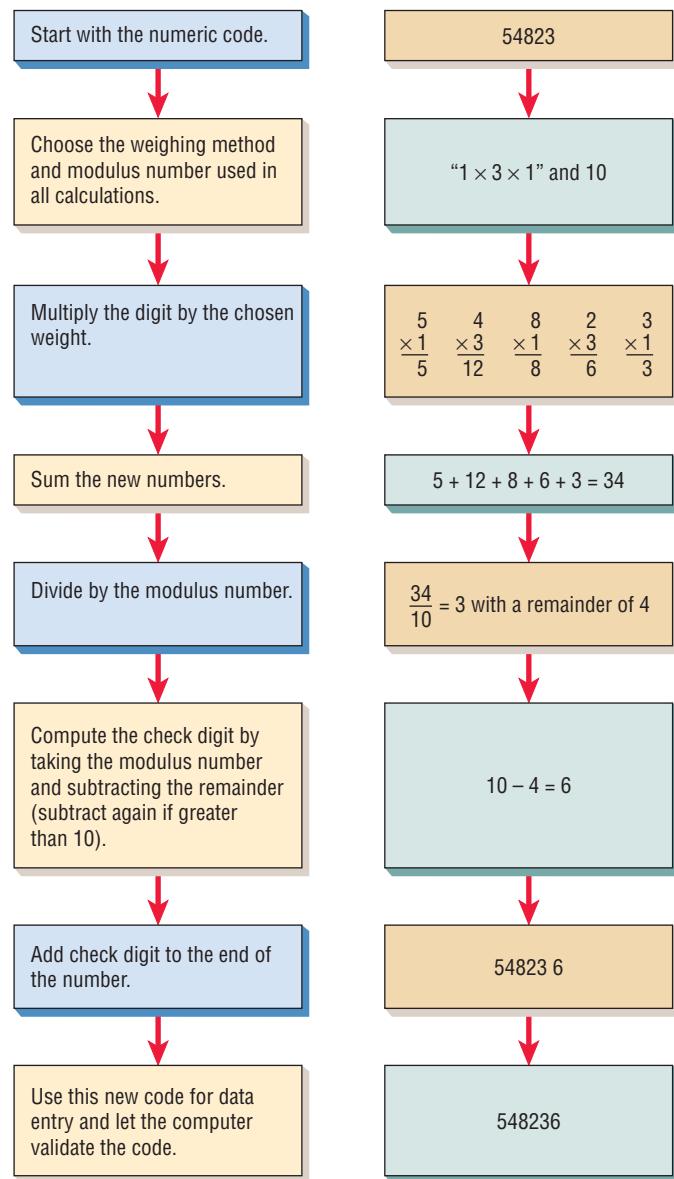


Figure 15.17 shows how a five-digit part number for a radiator hose (54823) is converted to a six-digit number containing a check digit. In this example, the weights chosen were the “1-3-1” system; in other words, the weights alternate between 1 and 3. After the digits 5, 4, 8, 2, and 3 were multiplied by 1, 3, 1, 3, and 1, they became 5, 12, 8, 6, and 3. These new digits sum to 34. Next, 34 is divided by the chosen modulus number, 10, with the result of 3 and a remainder of 4. The remainder, 4, is subtracted from the modulus number, 10, giving a check digit of 6. The digit 6 is now tacked onto the end of the original number, giving the official product code for the radiator hose (548236).

**Using Check Digits** The check digit system works in the following way. Suppose we had the part number 53411. This number has to be typed into the system, and while that is being done, different types of errors can occur. One possible error is the single-digit miskey; for example, the clerk types in 54411 instead of 53411. Only the digit in the thousands place is incorrect, but this error may result in the wrong part being shipped.

A second type of error is transposed digits. It commonly occurs that the intended number 53411 gets typed in as number 54311 instead, just because two keys are pressed in reverse order. Transposition errors are also difficult for humans to detect.

These errors are avoidable through the use of a check digit because each of these numbers—the correct one and the error—would have a different check digit number, as shown in Figure 15.18.

Status	Original Code	Check Digit	New Code
Correct	5 3 4 1 1	8	534118
Single-digit miskey	5 <b>4</b> 4 1 1	5	544115
Transpose	5 <b>4</b> <b>3</b> 1 1	6	543116

If part number 53411 was modified to 534118 (including the check digit 8) and either of the two errors just described occurred, the mistake would be caught. If the second digit was miskeyed as a 4, the computer would not accept 544118 as a valid number, because the check digit for 54411 would be 5, not 8. Similarly, if the second and third digits were transposed, as in 543118, the computer would also reject the number because the check digit for 54311 would be 6, not 8.

The systems analyst chooses the weights and the modulus number, but once chosen, they must not change. Some examples of weighting methods and modulus numbers can be found in Figure 15.19.

**VERIFYING CREDIT CARDS.** When credit cards are entered into a Web site or computer program, the first check is the length of the number. Credit card companies designed their cards to include a different number of digits. For example, Visa cards are 16 digits long while American Express card numbers are 15 digits in length.

Another test is to match the credit card company and bank to verify that it is indeed a card issued by that company. The first four digits usually signify the type of card. The middle digits usually represent the bank and the customer. The last digit is a check digit.

In addition to these verification methods, credit card processing uses a check digit formula called the Luhn formula, created in the 1960s. Suppose we are given a number 7-7-7-8-8-8, where

**FIGURE 15.18**

Avoiding common data-entry errors through the use of a check digit.

Check Digit Method	Calculations for Check Digit to Be Added to the Original Number 29645									
Modulus 10 “2-1-2”	2      9      6      4      5 $\times 2$ $\times 1$ $\times 2$ $\times 1$ $\times 2$ 4 + 9 + 12 + 4 + 10 = 39/10 = 3 remainder Check digit equals Code with check digit is 296451.								10 (9) 1	
Modulus 10 “3-1-3”	2      9      6      4      5 $\times 3$ $\times 1$ $\times 3$ $\times 1$ $\times 3$ 6 + 9 + 18 + 4 + 15 = 52/10 = 5 remainder Check digit equals Code with check digit is 296458.							10 (2) 8		
Modulus 11 “Arithmetic”	2      9      6      4      5 $\times 6$ $\times 5$ $\times 4$ $\times 3$ $\times 2$ 12 + 45 + 24 + 12 + 10 = 103/11 = 9 remainder Check digit equals Code with check digit is 296457.							11 (4) 7		
Modulus 10 “Geometric”	2      9      6      4      5 $\times 32$ $\times 16$ $\times 8$ $\times 4$ $\times 2$ 64 + 144 + 48 + 16 + 10 = 282/11 = 25 remainder Check digit equals Code with check digit is 296454.							11 (7) 4		

**FIGURE 15.19**

Examples of weighting methods and modulus numbers.



## CONSULTING OPPORTUNITY 15.4

### Do You Validate Parking?

**“W**hat are we going to do, Mercedes?” Edsel asks wearily. Together, Mercedes and Edsel are reviewing the latest billing printout for their firm, Denton and Denton Parking Garages. They have been purchasing batch billing services from a small, local computer services company since they acquired three parking garages in a medium-sized metropolitan area. Denton and Denton Parking Garages rents daily, monthly, and yearly parking places to corporations and individuals.

Mercedes replies, “I’m not sure what our next move is, but the billing is all wrong. Maybe we should try to talk to the IT people.”

“They said they could figure out how to compute these charges from looking at what the old owners did by hand before, and they said they didn’t want to run the old and new systems in parallel,” Edsel remarks, shaking his head. “That isn’t right, though. At least I can’t figure it out. Maybe you can.”

Mercedes accepts the notion of chasing the suspect output and starts looking at the report in detail. “Well, for one thing, they don’t realize we get cars from all over in here. Wherever we’ve got a car with plates that aren’t in-state, it seems as if the computer stops figuring. Look, our plates start with a number and then a letter, right?

Well this one from New York begins with three letters. The computer can’t handle it,” she says.

Edsel catches on and starts to think about the business as he looks at the printout. “Yeah, and look here. This person doesn’t have a yearly account number, just a monthly one, so no bill came out,” he says. “We’ve got monthlies, too, and the computer doesn’t know it.”

“And look at this. It still made daily charges for the three days in November when we told them right out there weren’t any vacancies for daily customers. It isn’t reasonable,” Mercedes asserts.

Edsel continues paging through the printout, but Mercedes stops him, saying, “Don’t look any further. I’m calling the IT people so we can get this mess straightened out.”

How would you characterize the problems being encountered with the current garage billing system? Use a paragraph to formulate a response. What are some tests for validity of data that could be included in the software for a revised billing system for the parking garages? List them. What could the programmer and analysts for the computer services company have done differently so that the customer was not faced with correcting the poor-quality output? Use three paragraphs to do a critical analysis of what was done and what *should* have been done.

the first five numbers represent a bank account number and the last digit is a check digit. Let’s apply the Luhn formula to see if this is a valid number.

1. Double the second last digit, then double every other digit (i.e., skip a digit, double the next, skip a digit, double the next, etc.). For example, the number 7-7-7-8-8-8 becomes 14-7-14-8-16-8.
2. If doubling any digit results in a number that is larger than 10, reduce this two-digit number to a single digit by adding the numbers together. In our example, the 14 becomes  $1 + 4 = 5$  and the 16 becomes  $1 + 6 = 7$ . In doing so, our original number, 7-7-7-8-8-8 has been transformed into a new number, 5-7-5-8-7-8.
3. Now add all the digits in the new number together. So,  $5 + 7 + 5 + 8 + 7 + 8 = 40$ .
4. Look at the total. If it ends in zero, the number is valid according to the Luhn formula.

Since 40 ends in zero, we can say that it passes the Luhn formula test.

The Luhn formula can be used to identify mistakes in entering an incorrect credit card. For example, the credit card number 1334-1334-1334-1334 is assumed to be valid because the digits of the transformed number 2364-2364-2364-2364 will add up to 60, a number ending in zero. If a user incorrectly enters a wrong digit, the total would not be a multiple of zero.

The Luhn formula does not catch every error, however. If a user makes mistakes in entering more than one digit, for example entering 1334-1334-1334-3314, the total of the transformed number, 2364-2364-2364-6324, is still 60. This transposition error (flipping the second last and fourth last digit) will not be caught.

Credit card companies also use the expiration date and a three- or four-digit verification code, often written on the reverse side of the card for more security.

The seven tests for checking on validity of input can go a long way toward protecting the system from the entry and storage of erroneous data. Always assume human errors in input are more likely than not to occur. It is your responsibility to understand which errors will invalidate data, and how to use the computer to guard against those human errors and thus limit their intrusion into system data.

## The Process of Validation

It is important to validate each field until it is either valid or an error has been detected. The order of testing data is to first check for missing data. Then a syntax test can check the length of the data entered and check for proper class and composition. Only after the syntax is correct are the semantics, or meaning, of the data validated. This includes a range, reasonable, or value test, followed by a check digit test.

GUI screens help to reduce the number of human input errors when they incorporate radio buttons, check boxes, and drop-down lists. When radio buttons are used, one should be set as the default, and the only way it would be unchecked is if the user clicks a different radio button. In the case of drop-down lists, the first choice should contain a message informing the user to change the list. If the first choice is still selected when the form is submitted, a message should inform the user to select a different option.

Usually validating a single field is done with a series of IF . . . ELSE statements, but there are also pattern validation methods. Usually these patterns are found in the database design (as in Microsoft Access) but may be included in programming languages, such as Perl, JavaScript, and XML schemas. The patterns are called regular expressions and contain symbols that represent the type of data that must be present in a field. Figure 15.20 illustrates characters used in JavaScript regular expressions.

An example of pattern validation used to test an email address is

```
[A-Za-z0-9]\w{2,}@[A-Za-z0-9]{3,}\.[A-Za-z]{3}/
```

The meaning of this pattern is as follows: The first letter must be any uppercase letter, lowercase letter, or number ([A-Za-z0-9]). This is followed by two or more characters that are any letter, number, or an underscore (\w{2,}). There must then be an @ symbol, followed by at least three letters or numbers, a period, and exactly three characters after the period.

A cross-reference check assumes that the validity of one field may depend on the value of another field. An example of a cross-reference check is checking for a valid date. In one very special case, the validity of the day of the month depends on the year. That is, February 29 is only valid during leap years. Once single fields have been checked, you can perform cross-reference checks. Obviously, if one of the fields is incorrect, the cross-reference check is meaningless and should not be performed.

Character Code	Meaning Used in Regular Expression Validation
\d	Any digit 0–9
\D	Any nondigit character
\w	Any letter, number, or underscore
\W	Any character other than a letter, number, or underscore
.	Matches any character
[characters]	Matches the characters in the brackets
[char-char]	Matches the range of characters
[a-z][A-Z][0-9]	Will accept any letter or digit
[^characters]	Match anything other than the characters
[^char-char]	Match anything outside the range of characters
[^a-z]	Will accept anything except lowercase letters
{n}	Match exactly n occurrences of the preceding character
{n,}	Match at least n occurrences of the character
\s	Any white space formatting character (tab, new line, return, etc.)
\S	Any nonwhite space character

**FIGURE 15.20**

These characters are used in regular expression (pattern) validation.

XML documents may be validated by comparing them to a document type definition (DTD) or a schema (refer to Chapter 8). The DTD will check to see whether the format of the document is valid, but a schema is much more powerful and will check the type of data, such as a short or long integer, a decimal number, or date. A schema will also check a range of values, the number of digits to the left and right of a decimal point, and the values of codes. There are free tools to validate a DTD or schema. IEXMLTLS is a Microsoft extension to Internet Explorer that adds new menu options when the user right-clicks in an XML document.

## ACCURACY ADVANTAGES IN ECOMMERCE ENVIRONMENTS

One of the many bonuses of ecommerce transactions is increased accuracy of data, due to four reasons:

1. Customers generally key or enter data themselves.
2. Data entered by customers are stored for later use.
3. Data entered at the point of sale are reused throughout the entire order fulfillment process.
4. Information is used as feedback to customers.

An analyst needs to be aware of the advantages that have resulted from ecommerce and the electronic capture and use of information.

### Customers Keying Their Own Data

First, customers know their own information better than anyone else. They know how to spell their street address, they know whether they live on a “Drive” or a “Street,” and they know their own area code. If this information is transmitted by phone, it is easier to make a mistake spelling the address; if it is entered by using a faxed paper form, mistakes can occur if the fax transmission is difficult to read. If users enter their own information, however, accuracy increases.

### Storing Data for Later Use

After customers enter information, it may be stored on their own personal computers. If they return to that ecommerce site and fill out the same form to complete a second transaction, they will witness the advantage of storing this information. As they begin to type their name, drop-down lists will prompt them with their full name even though only a couple of characters were entered. By clicking on this prompt, the full name is entered and no further typing is necessary for this field. This auto-complete feature can suggest matches for credit card and password information as well, and this information is encrypted so that Web sites cannot read the information stored on the user’s computer.

Companies that want to store information to enable faster and more accurate transactions do so in small files called cookies. Personal information can only be accessed by the company that placed the cookie on the user’s computer.

### Using Data through the Order Fulfillment Process

When companies capture information from a customer order, they can use and reuse that information throughout the entire order fulfillment process. Hence, the information gathered to complete an order can also be used to send an invoice to a customer, obtain the product from the warehouse, ship the product, send feedback to the customer, and restock the product by notifying the manufacturer. It can also be used again to send a paper catalog to the customer or send a special offer by email.

These ecommerce enhancements replace the traditional approach, which used a paper-based procurement process with purchase orders sent via fax or mail. This electronic process not only speeds up the delivery of the product, but also increases the accuracy so that the product is delivered to the correct address. Rather than reading a fax or a mailed-in form, a shipper uses the more accurate electronic version of the data. Electronic information allows better supply chain management, including checking product and resource availability electronically, and automating planning, scheduling, and forecasting.

### Providing Feedback to Customers

Confirmations and order status updates are ways to enhance feedback to customers. If a customer receives confirmation of a mistake in an order just placed, the order can be corrected immediately.



## HYPERCASE® EXPERIENCE 15

“Sometimes I think I’m the luckiest person on earth. Even though I’ve been here five years, and away from the UK all of that time, I still enjoy the people I meet and what I do. Yes, I know Snowden’s demanding. You’ve experienced some of that, haven’t you? He, for one, loves codes. I think they are a pain. I always forget them or try to make up new ones or something. Some of the physicians, though, think they’re great. It must be all those Latin abbreviations they studied in med school. I hear that your most pressing assignment this week has to do with actually getting the information into the project reporting system. The Training group wants your ideas, and it wants them fast. Good luck with it. Oh, and when Snowden gets back from Thailand, I’m certain he’ll want to take a peek at what your team has been up to.”

### HyperCase Questions

1. Using a CASE tool, a software package such as Microsoft Access, or a paper layout form, design a data entry procedure for the proposed project reporting system for the Training group. Assume we are particularly concerned about the consulting physicians staff, who don’t want to spend a great deal of time keying in large amounts of data when using the system.
2. Test your data entry procedure on three teammates. Ask for feedback concerning the appropriateness of the procedure, given the type of users the system will have.
3. Redesign the data entry procedure to include the feedback you have received. Explain in a paragraph how your changes reflect the comments you were given.

For example, suppose a customer mistakenly submits an order for two copies of a DVD rather than one. After submitting the order, the customer receives an email confirming the order. The customer notices the mistake, immediately contacts the company, and has the order corrected, thereby avoiding having to return the extra copy of the DVD. Accuracy is improved by better feedback.

## SUMMARY

Ensuring the quality of the data input to the information system is critical to ensuring quality output. The quality of data entered can be improved through effective coding, effective and efficient data capture, and the validation of data.

Data entry by humans can be speeded up through effective use of coding, which puts data into short sequences of digits and/or letters. Both simple sequence codes and alphabetic derivation codes can be used to follow the progress of a given item. Classification codes and block sequence codes are useful for distinguishing classes of items from each other. Cipher codes are also useful because they can conceal information that is sensitive or is restricted to employees.

Codes are also worthwhile for revealing information to users, since they can enable employees to locate items in stock and also make data entry more meaningful. Significant-digit subset codes use subgroups of digits to describe a product. Mnemonic codes also reveal information by serving as human memory aids that can help a data entry operator enter data correctly or help the user. The Unicode character set includes all standard language symbols. You can display Web pages written in other alphabets by downloading an input method editor from Microsoft. Function codes are useful shortcuts for informing computers or people about what functions to perform or what actions to take.

Effective data entry should also consider input devices. A well-designed, effective form that serves as a source document is the first step. Data can be input through many different methods, each with varying speed and reliability. Keyboards have been redesigned for efficiency and improved ergonomics. Optical character recognition (OCR), magnetic ink character recognition (MICR), and mark-sense forms each have special capacities for improving efficiency. Bar codes also speed data entry, improve data accuracy, and increase reliability. RFID allow the automatic collection of data using RFID tags on products, people, or animals. They can improve inventory management and supply chain processes.

Accurate data entry also can be enhanced through the use of input validation. Analysts must work with users to design input validation tests to prevent erroneous data from being processed and stored, which is costly and potentially detrimental.

Input transactions should be checked to ensure the request is acceptable, authorized, and correct. Input data can be validated through software using several types of tests that check for missing data, length of data items, range and reasonableness of data, and invalid values for data. Input data can also be compared with

stored data for validation purposes. Once numerical data are input, they can be checked and corrected automatically through the use of check digits and the Luhn formula.

There is a set order for the testing of data to validate each field. There are also pattern validation methods found in the database design or included in programming languages. The patterns are called regular expressions and contain symbols that represent the type of data that must be present in a field.

Ecommerce environments afford the opportunity for increasing accuracy of data. With proper emphasis on user-centered design elements, customers can enter their own data, store data for later use, use the same stored data throughout the order fulfillment process, and receive feedback regarding order confirmations and updates.

## KEYWORDS AND PHRASES

alphabetic derivation code	mnemonic code
autocomplete feature	optical character recognition (OCR)
bar code	radio frequency identification (RFID)
block sequence code	redundancy in input data
bottleneck	regular expression
changeable	self-validating code
check digit	significant-digit subset code
cipher code	simple sequence code
classification code	supply chain management
coding	test for class or composition
cookies	test for comparison with stored data
cross-reference test	test for correct field length
differentiated	test for invalid values
function code	test for missing data
keyboarding	test for range or reasonableness
Luhn formula	Unicode
magnetic ink character recognition (MICR)	validating input
mark-sense form	

## REVIEW QUESTIONS

1. What are the four primary objectives of data entry?
2. List the five general purposes for coding data.
3. Define the term *simple sequence code*.
4. When is an alphabetic derivation code useful?
5. Explain what is accomplished with a classification code.
6. Define the term *block sequence code*.
7. What is the simplest type of code for concealing information?
8. What are the benefits of using a significant-digit subset code?
9. What is the purpose of using a mnemonic code for data?
10. Define the term *function code*.
11. List the eight general guidelines for proper coding.
12. What are changeable data?
13. What are differentiation data?
14. What is one specific way to reduce the redundancy of data being entered?
15. Define the term *bottleneck* as it applies to data entry.
16. What three repetitive functions of data entry can be done more efficiently by a computer than by a data entry operator?
17. List six data entry methods.
18. List the three main problems that can occur with input transactions.
19. Define RFID. What are the differences between active and passive RFID tags?
20. Give two examples of the use of RFID tags in process or inventory management in retail or health care environments.
21. What are the eight tests for validating input data?
22. Which test checks to see whether data fields are correctly filled in with either numbers or letters?
23. What common error is missed by the Luhn formula?
24. Which test would not permit a user to input a date such as October 32?
25. Which test ensures data accuracy by the incorporation of a number in the code itself?
26. List four improvements to data accuracy that transactions conducted over ecommerce Web sites can offer.

27. What is Unicode, and how is it used?
28. What is the process for validating data entered into fields?
29. What is a regular expression?

## PROBLEMS

1. A small, private university specializing in graduate programs needs to keep track of the list of students who (a) apply, (b) are accepted, and (c) actually enroll in the university. For security purposes the university also must send a report to the government with a list of foreign students who enroll but fail to register. Suggest a kind of code for this purpose, and give an example of its use in the university that demonstrates its appropriateness. What are its advantages?  
In a paragraph, suggest a different coding scheme that will help uniquely identify each ticket holder and explain how it will prevent mix-ups.
2. The Central Pacific University Chipmunks have been using a simple sequence code to keep track of season ticket holders and fans who are not season ticket holders for all of its sports programs. There have been some upsetting mix-ups.  
In a paragraph, suggest a different coding scheme that will help uniquely identify each ticket holder and explain how it will prevent mix-ups.
3. A code used by an ice cream store to order its products is 12DRM215-220. This code is deciphered in this manner: 12 stands for the count of items in the box, DRM stands for Dreamcicles (a particular kind of ice cream novelty), and 215-220 indicates the entire class of low-fat products carried by the distributor.
  - a. What kind of code is used? Describe the purpose behind each part (12, DRM, 215-220) of the code.
  - b. Construct a coded entry using the same format and logic for an ice cream novelty called Pigeon Bars, which come in a six-count package and are *not* low-fat.
  - c. Construct a coded entry using the same format and logic for an ice cream novelty called Airwhips, which come in a 24-count package and are low-fat.
4. The data entry operators at Michael Mulheren Construction have been making errors when entering the codes for residential siding products, which are as follows: U = stUcco, A = Aluminum, R = bRick, M = Masonite, EZ = EZ color-lok enameled masonite, N = Natural wood siding, AI = pAInted finish, SH = SHake SHingles. Only one code per address is permitted.
  - a. List the possible problems with the coding system that could be contributing to erroneous entries.  
*(Hint: Are the classes mutually exclusive?)*
  - b. Devise a mnemonic code that will help the operators understand what they are entering and subsequently help their accuracy.
  - c. How would you redesign the classes for siding materials? Respond in a paragraph.
5. The following is a code for one product in an extensive cosmetic line: L02002Z621289. L means that it is a lipstick, 0 means it was introduced without matching nail polish, 2002 is a sequence code indicating in what order it was produced, Z is a classification code indicating that the product is hypoallergenic, and 621289 is the number of the plant (there are 15 plants) where the product is produced.
  - a. Critique the code by listing the features that might lead to inaccurate data entry.
  - b. Designer Brian d'Arcy James owns the cosmetic firm that uses this coding scheme. Always interested in new design, Brian is willing to look at a more elegant code that encodes the *same* information in a better way. Redesign the coding scheme and provide a key for your work.
  - c. Write a sentence for each change you have suggested, indicating what data entry problem (from Problem 5a) the change will eliminate.
  - d. Mr. d'Arcy James is delighted with your work. He says the firm would like to hire you to help them branch out into selling theatrical makeup (shows such as *Wicked* and *Shrek* with eight performances a week use a lot of green greasepaint). Add any necessary new codes for the coding scheme you suggested in b, and provide a key for your work.
6. The d'Arcy James cosmetics firm requires its salespeople to use notebooks to enter orders from retail department stores (their biggest customers). This information is then relayed to warehouses, and orders are shipped on a first-come, first-served basis. Unfortunately, the stores are aware of this policy and are extremely competitive about which one of them will offer a new d'Arcy James product first. Many retailers have taken the low road and persuaded salespeople to falsify their order dates on sales forms by making them earlier than they actually were.
  - a. This problem is creating havoc at the warehouse. Disciplining any of the personnel involved is not feasible. How can the warehouse computer be used to certify when orders are actually placed? Explain in a paragraph.
  - b. Salespeople are complaining that they have to ignore their true job of selling so that they can key in order data. List the data items relating to sales of cosmetics to retailers that should be stored in and retrieved from the central computer rather than keyed in for every order.
  - c. Describe in a paragraph or two how bar coding might help solve the problem in Problem 6b.

7. List the best data entry method and your reason for choosing it for each of the following six situations:
  - a. Turnaround document for a utility company that wants notification of a change in the customer address.
  - b. Data retrieval allowed only if there is positive machine identification of the party requesting data.
  - c. Not enough trained personnel available to interpret long, written responses; many forms submitted that capture answers to multiple-choice examinations; high reliability necessary; fast turnaround not required.
  - d. Warehouse set up for a discount compact disc operation; bins are labeled with price information, but individual discs are not; and few skilled operators are available to enter price data.
  - e. Poison control center that maintains a large database of poisons and antidotes; needs a way to enter data on the poison taken; also enter weight, age, and general physical condition of the victim when a person calls the center's toll-free number for emergency advice.
  - f. Online purchase of a DVD by a consumer with a credit card.
8. Ben Coleman, one of your systems analysis team members, surprises you by asserting that when a system uses a test for correct field length, it is redundant also to include a test for range or reasonableness. In a paragraph, give an example that demonstrates that Ben is mistaken on this one.
9. Several retailers have gotten together and begun issuing a “state” credit card that is good only in stores in their state. As a courtesy, salesclerks are permitted to transcribe the 15-digit account number by hand (after getting it from the accounting office) if the customer is not carrying the card. The only problem with accounts that retailers have noticed so far is that sometimes erroneous account numbers are accepted into the computer system, resulting in a bill being issued to a nonexistent account.
  - a. What sort of validity test would clear up the problem? How? Respond in a paragraph.
  - b. Suggest an alternative data entry method that might alleviate this problem altogether.
10. The following are part numbers: 238902, 238933, 239402, 235693, 235405, 239204, 240965. Develop a check digit for them using 1-3-1-3-1 multipliers and modulus 11. Use the method presented in this chapter. Why do some numbers have the same check digit?
11. Develop a check digit system for the part numbers in Problem 10 using 5-4-3-2-1 multipliers and modulus 11.
12. Develop a check digit system for the part numbers in Problem 10 using the Luhn formula.
13. Why would a check digit system such as 1-1-1-1-1 not work as well as other methods? What errors would it miss?
14. Define a regular expression for validating each of the following:
  - a. A U.S. zip code, which must have five digits, followed by an optional hyphen and four digits.
  - b. A telephone number in the format (aaa) nnn-nnnn, where aaa represents the area code and the ns represent digits.
  - c. A date in the form of day-month-year, where the month is a three-letter code and the year is four digits. Hyphen must separate the day and month and year and month.
  - d. The alphabetic derivation code illustrated in this chapter for a magazine subscriber. The format is 99999XXX9999XXX, where X represents a letter and 9 represents a number.
15. For the following codes, define the validation criteria (there may be multiple checks for each field) and the order that you would test each of the conditions.
  - a. **A credit card number entered on a Web form:** The customer has selected the type of credit card from a drop-down list.
  - b. **A part number in a hardware store:** The part number is a complex code, where the first digit represents the department (such as housewares, automotive, and so on), and the number should be self-checking. There are seven different departments.
  - c. **The date that a book was postmarked when returned to an online bookstore:** A copy of the customer receipt must be included with the book. Returned books must be postmarked within 30 days of the purchase date.
  - d. **A language spoken code used on a Web site:** Hint: Search the Web for standard language codes.
  - e. **A driver's license number, composed of several parts:** The person's birth month, the birthday, and birth year, not necessarily together; a code representing eye color; and a sequence number. The driver's license contains the date of birth, the eye and hair color, as well as the person's name and address.
  - f. **The Canadian postal code:** The format is X9X 9X9 (X is any letter, 9 is any number).
  - g. **Airline luggage codes:** Such as LAX for Los Angeles or DUB for Dublin.
  - h. **A product key used to unlock purchased software:** The key consists of four groups of five characters each. The first group must have two letters followed by three numbers; the second group must contain two numbers followed by three letters; the third group must contain two

letters, each from A through G, followed by three numbers from one through four; and the last group must contain a letter, either an E, G, or C, two digits with values from four through seven, and two letters, either an A, B, or C. *Hint:* A pattern may be the best way to validate the product key.

## GROUP PROJECTS

1. Along with your group members, read Consulting Opportunity 15.3, “To Enter or Not to Enter: That Is the Question,” presented earlier in this chapter. Design an appropriate data entry system for Elsinore Industries. Your group’s design should emphasize efficiency and accuracy. In addition, distinguish between data that are changeable and data that differentiate an item being entered from all others. Draw prototypes of any screen necessary to explain what you are recommending.
2. Divide your group into analysts and Elsinore Industries employees to role-play. The analysts should present the new data entry system, complete with prototype displays. Ask for feedback on the design from Elsinore employees.
3. Write a brief paragraph describing how to improve the original data entry design based on the comments received.

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## EPISODE 15

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Entering Naturally

Tuesday afternoon finds Anna and Chip having their weekly analysis and design review session. Chip waves toward a large stack of documents that are neatly organized on a large table. “I can’t believe that we’re almost finished with the design of this system,” he remarks. “It’s been a long process, but I’ll bet we’ve obtained enough user feedback to ensure a high-quality system. All that’s left is the design of the data entry procedures, and we’ll be ready to start packaging the specs for the programmers.”

“Yes,” replies Anna, “the end is in sight. Let’s start by examining the design of the input portion of the system.”

“The ADD SOFTWARE program is online,” notes Chip. “The operator will have to sight-verify each transaction. After all data fields have been edited for accuracy, a message will appear on the bottom of the display. It will prompt the operators to check the data on the display for accuracy against the form and click the **Save Record** button if correct. The operators will have a chance to make changes if the data are keyed incorrectly.”

Every data field must be edited for accuracy. Chip notes, “In the long run, it’s better to have complete editing for accuracy in the programs rather than to find that erroneous data have been stored on master files and printed on reports.”

The strategy for field editing is to check the data in the following order:

1. Syntax—whether the data are numeric or alphabetic—and the length of the data. An example is the HARDWARE INVENTORY NUMBER, which must be eight characters in length and numeric.
2. The contents of the field, including range, limit, and values for the data. When validating the DATE PURCHASED, the month must be from 1 to 12. This check should occur only after the month has been verified as numeric.
3. Cross-reference checks between two or more data elements. To check the day portion of the DATE PURCHASED, a table of the number of days possible for each month will be used for an upper limit. This table could not be used if the month number was not between 1 and 12. Check digits are another example of a cross-reference edit.
4. External edits, such as reading a file to verify if the record to be added already exists in the file. Reading records is slower than editing, which is performed in main memory, and it should occur only after the data successfully pass all other edits.

Edit criteria have been entered on the Visible Analyst **Element Repository** display screen as the elements were added to the design. These elements include simple editing criteria and table checking. The **Notes** area may be used to enter editing criteria. The HARDWARE INVENTORY NUMBER entry includes a reference for using the modulus-11 method of verifying the check digit portion of the number. Furthermore, when adding a new computer, the COMPUTER MASTER must be read to ensure that a record does not already exist with the same HARDWARE INVENTORY NUMBER.

Several of the elements have **Notes** areas referring to tables, as well as entries for the codes in the **Values and Meanings** area. An example is the OPERATING SYSTEM element. “I’ll produce a list of all tables we’ll require,” Anna offers. Produce the list by searching the Repository Web page or using the Visible Analyst **Report Query** feature. A list of all elements containing notes starting with “Table of codes” is printed. Included on the list are the **Picture** and **Length**, showing the syntax of the code. With this list, tables are created.

Each table of codes is defined using Microsoft Access tables. Chip and Anna each spend time working on the tables. A mnemonic code is chosen for OPERATING SYSTEM, and to represent the SOFTWARE CATEGORY because it is easy for the users to work with. “I think a significant-digit subset coding scheme would be the best for coding the campus buildings,” remarks Chip. Anna agrees. “That’s good, Chip. The first digit for the campus location, and the remaining two digits representing individual buildings in the campus.”

Chip designs the codes used for the OPERATING SYSTEM table. The Microsoft Access display is shown in Figure E15.1. Two columns are used to define codes. The left column contains the code, and the right column contains the meaning of the code. These entries may be modified, and new entries may be added, providing flexibility in the final system.

“Here’s the SOFTWARE CATEGORY table that I created,” says Anna. “This table may be easily updated as new software is developed and acquired by the university. It’s amazing how fast software can change.”

“That’s a valuable component of the system,” Chip comments. “It provides consistency for all codes and their meanings.”

	Operating System	Operating System Meaning
+ L	Linux	
+ M	Mac OS X Leopard	
+ N	Ubuntu	
+ U	Unix	
+ B	Windows Vista Business	
+ W	Windows Vista Ultimate	
+ 7	Windows 7	
+ V	Windows Vista	
+ X	Windows XP	
+ P	Windows XP Pro	

**FIGURE E15.1**

OPERATING SYSTEM TABLE OF CODES defined using Microsoft Access.

Chip and Anna finish their work the next morning at about 11:30. They glance around the room happily, frequently reexamining the final design. The months of analysis, design work, consultation with the users, and careful adherence to standards are finally complete.

"I feel really good about this project," says Anna.

Chip agrees, "I'm proud of the quality we put in."

## EXERCISES

- E-1. Modify and print the following elements with edit criteria in the **Notes** (or **Values and Meanings** for specific codes) area. These may be found in the Repository Web page or in the Visible Analyst repository.



Element	Edit Criteria
a. SOFTWARE CATEGORY	Table of codes: Software Category Code
b. COURSE TRAINING LEVEL CODE	B - Beginning; I - Intermediate; A - Advanced
c. OPERATING SYSTEM	W - Windows Vista Ultimate; B - Windows Vista Business; U - Unix

- E-2. Modify and print the following elements with edit criteria placed in the **Notes** area:



- a. Element: SOFTWARE INVENTORY NUMBER  
Notes: A modulus-11 check digit must be verified when entering the number. The ADD SOFTWARE program creates the check digit.  
The ADD SOFTWARE program should also check the SOFTWARE MASTER file to ensure that a record with the same inventory number does not already exist.
- b. Element: DATE PURCHASED  
Notes: Verify that the DATE PURCHASED is less than or equal to the current date.
- c. Element: QUANTITY RECEIVED  
Notes: Verify that the QUANTITY RECEIVED is less than or equal to the QUANTITY ORDERED.
- d. Element: SOFTWARE UPGRADE VERSION  
Notes: Ensure that the software UPGRADE VERSION is greater than the current version.
- e. Element: SECOND HARD DRIVE  
Notes: SECOND HARD DRIVE may exist only if there is an entry for HARD DRIVE.



E-3. After speaking with Dot Matricks and Mike Crowe, it has become apparent that the campus codes must be sortable for installing hardware and software, as well as for creating inventory sheets. Use Microsoft Access to modify and print the CAMPUS LOCATION CODES table. The first digit represents the campus location. Values are as follows:

- 1 Central Campus
- 2 Waterford Campus
- 3 Hillside Campus

The next three digits represent buildings in the campus, with the following building codes:

001	Administration	010	Environmental Studies
002	Admissions	011	Geology
003	Agricultural	012	Law
004	Astronomy	013	Library
005	Business	014	Mathematics
006	Chemical Engineering	015	Medicine
007	Computer Science	016	Physics
008	Education	017	Psychology
009	Engineering	018	Zoology

Use a combination (your choice) of campus and building codes to build the final table of codes. Include the meaning of the code.

The exercises preceded by a www icon indicate value-added material is available from the Web site at [www.pearsonhighered.com/kendall](http://www.pearsonhighered.com/kendall). Students can download a sample Microsoft Visio, Visible Analyst, Microsoft Project, or a Microsoft Access file that can be used to complete the exercises.

# CHAPTER 16

## Quality Assurance and Implementation

### LEARNING OBJECTIVES

Once you have mastered the material in this chapter you will be able to:

1. Recognize the importance of users and analysts taking a total quality approach to improve the quality of software design and maintenance.
2. Realize the importance of documentation, testing, maintenance, and auditing.
3. Understand how service-oriented architecture and cloud computing are changing the nature of information system design.
4. Design appropriate training programs for users of the new system.
5. Recognize the differences among physical conversion strategies, and be able to recommend an appropriate one to a client.
6. Address security, disaster preparedness, and disaster recovery concerns for traditional and Web-based systems.
7. Understand the importance of evaluating the new system, and be able to recommend a suitable evaluation technique to a client.



Quality has long been a concern of businesses, as it should be for systems analysts in the analysis and design of information systems. The user of the information system is the single most important factor in establishing and evaluating its quality. It is far less costly to correct problems in their early stages than it is to wait until a problem is articulated through user complaints or crises. The three approaches to quality assurance through software engineering are (1) securing total quality assurance by designing systems and software with a top-down, modular approach; (2) documenting software with appropriate tools; and (3) testing, maintaining, and auditing software.

The process of ensuring that the information system is operational and then allowing users to take over its operation for use and evaluation is called implementation. Implementation concerns moving computer power to individual users by shifting computer power and responsibility to groups and individuals throughout the business with the help of distributed computing, cloud computing, and service-oriented architecture; training users and making sure that each user understands any new roles they must take on because of the new information system; choosing a conversion strategy; providing proper security, privacy, and disaster plans; and evaluating the new or modified information system.

## THE TOTAL QUALITY MANAGEMENT APPROACH

Total quality management (TQM) is essential throughout all the systems development steps. According to Evans and Lindsay (2004), the primary elements of TQM are meaningful only when occurring in an organizational context that supports a comprehensive quality effort. It is in this context that the elements of customer focus, strategic planning and leadership, continuous improvement, empowerment, and teamwork are united to change employees' behavior and, ultimately, the organization's course. Notice that the concept of quality has broadened over the years to reflect an organizational, rather than an exclusively production, approach. Instead of conceiving of quality as controlling the number of defective products produced, quality is now thought of as an evolutionary process toward perfection that is referred to as total quality management.

Systems analysts must be aware of the factors that are driving the interest in quality. It is important to realize that the increasing commitment of businesses to TQM fits extraordinarily well into the overall objectives for systems analysis and design.

### Six Sigma

The advent of Six Sigma has changed the approach to quality management. Systems analysts and systems users need to be aware of Six Sigma and apply some of the principles to their systems analysis projects. Originally developed by Motorola in the 1980s, Six Sigma is more than a methodology; it is a culture built on quality. The goal of Six Sigma is to eliminate all defects. This applies to any product, service, or process. In operations management textbooks from the 1970s to the end of the century, quality control was expressed in terms of three standard deviations from the mean, or three sigma, which equals about 67,000 defects per million opportunities. Six Sigma implies a goal of no more than 3.4 defects per million opportunities.

Six Sigma is a top-down approach. It requires a CEO to adopt the philosophy and an executive to serve as project champion. A Six Sigma project leader is called a Black Belt. (The metaphor of the Black Belt comes from the ranking system of capabilities in martial arts.) Black Belts are certified after they have successfully led projects. Other project members are called Green Belts. Master Black Belts are Black Belts who have worked on many projects and are available as a resource to project teams.

Six Sigma can be summarized as a methodology. The steps of Six Sigma are shown in Figure 16.1. Six Sigma, however, is much more than a methodology; it is a philosophy and a culture. For more information on Six Sigma and quality management, visit the Web site for the Juran Center at the Carlson School of Management, University of Minnesota, Twin Cities ([www.csom.umn.edu](http://www.csom.umn.edu)). In 2002 the Juran Center issued a proclamation to support and encourage quality. The authors of this book signed the charter at that time, and we agree wholeheartedly with its principles.

The late Joseph M. Juran said, "All quality improvement occurs on a project-by-project basis and in no other way" (Juran, 1964). Systems analysts, project managers, and users should take that to heart.

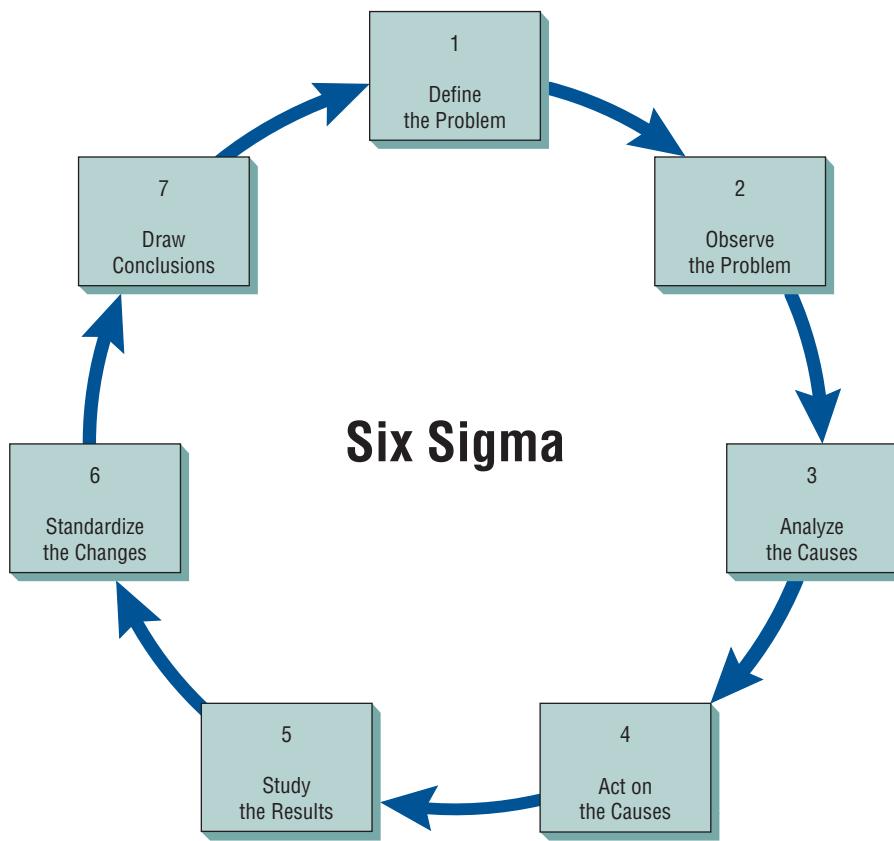
### Responsibility for Total Quality Management

Practically speaking, a large portion of the responsibility for the quality of information systems rests with systems users and management. Two things must happen for TQM to become a reality with systems projects. First, the full organizational support of management must exist, which is a departure from merely endorsing the newest management gimmick. Such support means establishing a context for management people to consider seriously how the quality of information systems and information itself affects their work.

Early commitment to quality from the analyst and business users is necessary to achieve the goal of quality. This commitment results in exerting an evenly paced effort toward quality throughout the systems development life cycle, and it stands in stark contrast to having to pour huge amounts of effort into ironing out problems at the end of the project.

Organizational support for quality in management information systems can be achieved by providing on-the-job time for IS quality circles, which consist of six to eight organizational peers specifically charged with considering both how to improve information systems and how to implement improvements.

Through work in IS quality circles or through other mechanisms already in place, management and users must develop guidelines for quality standards of information systems. Preferably,

**FIGURE 16.1**

Every systems analyst should understand the methodology and philosophy of Six Sigma.

standards will be reshaped every time a new system or major modification is to be formally proposed by the systems analysis team.

Hammering out quality standards is not easy, but it is possible and has been done. Part of the systems analyst's job is encouraging users to crystallize their expectations about information systems and their interactions with them.

Departmental quality standards must then be communicated through feedback to the systems analysis team. The team is often surprised at what has developed. Expectations typically are less complex than what experienced analysts know could be done with a system. In addition, human issues that have been overlooked or underrated by the analyst team may be designated as extremely pressing in users' quality standards. Getting users involved in spelling out quality standards for information systems will help the analyst avoid expensive mistakes in unwanted or unnecessary systems development.

### Structured Walkthrough

One of the strongest quality management actions the systems analysis team can take is to do structured walkthroughs routinely. Structured walkthroughs are a way of using peer reviewers to monitor the system's programming and overall development, point out problems, and allow the programmer or analyst responsible for that portion of the system to make suitable changes.

Structured walkthroughs involve at least four people: the person responsible for the part of the system or subsystem being reviewed (a programmer or analyst), a walkthrough coordinator, a programmer or analyst peer, and a peer who takes notes about suggestions.

Each person attending a walkthrough has a special role to play. The coordinator is there to ensure that the others adhere to any roles assigned to them and to ensure that any activities scheduled are accomplished. The programmer or analyst is there to listen, not to defend his or her thinking, rationalize a problem, or argue. The programmer or analyst peer is present to point out errors or potential problems, not to specify how the problems should be remedied. The notetaker records what is said so that the others present can interact without encumbrance.

Structured walkthroughs fit well in a total quality management approach when performed throughout the systems development life cycle. The time they take should be short—half an hour



## CONSULTING OPPORTUNITY 16.1

### The Quality of MIS Is Not Strained

**M**erle, come here and take a look at these end-of-the-week reports," Portia pleads. As one of the managers on the six-person IS task force/quality assurance committee, Portia has been examining for her marketing department the system output that has been produced by the prototype. The systems analysis team has asked her to review the output.

Merle Chant walks over to Portia's desk and takes a look at the prospectus she's holding. "Why, what's wrong?" he asks. "It looks okay to me. I think you're taking this task force deal too much to heart. We're supposed to get our other work done as well, you know." Merle turns to leave and returns to his desk slightly perturbed at being interrupted.

"Merle, have a little mercy. It is really silly to put up with these reports the way they are. I can't find anything I need, and then I'm supposed to tell everyone else in the department what part of the report to read. I, for one, am disappointed. This report is slipshod. It doesn't make any sense to me. It's a rehash of the output we're getting now. Actually, it looks worse. I am going to bring this up at the next task force meeting," Portia proclaims insistently.

Merle turns to face her, saying, "Quality is their responsibility, Portia. If the system isn't giving us good reports, they'll fix it when

it's all together. All you're doing is making waves. You're acting as if they actually value our input. I wouldn't give them the time of day, let alone do their work for them. They're so smart, let them figure out what we need."

Portia looks at Merle blankly, then starts getting a little angry. "We've been on the task force for four weeks," she says. "You've sat in on four meetings. We're the ones who know the business. The whole idea of TQM is to tell them what we need, what we're satisfied with. If we don't tell them what we need, then we can't complain. I'm bringing it up the next time we meet."

How effective do you think Merle will be in communicating his standards of quality to the systems analysis team and members of the IS task force? Respond in a paragraph. If the systems analysts are able to perceive Merle's unwillingness to work with the task force on developing quality standards, what would you say to convince him of the importance of user involvement in TQM? Make a list of arguments supporting the use of TQM. How can the systems analysis team respond to the concerns Portia is bringing up? In a paragraph, devise a response.

to an hour at most—which means that they must be well coordinated. Figure 16.2 shows a form that is useful in organizing the structured walkthrough and reporting its results. Because walkthroughs take time, do not overuse them.

Use structured walkthroughs as a way to obtain (and then act on) valuable feedback from a perspective that you lack. As with all quality assurance measures, the point of walkthroughs is to evaluate the product systematically on an ongoing basis rather than wait until completion of the system.

### Top-Down Systems Design and Development

Many companies first introduced computer systems on the lowest level of the organization. This is where the immediate benefits to computerization are most observable and cost-effective. Businesses often take this approach to systems development by going out and acquiring, for example, COTS software for accounting, a different package for production scheduling, and another one for marketing.

When in-house programming is done with a bottom-up approach, it is difficult to interface the subsystems so that they perform smoothly as a system. Interface bugs are enormously costly to correct, and many of them are not uncovered until programming is complete, when analysts are trying to meet a deadline in putting the system together. At this juncture, there is little time, budget, or user patience for the debugging of delicate interfaces that have been ignored.

Although each small subsystem appears to get the working software what it wants, when the overall system is considered, there are severe limitations to taking a bottom-up approach. One is that there is a duplication of effort in purchasing software and even in entering data. Another is that worthless data are entered into the system. A third, and perhaps the most serious drawback of the bottom-up approach, is that, while pockets of users' needs may have been met, overall organizational objectives are not considered and hence cannot be met.

Top-down design allows the systems analyst to ascertain overall organizational objectives first, as well as to ascertain how they are best met in an overall system. Then the analyst divides that system into subsystems and their requirements.

**Report to Management  
on Structured Walkthrough**

Project Name:	Date of Walkthrough: / / Time:
Project Number:	
Portion (Description) of Work Examined:	
Walkthrough Coordinator: List of Participants:	
Comments:	
Signature of Coordinator:	Action Recommended (Check One):
Date Report Is Filed: / /	<input type="checkbox"/> ACCEPT WORK AS FOUND <input type="checkbox"/> REVISE WORK <input type="checkbox"/> REVISE WORK AND CONDUCT FOLLOW-UP WALKTHROUGH <input type="checkbox"/> REJECT WORK

**FIGURE 16.2**

A form to document structured walkthroughs; walkthroughs can be done whenever a portion of coding, a system, or a subsystem is complete.

Top-down design is compatible with the general systems thinking that was discussed in Chapter 2. When systems analysts employ a top-down approach, they are thinking about the interrelationships and interdependencies of subsystems as they fit into the existing organization. The top-down approach also provides desirable emphasis on synergy or the interfaces that systems and their subsystems require, which is lacking in the bottom-up approach. It helps to answer the question of how teams must work together to accomplish their goals.

The advantages of using a top-down approach to systems design include avoiding the chaos of attempting to design a system all at once. As we have seen, planning and implementing management information systems is incredibly complex. Attempting to get all subsystems in place and running at once is agreeing to fail.

A second advantage of taking a top-down approach to design is that it enables separate systems analysis teams to work in parallel on different but necessary subsystems, which can save a great deal of time. The use of teams for subsystems design is particularly well suited to a total quality assurance approach.

**MAC APPEAL**

An analyst who needs to complete a structured walkthrough might find it useful to take along Things, an app for Apple's iPhone. When the analysts return to the office, they can upload the information to the desktop version. Things is just another way to get organized, but it is much simpler than OMNI-focus (explained elsewhere in this book).

**FIGURE 16.MAC**  
Things from Cultured Code.

A third advantage is that a top-down approach avoids a major problem associated with a bottom-up approach: it prevents systems analysts from getting so mired in detail that they lose sight of what the system is supposed to do.

Total quality management and the top-down approach to design can go hand-in-hand. The top-down approach provides the systems group with a ready-made division of users into task forces (specialized teams of users) for subsystems. Task forces set up in this manner can then serve a dual function as quality circles for the management information system. The necessary structure for quality assurance is then in place, as is proper motivation for getting the subsystem to accomplish the departmental goals that are important to the users involved.

### Using Structure Charts to Design Modular Systems

Once the top-down design approach is taken, the modular approach is useful in programming. This approach involves breaking the programming into logical, manageable portions, or modules. This kind of programming works well with top-down design because it emphasizes the interfaces between modules and does not neglect them until later in systems development. Ideally, each individual module should be functionally cohesive so that it is charged with accomplishing only one function.

Modular program design has three main advantages. First, modules are easier to write and debug because they are virtually self-contained. Tracing an error in a module is less complicated, because a problem in one module should not cause problems in others.

A second advantage of modular design is that modules are easier to maintain. Modifications usually will be limited to a few modules and will not be spread over an entire program.

A third advantage of modular design is that modules are easier to grasp, because they are self-contained subsystems. Hence, a reader can pick up a code listing of a module and understand its function.

Some guidelines for modular programming include the following:

1. Keep each module to a manageable size (ideally including only one function).
2. Pay particular attention to the critical interfaces (the data and control variables that are passed to other modules).
3. Minimize the number of modules the user must modify when making changes.
4. Maintain the hierarchical relationships set up in the top-down phases.

The recommended tool for designing a modular, top-down system is called a structure chart. A structure chart is simply a diagram consisting of rectangular boxes, which represent the modules, and connecting arrows.

Figure 16.3, a set of modules used to change a customer record, shows seven modules that are labeled 000, 100, 110, 120, and so on. Higher-level modules are numbered by 100s, and lower-level modules are numbered by 10s. This numbering allows programmers to insert modules using a number between the adjacent module numbers. For example, a module inserted between modules 110 and 120 would receive number 115.

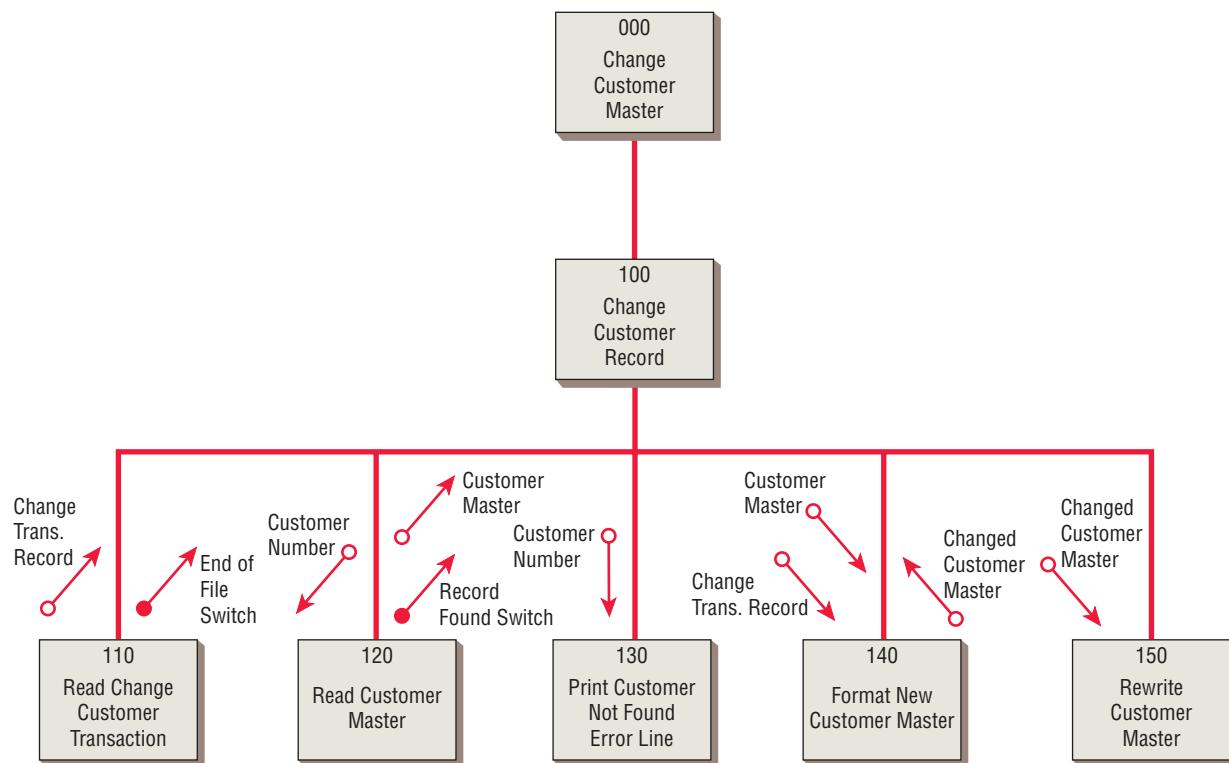
Off to the sides of the connecting lines, two types of arrows are drawn. The arrows with the empty circles are called data couples, and the arrows with the filled-in circles are called control flags or switches. A switch is the same as a control flag except that it is limited to two values: either yes or no. These arrows indicate that something is passed either down to the lower module or up to the upper one.

Ideally, the analyst should keep this coupling to a minimum. The fewer data couples and control flags one has in the system, the easier it is to change the system. When these modules are actually programmed, it is important to pass the least number of data couples between modules.

Even more important is that numerous control flags should be avoided. Control is designed to be passed from lower-level modules to those higher in the structure. On rare occasions, however, it will be necessary to pass control downward in the structure. When control is passed downward, a

**FIGURE 16.3**

A structure chart encourages top-down design using modules.



low-level module is allowed to make a decision, and the result is a module that performs two different tasks. This result violates the ideal of a functional module: It should perform only one task.

Even when a structure chart accomplishes all the purposes for which it was drawn, the structure chart cannot stand alone as the sole design and documentation technique. First, it doesn't show the order in which the modules should be executed (a data flow diagram will accomplish that). Second, it doesn't show enough detail (Structured English will accomplish that).

### Service-Oriented Architecture (SOA)

Modular development has led to a concept called service-oriented architecture (SOA), but one that is very different from the modules in the structure chart. Instead of being hierarchical like the top-down approach found in structure charts, the SOA approach is to make individual SOA services that are unassociated or only loosely coupled to one another.

Each service executes one action. One service may return the number of days in this month; another may tell us if this is a leap year; a third service may reserve five nights in a hotel room from the end of February to the beginning of March. Although the third service needs to know the values obtained from the first and second services, they are independent of one another. Each service can be used in other applications within the organization or even in other organizations.

We can say that service-oriented architecture is simply a group of services that can be called upon to provide specific functions. Rather than including calls to other services, a service can use certain defined protocols so that it can communicate with other services.

Figure 16.4 shows how services are called upon throughout the system. Services can be general in nature and can be outsourced or even be available on the Web. Other services are more specialized and oriented toward the business itself. These enterprise-based services provide business rules and can also differentiate one business from another. Services can be called upon at a time and can be called on repeatedly in many application modules.

The burden of connecting services in a useful fashion, a process called orchestration, is placed upon the systems designer. This can even be accomplished by selecting services from a menu of services and monitoring them by setting up an SOA dashboard.

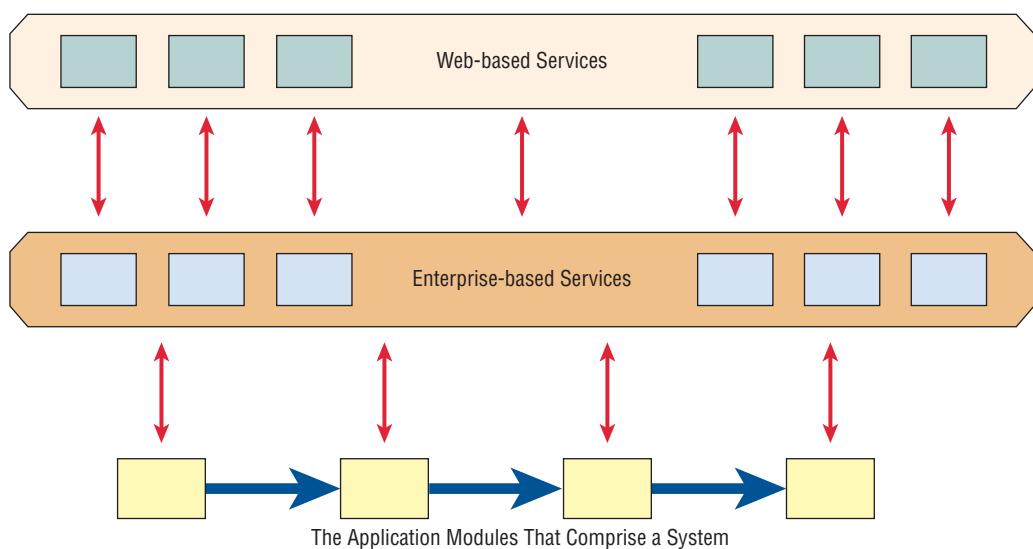
In order to set up an SOA, the services must be:

1. modular,
2. reusable,
3. work together with other modules (interoperability),
4. able to be categorized and identified,
5. able to be monitored, and
6. comply with industry-specific standards.

While the advantages of reusability and interoperability are obvious, SOA is not without its challenges. First industry standards must be agreed upon. Next, a library must be maintained so

**FIGURE 16.4**

Modules in service-oriented architectures are independent and can be ubiquitous.



that developers can find the services they need. Finally, security and privacy can be issues when using software developed by someone else. Advocates of SOA claim that service-oriented architecture has made many of the features found in Web 2.0 possible.

## DOCUMENTATION APPROACHES

The total quality assurance effort requires that programs be documented properly. Software, systems, and formal and informal procedures need to be documented so that systems can be maintained and improved. Documentation allows users, programmers, and analysts to “see” the system, its software, and procedures without having to interact with it.

Turnover of information service personnel has traditionally been high in comparison with other departments, so chances are that the people who conceived of and installed the original system will not be the same ones who maintain it. Consistent, well-updated documentation will shorten the number of hours required for new people to learn the system before performing maintenance.

There are many reasons why systems and programs are undocumented or underdocumented. Some of the problems reside with the systems and programs themselves, others with systems analysts and programmers.

Systems analysts may fail to document systems properly because they do not have the time or are not rewarded for time spent documenting. Some analysts do not document because they dread doing so or think it is not their real work. Furthermore, many analysts are reticent about documenting systems that are not their own, perhaps fearing reprisals if they include incorrect material about someone else’s system. Defenders of the SDLC approach remind us that documentation accomplished by means of a CASE tool during the analysis phases can address many of these problems.

### Procedure Manuals

Procedure manuals are common organizational documents that most people have seen. They are the English-language component of documentation, although they may also contain program codes, flowcharts, and so on. Manuals are intended to communicate to those who use them. They may contain background comments, steps required to accomplish different transactions, instructions on how to recover from problems, and what to do next if something isn’t working (troubleshooting). Many manuals are now available online, with hypertext capability that facilitates use.

A straightforward, standardized approach to creating user support documentation is also desirable. To be useful, user documentation must be kept up to date. Use of the Web has revolutionized the speed with which assistance can be obtained by users. Many software developers have moved user support—complete with manuals, FAQ pages, online chat, and user communities—to the Web.

Key sections of a manual should include an introduction, how to use the software, what to do if things go wrong, a technical reference section, an index, and information on how to contact the manufacturer. The biggest complaints with procedure manuals are that (1) they are poorly organized, (2) it is hard to find needed information in them, (3) the specific case in question does not appear in the manual, and (4) the manual is not written in plain English.

### The FOLKLORE Method

FOLKLORE is a systems documentation technique that was created to supplement some of the techniques just covered. Even with the plethora of techniques available, many systems are inadequately documented or not documented at all. FOLKLORE gathers information that is often shared among users but is seldom written down.

FOLKLORE was first developed in the 1980s by Kendall and Losee, well before the creation of blogs and user communities. FOLKLORE has two main advantages over commonly found user communities: (1) it is structured, resulting in more organized, more complete documentation, and (2) it encourages someone familiar with the software to seek out information rather than depending on users to come forth on their own.

FOLKLORE is a systematic technique, based on traditional methods used in gathering folklore about people and legends. This approach to systems documentation requires the analyst to interview users, investigate existing documentation in files, and observe the processing of information. The objective is to gather information corresponding to one of four categories: customs, tales, sayings, and art forms. Figure 16.5 suggests how each category relates to the documentation of information systems.



## CONSULTING OPPORTUNITY 16.2

### Write Is Right

**I**t's so easy to understand. I say if everybody uses pseudocode, we won't have trouble, you know, with things not being standardized," says Al Gorithm, a new programmer who will be working with your systems analysis team. Al is speaking to an informal meeting among three members of the systems analysis team, a six-person MIS task force from the advertising department, and two programmers, who were all working to develop an information system for advertising personnel.

Philip, an advertising account executive and one of the members of the MIS task force, looks up in surprise. "What is this method called?" The two programmers reply at the same time, "Pseudocode." Philip looks unimpressed and says, "That doesn't say anything to me."

Neeva Phail, one of the systems analysts, begins explaining. "It probably won't matter one way or the other what we use, if—"

Flo Chart, another systems analyst, breaks in saying, "I hate pseudocode." She looks hopefully at the programmers. "I'm sure we can agree on a better technique."

David, an older advertising executive, seems slightly upset, stating, "I learned about flowcharting from the first systems analysts we had years ago. Don't you people do that anymore? I think they work best."

What was at first a friendly meeting suddenly seems to have reached an impasse. The participants are looking at each other warily. As a systems analyst who has worked on many different projects with many different kinds of people, you realize that the group is looking to you to make some reasonable suggestions.

Based on what you know about the various documentation techniques, what technique(s) would you propose to the members of the group? How will the technique(s) you proposed overcome some of the concerns they have voiced? What process will you use to decide on appropriate techniques? Compose your answer in one page.

When documenting customs, the analyst (or other folklorist) tries to capture in writing what users are currently doing to get all programs to run without problems. An example of a custom is: "Usually, we take two days to update the monthly records because the task is quite large. We run commercial accounts on day one and save the others for the next day."

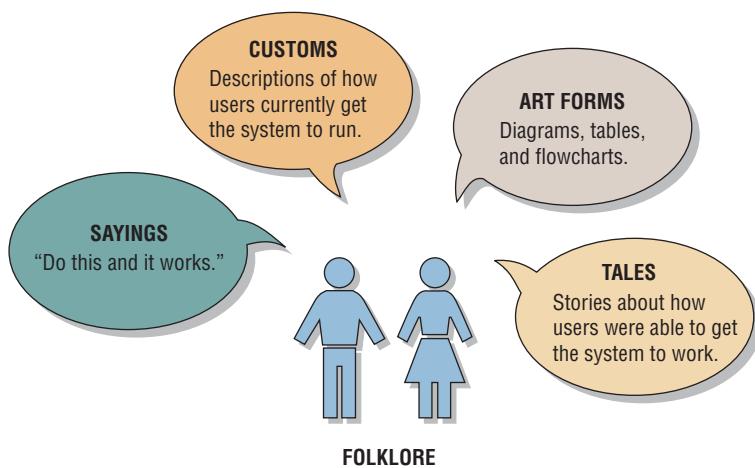
Tales are stories that users tell regarding how the system worked. The accuracy of the tale, of course, depends on the user's memory and is at best an opinion about how the program worked. Tales normally have a beginning, a middle, and an end. So we would have a story about a problem (the beginning), a description of the effects (the middle), and the solution (the end).

Sayings are brief statements representing generalizations or advice. We have many sayings in everyday life, such as "April showers bring May flowers," or "A stitch in time saves nine." In systems documentation, we have many sayings, such as "Omit this section of code and the program will bomb," or "Always back up frequently." Users like to give advice, and the analyst should try to capture this advice and include it in the FOLKLORE documentation.

Gathering art forms is another important activity of traditional folklorists, and the systems analyst should understand its importance, too. Flowcharts, diagrams, and tables that users draw

**FIGURE 16.5**

Customs, tales, sayings, and art forms used in the FOLKLORE method of documentation apply to information systems.





## HYPERCASE® EXPERIENCE 16.1

“This is a fascinating place to work. I’m sure you agree, now that you’ve had a chance to observe us. Sometimes I think it must be fun to be an outsider . . . don’t you feel like an anthropologist discovering a new culture? I remember when I first came here. Everything was so new, so strange. Why, even the language was different. It wasn’t a ‘customer,’ it was a ‘client.’ We didn’t have ‘departments,’ we had ‘units.’ It’s not an employee cafeteria, it’s the ‘canteen.’ That goes for the way we work, too. We all have our different ways to approach things. I think I’m getting the hang of what Snowden expects, but every once in a while I make a mistake, too. For instance, if I can give him work online, he’d just as soon see it that way than get a printed report. That’s why I have two computers on my desk, too! I always see you taking so many notes . . . I guess it makes sense, though. You’re supposed to document what we do with our systems and information as well as what your team is doing, aren’t you?”

### HYPERCASE Questions

1. Use the FOLKLORE method to complete the documentation of the Management Information Systems Unit GEMS system. Be sure to include customs, tales, sayings, and art forms.
2. In two paragraphs, suggest a PC-based approach for capturing the elements of FOLKLORE so that it is not necessary to use a paper-based log. Make sure that your suggested solution can accommodate graphics as well as text.
3. Design input and output screens for FOLKLORE that facilitate easy entry, and provide prompting so that recall of FOLKLORE elements is immediate.



**FIGURE 16.HC1**

In HyperCase, use FOLKLORE to document art forms that users have created or collected to make sense of their systems.

sometimes may be better or more useful than flowcharts drawn by the original system author. Analysts will often find such art posted on bulletin boards, or they may ask the users to clean out their files and retrieve any useful diagrams.

Contributors to the FOLKLORE document do not have to document the entire system, only the parts they know about. Just like with Web-based user communities, the danger of relying on FOLKLORE is that the information gathered from users may be correct, partially correct, or incorrect.

### Choosing a Design and Documentation Technique

The techniques discussed in this chapter are extremely valuable as design tools, memory aids, productivity tools, and as a means of reducing dependencies on key staff members. The systems analyst, however, is faced with a difficult decision regarding which method to adopt. The following is a set of guidelines to help the analyst use the appropriate technique.

Choose a technique that:

1. Is compatible with existing documentation.
2. Is understood by others in the organization.
3. Allows you to return to working on the system after you have been away from it for a period of time.
4. Is suitable for the size of the system on which you are working.
5. Allows for a structured design approach if that is considered to be more important than other factors.
6. Allows for easy modification.

## TESTING, MAINTENANCE, AND AUDITING

Once the analyst has designed and coded the system, testing, maintenance, and auditing of it are prime considerations.

### The Testing Process

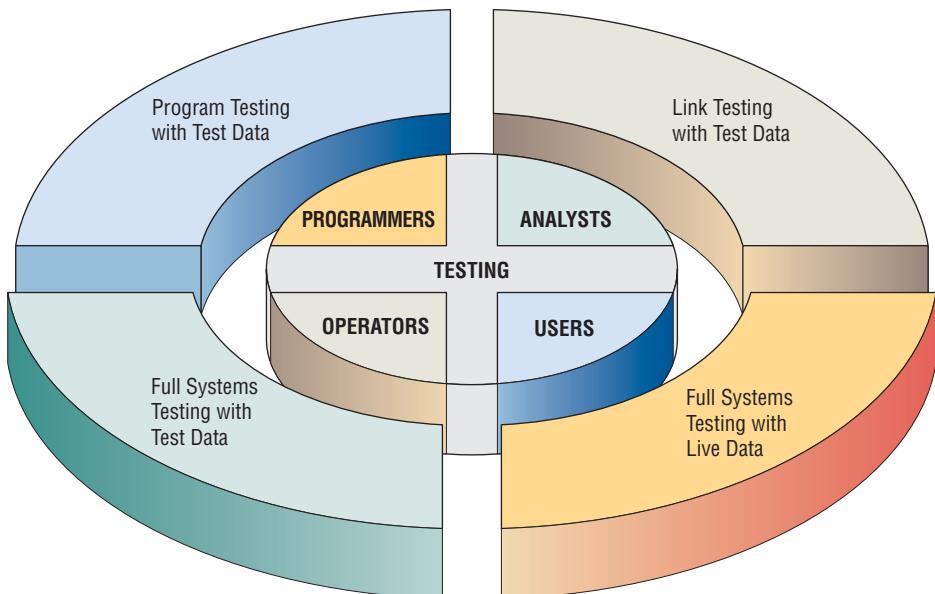
All the system's newly written or modified application programs—as well as new procedural manuals, new hardware, and all system interfaces—must be tested thoroughly. Haphazard, trial-and-error testing will not suffice. Testing is done throughout systems development, not just at the end. It is meant to turn up heretofore unknown problems, not to demonstrate the perfection of programs, manuals, or equipment.

Although testing is tedious, it is an essential series of steps that helps ensure the quality of the eventual system. It is far less disruptive to test beforehand than to have a poorly tested system fail after installation. Testing is accomplished on subsystems or program modules as work progresses. Testing is done on many different levels at various intervals. Before the system is put into production, all programs must be desk checked, checked with test data, and checked to see if the modules work together with one another as planned.

The system as a working whole must also be tested. Included here are testing the interfaces between subsystems, the correctness of output, and the usefulness and understandability of systems documentation and output. Programmers, analysts, operators, and users all play different roles in the various aspects of testing, as shown in Figure 16.6. Testing of hardware is typically

**FIGURE 16.6**

Programmers, analysts, operators, and users all play different roles in testing software and systems.



provided as a service by vendors of equipment, who will run their own tests on equipment when it is delivered onsite.

**PROGRAM TESTING WITH TEST DATA.** Much of the responsibility for program testing resides with the original author(s) of each program. The systems analyst serves as an advisor and coordinator for program testing. In this capacity, the analyst works to ensure that correct testing techniques are implemented by programmers but probably does not personally carry out this level of checking.

At this stage, programmers must first desk check their programs to verify the way the system will work. In desk checking, the programmer follows each step in the program on paper to check whether the routine works as it is written.

Next, programmers must create both valid and invalid test data. These data are then run to see if base routines work and also to catch errors. If output from main modules is satisfactory, you can add more test data so as to check other modules. Created test data should test possible minimum and maximum values as well as all possible variations in format and codes. File output from test data must be carefully verified. It should never be assumed that data contained in a file are correct just because a file was created and accessed.

Throughout this process, the systems analyst checks output for errors, advising the programmer of any needed corrections. The analyst will usually not recommend or create test data for program testing but might point out to the programmer omissions of data types to be added in later tests.

**LINK TESTING WITH TEST DATA.** When programs pass desk checking and checking with test data, they must go through link testing, which is also referred to as string testing. Link testing checks to see if programs that are interdependent actually work together as planned.

The analyst creates special test data that cover a variety of processing situations for link testing. First, typical test data are processed to see if the system can handle normal transactions, those that would make up the bulk of its load. If the system works with normal transactions, variations are added, including invalid data used to ensure that the system can properly detect errors.

**FULL SYSTEMS TESTING WITH TEST DATA.** When link tests are satisfactorily concluded, the system as a complete entity must be tested. At this stage, operators and end users become actively involved in testing. Test data, created by the systems analysis team for the express purpose of testing system objectives, are used.

As can be expected, there are a number of factors to consider when systems testing with test data:

1. Examining whether operators have adequate documentation in procedure manuals (hard copy or online) to afford correct and efficient operation.
2. Checking whether procedure manuals are clear enough in communicating how data should be prepared for input.
3. Ascertaining if work flows necessitated by the new or modified system actually “flow.”
4. Determining if output is correct and whether users understand that this output is, in all likelihood, as it will look in its final form.

Remember to schedule adequate time for system testing. Unfortunately, this step often gets dropped if system installation is lagging behind the target date.

Systems testing includes reaffirming the quality standards for system performance that were set up when the initial system specifications were made. Everyone involved should once again agree on how to determine whether the system is doing what it is supposed to do. This step will include measures of error, timeliness, ease of use, proper ordering of transactions, acceptable down time, and understandable procedure manuals.

**FULL SYSTEMS TESTING WITH LIVE DATA.** When systems tests using test data prove satisfactory, it is a good idea to try the new system with several passes on what is called live data, data that have been successfully processed through the existing system. This step allows an accurate comparison of the new system’s output with what you know to be correctly processed output, as well as a good idea for testing how actual data will be handled. Obviously, this step is not possible when creating entirely new outputs (for instance, output from an ecommerce transaction from a new corporate Web site). As with test data, only small amounts of live data are used in this kind of system testing.



## CONSULTING OPPORTUNITY 16.3

### Cramming for Your Systems Test

**W**e're strapped for time. Just look at this projection," says Lou Scuntroll, the newest member of your systems analysis team, showing you the PERT diagram that the team has been using to project when the new system would be up and running. "We can't possibly make the July target date for testing with live data. We're running three weeks behind because of that slow equipment shipment."

As one of the systems analysts who has seen deadlines come and go on other projects, you try to remain calm and to size up the situation carefully before you speak. Slowly, you question Lou about the possibility of delaying testing.

Lou replies, "If we try to push the testing off until the first weeks of August, there are two key people from accounting who are going to be out on vacation." Lou is visibly upset at the possibility of missing the deadline.

Stan Dards, another junior member of your systems analysis team, enters Lou's office. "You two look terrible. Things are going okay, aren't they? I'm not reassigned to program a payroll application, am I?"

Lou looks up, obviously neither appreciating Stan's sense of humor nor what seems like his single-minded self-concern. "Good thing you came in when you did. We've got some big decisions to make about scheduling." Lou holds up the PERT diagram for Stan's inspection. "Notice the July test date. Notice that there is no way we can make it. Any bright ideas?"

Stan contemplates the chart momentarily, then states, "Something's got to go. Let's see here . . . maybe move testing of the accounting module to—"

Lou interrupts, saying bluntly, "Nope, already thought of that, but Stanford and Binet from accounting are out of town in August. Maybe we can skip that portion of the testing. They've been really cooperative. I don't think they'd object if we just 'do it for real' and test as we actually go into production."

"I think that's a good idea, Lou," Stan agrees, trying to make up for his earlier jokes. "We haven't had any real trouble with that, and the programmers sure are confident. That way we could stay on schedule with everything else. I vote for *not* testing the accounting portion, but just sort of winging it when it starts up."

As the most senior member of the team present, what can you do to convince Lou and Stan about the importance of testing the accounting module with live data? What can systems analysts do in planning their time to allow adequate time for testing with test and live data? What are some of the possible problems the team members may encounter if they do not test the system completely with live data before putting the system into production? Realistically, are there steps in the systems analysis and design process that can be collapsed to bring a delayed project in on time? Respond to these questions in two pages.

Although much thought is given to user-system interaction (see Chapter 14), you can never fully predict the wide range of differences in the way users will actually interact with the system. It is not enough to interview users about how they are interacting with the system; you must observe them firsthand.

Items to watch for are ease of learning the system and user reaction to system feedback, including what happens when an error message is received, and what happens when the user is informed that the system is executing his or her commands. Be particularly sensitive to how users react to system response time and to the language of responses. Also listen to what users say about the system as they encounter it. Any real problems need to be addressed before the system is put into production, not just glossed over as adjustments to the system that users and operators ought to make on their own.

Procedure manuals, just like computer software, also need to be tested. Although manuals can be proofread by support staff and checked for technical accuracy by the systems analysis team, the only real way to test them is to have users and operators try them, preferably during full systems testing with live data. Consider user suggestions, and incorporate them into the final versions of Web pages, printed manuals, and other documentation.

### Maintenance Practices

Your objective as a systems analyst should be to install or modify systems that have a reasonably useful life. You want to create a system whose design is comprehensive and farsighted enough to serve current and projected user needs for several years to come. Part of your expertise should be used to project what those needs might be and then build flexibility and adaptability into the system. The better the system design, the easier it will be to maintain and the less money the business will have to spend on maintenance.

Reducing maintenance costs is a major concern, because software maintenance alone can devour upward of 50 percent of the total data processing budget for a business. Excessive maintenance costs reflect directly back on the system's designer, because approximately 70 percent of software errors have been attributed to inappropriate software design. From a systems perspective, it makes sense that detecting and correcting software design errors early on is less costly than letting errors remain unnoticed until maintenance is necessary.

Maintenance is performed most often to improve the existing software rather than to respond to a crisis or system failure. Maintenance is also done to update software in response to the changing organization. This work is not as substantial as enhancing the software, but it must be done. Emergency and adaptive maintenance comprises less than half of all system maintenance.

Part of the systems analyst's job is to ensure that there are adequate channels and procedures in place to permit feedback about—and subsequent response to—maintenance needs. Users must be able to communicate problems and suggestions easily to those who will be maintaining the system. Solutions are to provide users email access to technical support, as well as to allow them to download product updates or patches from the Web.

## Auditing

Auditing is yet another way of ensuring the quality of the information contained in the system. Broadly defined, auditing refers to having an expert who is not involved in setting up or using a system examine information in order to ascertain its reliability. Whether or not information is found to be reliable, the finding on its reliability is communicated to others for the purpose of making the system's information more useful to them.

For information systems, there are generally two kinds of auditors: internal and external. Whether both are necessary for the system you design depends on what kind of system it is. Internal auditors work for the same organization that owns the information system, whereas external (also called independent) auditors are hired from the outside.

External auditors are used when the information system processes data that influences a company's financial statements. External auditors audit the system to ensure the fairness of the financial statements being produced. They may also be brought in if there is something out of the ordinary occurring that involves company employees, such as suspected computer fraud or embezzlement.

Internal auditors study the controls used in the information system to make sure that they are adequate and that they are doing what they are purported to be doing. They also test the adequacy of security controls. Although they work for the same organization, internal auditors do not report to the people responsible for the system they are auditing. The work of internal auditors is often more in-depth than that of external auditors.

## IMPLEMENTING DISTRIBUTED SYSTEMS

If the reliability of a telecommunications network is high, it is possible to have distributed systems for businesses, a setup that can be conceived of as an application of telecommunications. The concept of distributed systems is used in many different ways. Here it will be taken in a broad sense so that it includes workstations that can communicate with each other and data processors, as well as different hierarchical architectural configurations of data processors that communicate with each other and that have differing data storage capabilities.

In this model, the processing functions are delegated either to clients (users) or to servers, depending on which machines are most suitable for executing the work. In this type of architecture, the client portion of a network application will run on the client system, with the server part of the application running on the file server. With a client-server model, users interact with limited parts of the application, including the user interface, data input, database queries, and report generation. Controlling user access to centralized databases, retrieving or processing data, and other functions (such as managing peripheral devices) are handled by the server.

### Client-Server Technology

The client-server model, client-server computing, client-server technology, and client-server architecture all refer to a design model that can be thought of as applications running on a network.

In very basic terms, you can picture the client requesting—and the server executing or in some way fulfilling—the request. That would be considered two-tier client-server architecture.

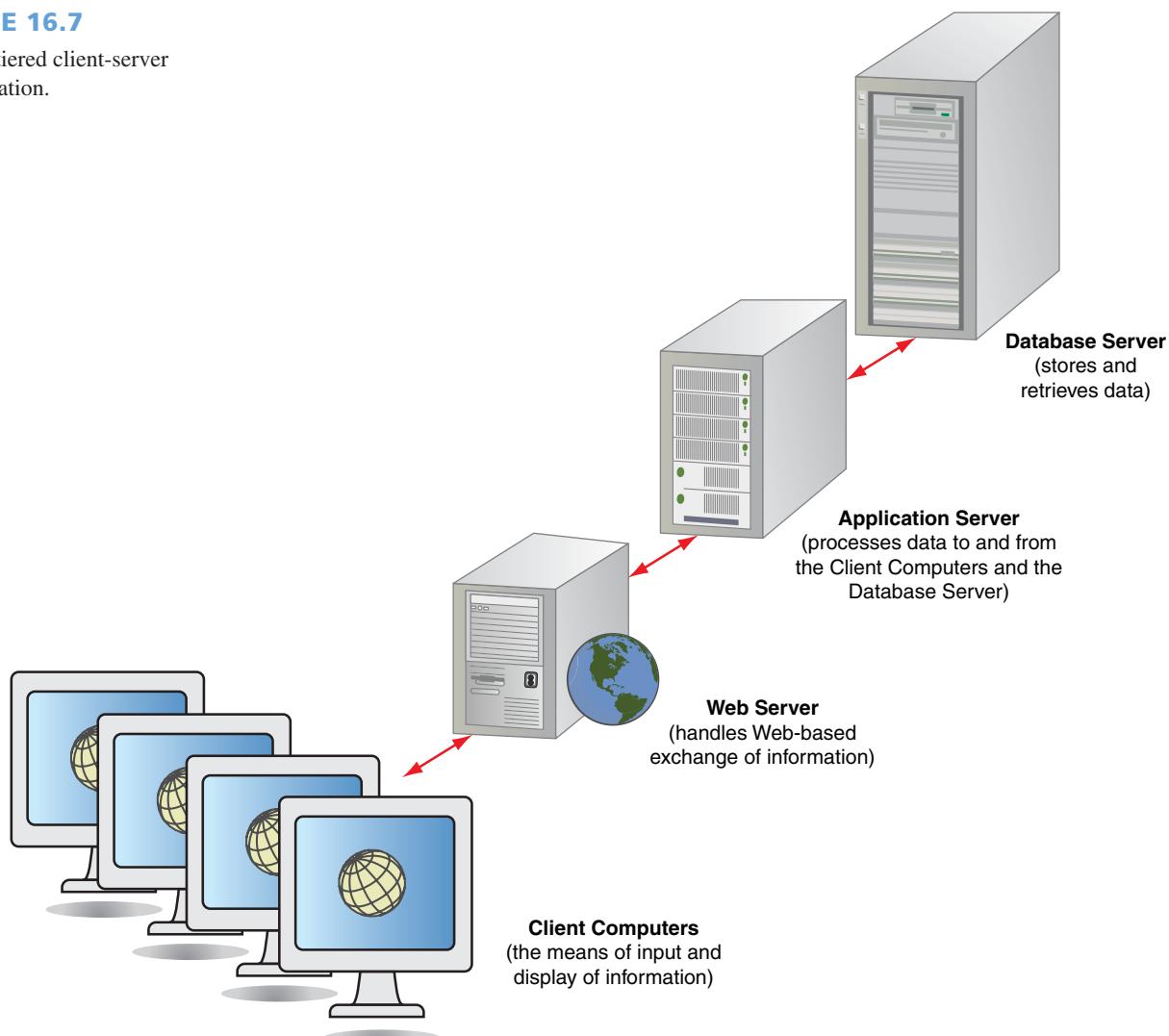
A more involved configuration uses three sets of computers to accomplish retrieval, processing, storage, and receiving of data. Figure 16.7 shows a three-tiered client-server model. In this figure, client computers access three different tiers of servers; Web servers, which handle Web-based exchange of information; application servers, which process data to and from the client computers and the database server; and the database server, which stores and receives data. The computers on the network are programmed to perform work efficiently by dividing up processing tasks among clients and servers.

When you think of the client-server model, you should think of a system that accentuates the users as the center of the work, with their interaction with data being the key concept. Although there are two elements working—the client and the server—it is the intent of the client-server model that users view it as one system. Indeed, the hope is that users are unaware of how the client-server network is performing its distributed processing, because it should have the look and feel of a unified system. In a peer-to-peer network, PCs can act as either the server or the client, depending on the requirements of the application.

**CLIENTS AS PART OF THE CLIENT-SERVER MODEL.** When you see the term *client*, you might be tempted to think of people or users; for example, we speak of “clients of our consulting practice.” In the client-server model, however, the term *client* refers not to people but to networked machines that are typical points of entry to the client-server system that is used by humans. Therefore, clients could be networked desktop computers, a workstation, or notebook computers, or any other way in which the user can enter the system.

**FIGURE 16.7**

A three-tiered client-server configuration.



Using a graphical user interface (GUI), individuals typically interface directly only with the client part. Client workstations use smaller programs that reside in the client to do front-end processing (as opposed to the back-end processing, mentioned later), including communicating with the user. If an application is called a client-based application, the application resides in a client computer and cannot be accessed by other users on the network.

**WEIGHING THE ADVANTAGES AND DISADVANTAGES OF THE CLIENT-SERVER MODEL.** Early adopters of the client-server model found that they were not always the best solution to an organization's computing problems. Often, the systems designer is asked to endorse a client-server model that is already in the works. Just as with any other corporate computing proposal that you did not have an active part in creating, you must review the plan carefully. Will the organization's culture support a client-server model? What kinds of changes must be made in the informal culture and in the formal work procedures before a client-server model can be used to its full potential? What should your role as a systems analyst be in this situation?

Although lower processing costs are cited as a benefit of the client-server model, there is very little actual data available to prove it (even though there is some anecdotal evidence to support this claim). There are well-documented high start-up or switch-over costs associated with a movement to a client-server architecture. Applications for the client-server model must be written as two separate software components, each running on separate machines, but they must appear as if they are operating as one application. Using the client-server model, however, affords greater computer power and greater opportunity to customize applications than other options.

Although networks can be characterized by their shape or topology, they are also discussed in terms of their geographic coverage and the kinds of services they offer. Standard types of networks include a wide area network (WAN) and a local area network (LAN). LANs are standard for linking local computers or terminals within a department, building, or several buildings of an organization. WANs can serve users over several miles or across entire continents.

Networking is now technically, economically, and operationally feasible for small offices as well, and it provides a solution that analysts must consider for small businesses. One of the costly aspects of implementing a LAN is that each time it is moved, it must be rewired. Some organizations are coping with this by setting up a high-speed, wireless local area network (WLAN). More specifically, these wireless networks are called Wi-Fi.

## Cloud Computing

The most rapidly growing type of computing is cloud computing. Cloud computing has been described as a metaphor for the Internet, since the Internet is often drawn as a cloud in network diagrams. Using cloud computing, organizations and individual users can use Web services, database services, and application services over the Internet, without having to invest in corporate or personal hardware, software, or software tools. Figure 16.8 depicts the exchanges between client computers and services in the cloud. Businesses use Web browsers such as Microsoft Internet Explorer or Mozilla Firefox to access applications. As you can see, servers store software and data for businesses.

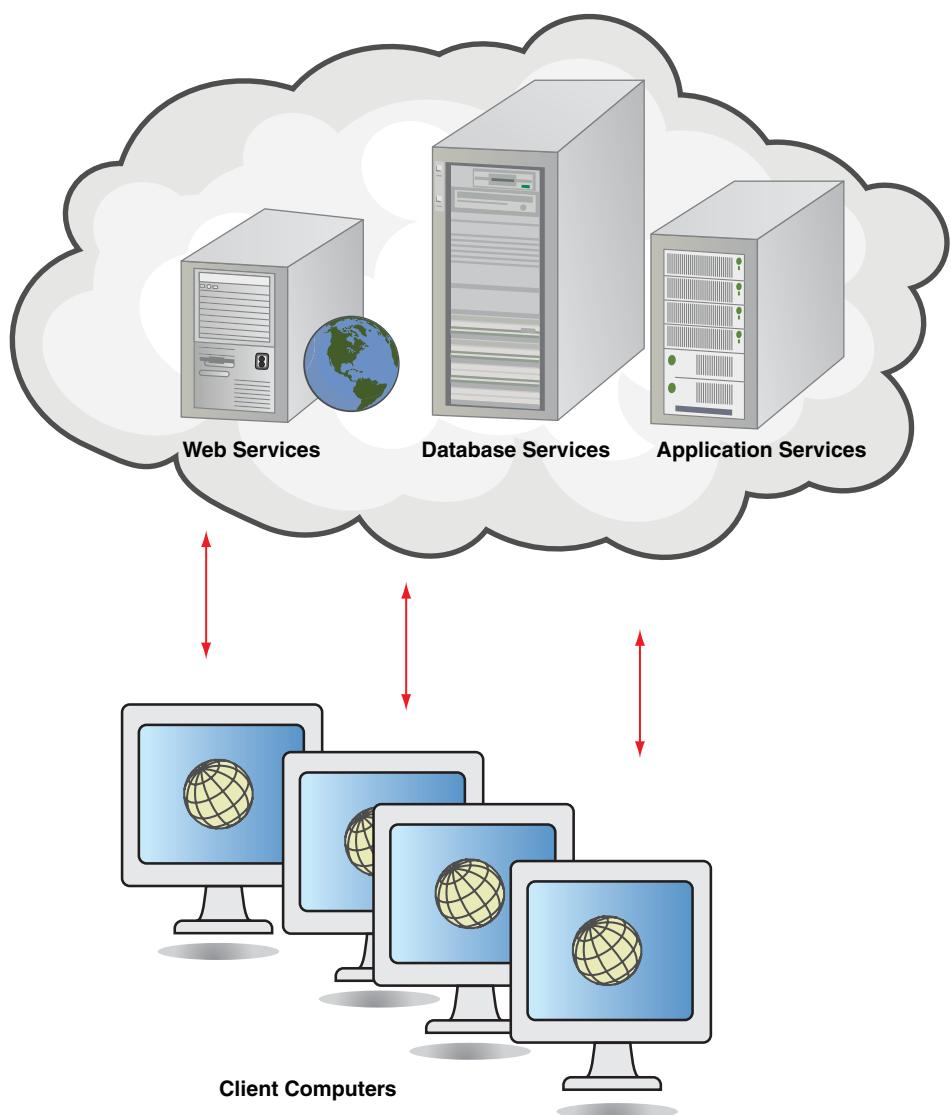
Many large, well-established hardware, software, and consulting companies such as Cisco, Dell, IBM, HP, Microsoft, SAP, and others are creating massive cloud computing endeavors, often with what are termed "virtualized resources." What is distinct about these approaches is their ability to grow and adapt to changing business needs. That is, they are scalable to suit growing (or changing) demand by users. The model of "software as a service," also called SaaS, is included in the concept of cloud computing.

For their part, users do not need to understand, control, or be experts in the technology infrastructure that composes the complex cloud infrastructure that enables them to accomplish their work. Often, organizations do not need to keep IT staff to scale up or down even when a contract or company budget changes upward or downward because of the lessened impact of these changes.

Often organizations that are using cloud computing do not find it necessary to make up-front capital expenditures on IT infrastructure, so it enables smaller companies with smaller and less predictable budgets to make advances in processing more quickly. It also allows larger corporations to invest in strategic projects rather than IT infrastructure.

**FIGURE 16.8**

Cloud computing offers many services.



Sharing IT resources via cloud computing means that a large collection of corporate users share Web services, but also then jointly bear the lowered cost of them; realize increases in peak-load capacity, and that underutilized systems are used more efficiently and widely.

Companies also hope to improve their ability to perform disaster recovery by using cloud computing that provides many redundant sites. While cloud computing is not immune to outages, it can spread the risk to multiple servers.

Organizations try to improve security via cloud computing by using services that are sold as possessing a security focus. However, there are concerns that centralization of this sort also can translate into loss of control over mission-critical data. Users might benefit from the mobility afforded by being liberated from a single computer installation or single interface. Rather, Web browsers and Web-based services made available through cloud computing free users to access applications from anywhere at any time without regard for location or the device they are using.

Many large software companies (some of which are called “pure players” since they have never existed as brick-and-mortar enterprises) are offering applications using cloud computing, where users can use their Web browser to access applications. These include Google Apps (for spreadsheets and calendars), Amazon Web Services, Akami, and CRM software by Salesforce.com that is now available on the iPhone as well. These software purveyors state that they are attempting to lower the cost to the user, as well as to provide increased flexibility.

Some observers believe that the move to cloud computing is a way for older, larger companies to solidify and retain their core businesses by incorporating SaaS (software as a service),

SOA (Service-Oriented Architecture), virtualization, open source, and many other trends from the last decade into their offerings of software, software tools, services, and computing power via the Internet. However, if the cost of infrastructure were to fall dramatically (as it has historically), the drive toward cloud computing could reverse. If that happened, organizations might make different decisions, and once again invest in their own infrastructure. In addition, many of the online services comprising cloud computing are being paid for through advertising revenue. In a faltering economy, advertising incomes would decline, and cloud computing sponsorships could dwindle as well.

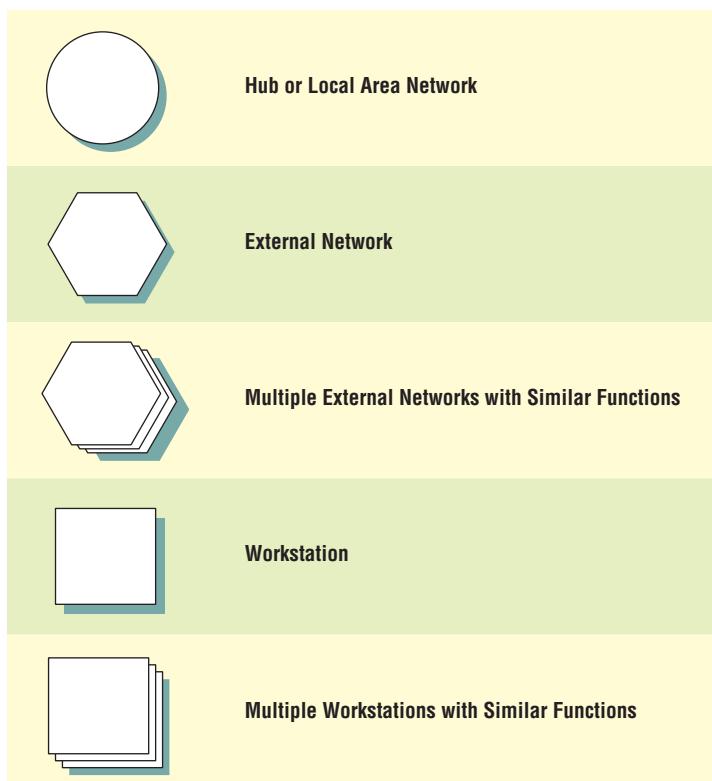
## Network Modeling

Because networking has become so important, the systems designer needs to consider network design. Whether a systems designer gets involved with decisions about the configurations of networks—or whether he or she worries about hardware such as routers and bridges that must be in place when networks meet—the systems designer must always consider the logical design of networks.

An analyst should adopt a set of symbols such as the ones in Figure 16.9 to model the network. It is useful to have distinct symbols to distinguish among hubs, external networks, and workstations. It is also useful to adopt a convention for illustrating multiple networks and workstations. The first step is to draw a network decomposition diagram that provides an overview of the system. Next, draw a hub connectivity diagram. Finally, explode the hub connectivity diagram to show the various workstations and how they are to be connected.

**DRAWING A NETWORK DECOMPOSITION DIAGRAM.** We can illustrate drawing a network decomposition model by referring once again to the World's Trend Catalog Division example from earlier chapters. Start by drawing a circle at the top and labeling it "World's Trend Network." Now draw a number of circles on the level below, as shown in Figure 16.10. These circles represent hubs for the Marketing Division and each of the three order-entry and distribution centers (the U.S. Division, the Canadian Division, and the Mexican Division).

We can extend this drawing further by drawing another level. This time, we can add the workstations. For example, the Marketing Division has two workstations connected to it, whereas the U.S. Division has 33 workstations on its LAN (Administration, the Warehouse, the Order-Entry

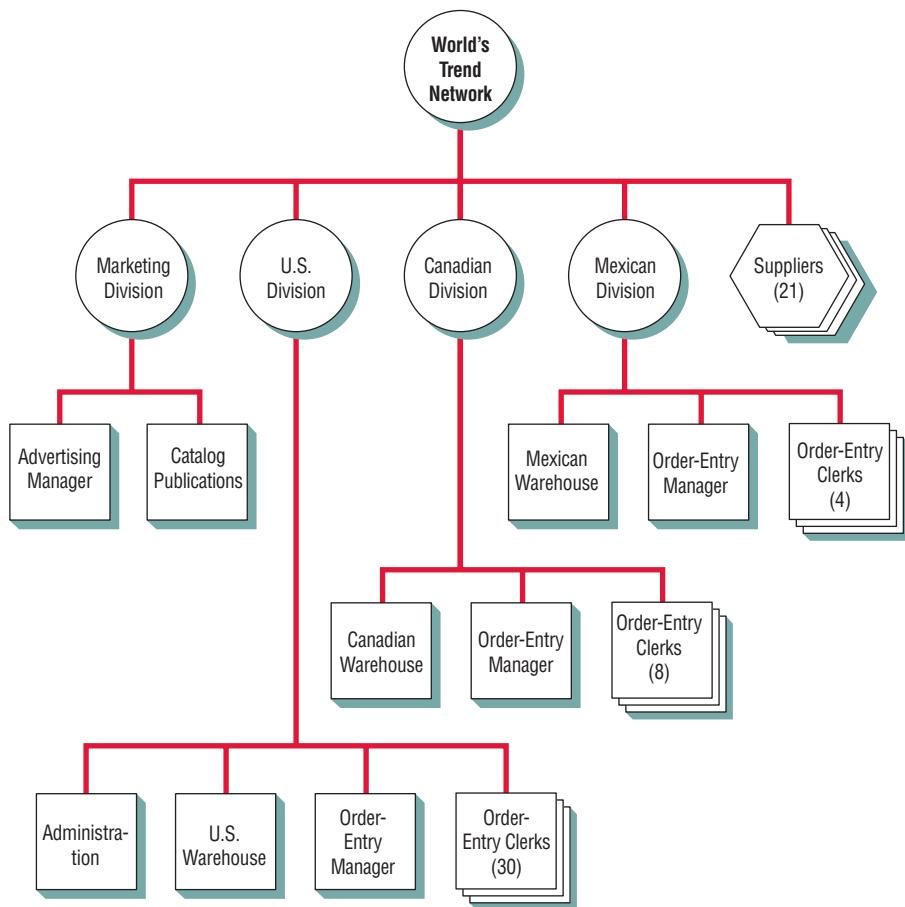


**FIGURE 16.9**

Use special symbols when drawing network decomposition and hub connectivity diagrams.

**FIGURE 16.10**

A network decomposition diagram for World's Trend.

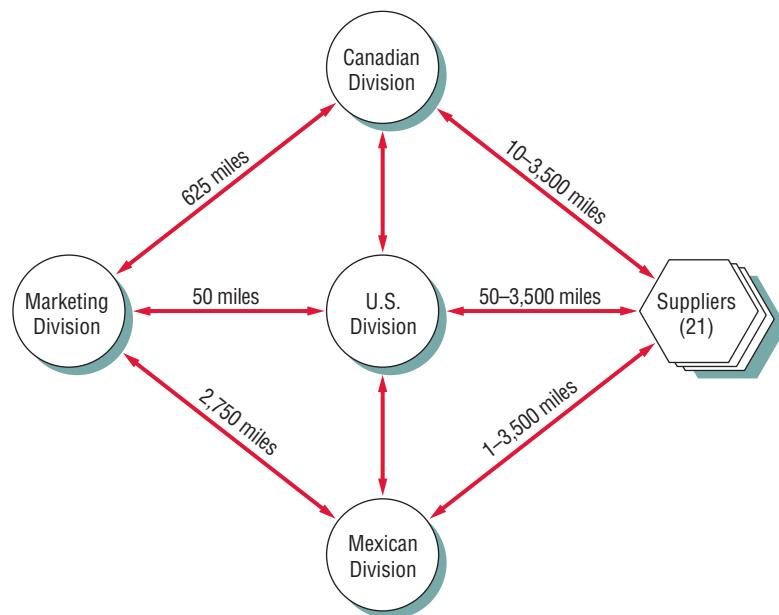


Manager, and 30 Order-Entry Clerks). This network is simplified for the purpose of providing a readily understandable example.

**CREATING A HUB CONNECTIVITY DIAGRAM.** The hub connectivity diagram is useful for showing how the major hubs are connected. At World's Trend, shown in Figure 16.11, there are four major hubs that are all connected to one another. In addition, there are external hubs (suppliers) that need

**FIGURE 16.11**

A hub connectivity diagram for World's Trend.



to be notified when inventory drops below a certain point, and so on. Each of the three country divisions are connected to the 21 suppliers; the Marketing Division, however, does not need to be connected to suppliers.

To produce an effective hub connectivity diagram, start by drawing all the hubs. Then experiment (perhaps sketching it first on a sheet of paper) to see which links are necessary. Once that is done, you can redraw the diagram so that it is attractive and communicates well to users.

#### **EXPLODING THE HUB CONNECTIVITY DIAGRAM INTO A WORKSTATION CONNECTIVITY DIAGRAM.**

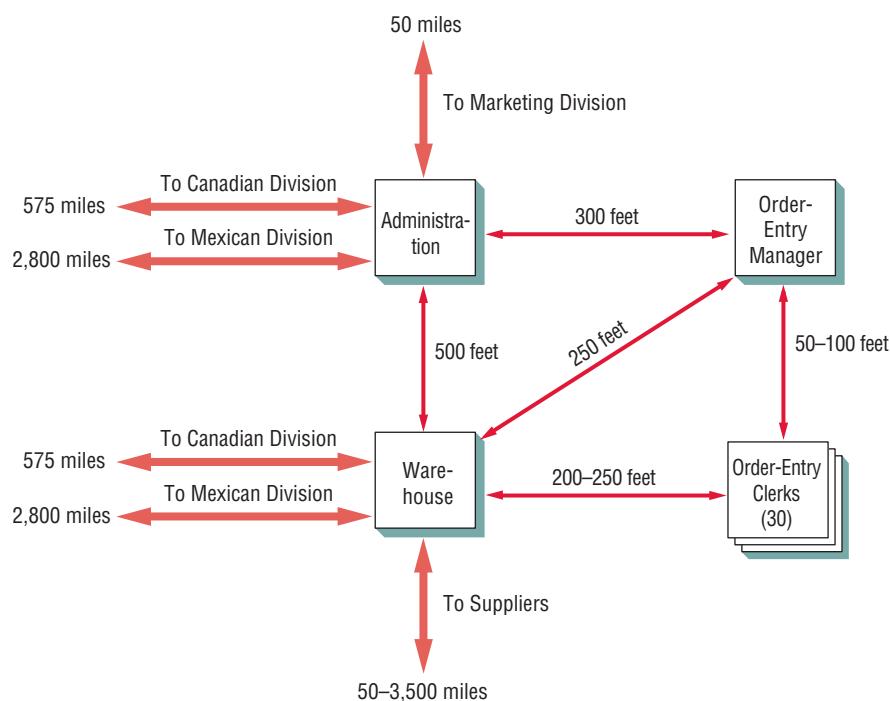
The purpose of network modeling is to show the connectivity of workstations in some detail. To do so, we explode the hub connectivity diagram. Figure 16.12 shows each of the 33 workstations for the U.S. Division and how they are to be connected.

Draw the diagrams for this level by examining the third level of the network decomposition diagram. Group items such as Order-Entry Manager and Order-Entry Clerks together, because you already recognize that they must be connected. Use a special symbol to show multiple workstations and indicate in parentheses the number of similar workstations. In our example, there are 30 Order-Entry Clerks.

On the perimeter of the diagram, place workstations that must be connected to other hubs. In this way, it will be easier to represent these connections using arrows. Draw the external connections in a different color or use thicker arrows. External connections are usually long distance. For example, Administration is connected to the Marketing Division, which is 50 miles away, and also to the Canadian and Mexican Divisions. The Warehouse needs to communicate directly with the Canadian and Mexican warehouses in case it is possible to obtain the merchandise from another warehouse. The Order-Entry Manager and Order-Entry Clerks do not have to be connected to anyone outside their LAN.

**ADVANTAGES OF DISTRIBUTED SYSTEMS.** Distributed systems allow the storage of data where they are not in the way of any online real-time transactions. For example, response time on inquiries might be improved if not all records need to be searched before a response is made. In addition, not all data are needed by all users all the time, so they can be stored in less-expensive media at a different site and only accessed when needed.

Use of distributed systems can also lower equipment costs, because not all parts of the system need to be able to perform all functions. Some capabilities, such as processing and storage, can be shared.



**FIGURE 16.12**

A workstation connectivity diagram for World's Trend.

**FIGURE 16.13**

There are five main advantages to creating distributed systems.

**Advantages of Distributed Systems**

- Allow data storage out of the way of online, real-time transactions
- Allow less expensive media for data storage when all data are not needed all the time by all users
- Lower equipment cost because not all system parts need to perform all functions
- Lower equipment cost by permitting flexibility in choice of manufacturer
- Less expensive than large systems initially because expansion can be planned for without actually purchasing hardware

Distributed systems can also help lower costs by permitting flexibility in the choice of manufacturer, because the whole focus of networks is on communicating between nodes, and manufacturers make compatible components. This compatibility allows the user to shop for price as well as for function. Furthermore, distributed systems can be less expensive initially than large systems because it is feasible to plan for expansion without actually having to buy hardware at the time the system is implemented. Developing corporate intranets is a proactive way to network organizational members, a way that can also serve as a means for cutting down on problematic aspects of the Internet (such as aimless Web surfing during corporate time, or possible security breakdowns caused by lack of firewalls) and at the same time support group work with useful applications. Extranets formed with suppliers and other important partners are also excellent ways of demonstrating that a business is outward looking and accessible. Advantages of distributed systems are given in Figure 16.13.

**DISADVANTAGES OF DISTRIBUTED SYSTEMS.** Distributed systems pose some unique problems that centralized computer systems do not. The analyst needs to weigh these problems against the advantages just presented and to raise them with the concerned business as well.

The first problem is that of network reliability. To make a network an asset rather than a liability, it must be possible to transmit, receive, process, and store data reliably. If there are too many problems with system reliability, the system will be abandoned.

Distributing greater computing power to individuals increases the threat to security because of widespread access. The need for secret passwords, secure computer rooms, and adequate security training of personnel are all concerns that multiply when distributed systems are implemented.

Systems analysts creating distributed systems need to focus on the network itself or on the synergistic aspect of distributed systems. Their power resides in their ability to interact as user work-groups share data. If the relationship between subsystems is ignored or deemphasized, you are creating more problems than you are solving. Disadvantages of distributed systems are listed in Figure 16.14.

**TRAINING USERS**

Systems analysts engage in an educational process with users that is called training. Throughout the systems development life cycle, the user has been involved so that by now the analyst should possess an accurate assessment of the users who must be trained.

**FIGURE 16.14**

There are four chief disadvantages to creating distributed systems.

**Disadvantages of Distributed Systems**

- Difficulty in achieving a reliable system
- Security concerns increase commensurately when more individuals have access to the system
- Analysts must emphasize the network and the interactions it provides and deemphasize the power of subsystems
- Choosing the wrong level of computing to support (i.e., individual instead of department, department instead of branch)

In the implementation of large projects, the analyst will often be managing the training rather than be personally involved in it. One of the most prized assets the analyst can bring to any training situation is the ability to see the system from the user's viewpoint. The analyst must never forget what it is like to face a new system. Those recollections can help analysts empathize with users and facilitate their training.

## Training Strategies

Training strategies are determined by who is being trained and who will train them. The analyst will want to ensure that anyone whose work is affected by the new information system is properly trained by the appropriate trainer.

**WHOM TO TRAIN.** All people who will have primary or secondary use of the system must be trained. They include everyone from data entry personnel to those who will use output to make decisions without personally using a computer. The amount of training a system requires depends on how much someone's job will change because of the new interactions required by the revised system.

You must ensure that users of different skill levels and job interests are separated. It is certain trouble to include novices in the same training sessions as experts, because novices are quickly lost and experts are rapidly bored with basics. Both groups are then lost.

**PEOPLE WHO TRAIN USERS.** For a large project, many different trainers may be used depending on how many users must be trained and who they are. Possible training sources include the following:

1. Vendors.
2. Systems analysts.
3. External paid trainers.
4. In-house trainers.
5. Other system users.

This list gives just a few of the options the analyst has in planning for and providing training.

Large vendors often provide off-site, one- or two-day training sessions on their equipment as part of the service benefits offered when corporations purchase expensive COTS software. These sessions include both lectures and hands-on training in a focused environment. They may also extend the experience with online user groups, dedicated blogs, or annual user conferences.

Because systems analysts know the organization's people and the system, they can often provide good training. The use of analysts for training purposes depends on their availability, because they also are expected to oversee the complete implementation process.

External paid trainers are sometimes brought into the organization to help with training. They may have broad experience in teaching people how to use a variety of computers, but they may not give the hands-on training that is needed for some users. In addition, they may not be able to custom-tailor their presentations enough to make them meaningful to users.

Full-time, in-house trainers are usually familiar with the skills and learning preferences of personnel and can tailor materials to their needs. One of the drawbacks of in-house trainers is that they may possess expertise in areas other than information systems and may therefore lack the depth of technical expertise that users require.

It is also possible to have any of these trainers train a small group of people from each functional area that will be using the new information system. They in turn can be used to train the remaining users. This approach can work well if the original trainees still have access to materials and trainers as resources when they themselves are providing training. Otherwise, it might degenerate into a trial-and-error situation rather than a structured one.

## Guidelines for Training

The analyst has four major guidelines for setting up training. They are (1) establishing measurable objectives, (2) using appropriate training methods, (3) selecting suitable training sites, and (4) employing understandable training materials.

**TRAINING OBJECTIVES.** Who is being trained in large part dictates the training objectives. Training objectives for each group must be spelled out clearly. Well-defined objectives are of



## CONSULTING OPPORTUNITY 16.4

### You Can Lead a Fish to Water . . . But You Can't Make It Drink

**S**am Monroe, Belle Uga, Wally Ide, and you make up a four-member systems analysis team that is developing an information system to help managers monitor and control water temperature, the number of fish released, and other factors at a large commercial fish hatchery. (They were last seen in "To Hatch a Fish," Consulting Opportunity 6.3, when they asked you, as their fourth member, to help solve a problem involving the timely delivery of a system prototype.)

With your input, the team successfully turned the tide of the earlier dilemma, and the project has continued. Now you are discussing the training that you have begun to undertake for managers and other systems users. Due to some scheduling difficulties, you have decided to cut down on the number of different training sessions offered, which has resulted in users at a variety of levels of management and computer expertise being in the same training sessions in some instances.

Laurie Hook, one of the operators who is being trained, has been in the same training "tank" with Wade Boot, one of the man-

agers with whom you have been working. Both Laurie and Wade have come to the team privately with different concerns.

Wade told you, "I'm mad that I have to type in my own data in the sessions. The Mississippi will freeze solid before I ever do that on my job. I've got to know *when* to expect output and how to interpret it when it comes. I'm not spending time in training sessions if I can't get that."

Laurie, who shares training sessions with Wade, also complained to your group. "We should be getting more hands-on training. All we hear is a bunch of lectures. It's like school. Not only that, but the managers in the group like to spin these 'fish stories' about what happened to them with the old system. It's boring. I want to know how to operate the thing. It's bait and switch, if you ask me. I'm not learning what you said I would, and besides, with all those bosses in there, I feel like a fish out of water."

What problems are occurring with the training sessions? How can they be addressed, given the scheduling constraints mentioned? What basic advice on setting up training sessions did your team ignore? Write a one-page response to these questions.

enormous help in letting trainees know what is expected of them. In addition, objectives allow evaluation of training when it is complete. For example, operators must know such basics as turning on the machine, what to do when common errors occur, basic troubleshooting, and how to end an entry.

**TRAINING METHODS.** Each user and operator will need slightly different training. To some extent, their jobs determine what they need to know, and their personalities, experience, and backgrounds determine how they learn best. Some users learn best by seeing, others by hearing, and still others by doing. Because it is often not possible to customize training for an individual, a combination of methods is often the best way to proceed. That way, most users are reached through one method or another.

Methods for those who learn best by seeing include demonstrations of equipment and exposure to training manuals. Those who learn best by hearing will benefit from lectures about procedures, discussions, and question-and-answer sessions among trainers and trainees. Those who learn best by doing need hands-on experience with new equipment. For jobs such as that of computer operator, hands-on experience is essential, whereas a quality assurance manager for a production line may only need to see output, learn how to interpret it, and know when it is scheduled to arrive.

**TRAINING SITES.** Training takes place in many different locations, some of which are more conducive to learning than others. Large computer vendors provide special off-site locations at which operable equipment is maintained free of charge. Their trainers offer hands-on experience as well as seminars in settings that allow users to concentrate on learning the new system. One of the disadvantages of off-site training is that users are away from the organizational context in which they must eventually perform.

Onsite training in the users' organization is also possible with several different kinds of trainers. The advantage is that users see the equipment placed as it will be when it is fully operational in the organizational context. A serious disadvantage is that trainees often feel guilty about not fulfilling their regular job duties if they remain onsite for training. Thus, full concentration on training may not be possible.

Elements	Relevant Factors
Training Objectives	Depend on requirements of user's job
Training Methods	Depend on user's job, personality, background, and experience; use combination of lecture, demonstration, hands-on, and study
Training Sites	Depend on training objectives, cost, availability; free vendor sites with operable equipment; in-house installation; rented facilities
Training Materials	Depend on user's needs; operating manuals, cases, prototypes of equipments and output; online tutorials

**FIGURE 16.15**

Appropriate training objectives, methods, sites, and materials are contingent on many factors.

Off-site training sites are also available for a fee through consultants and vendors. Training sites can be set up in places with rented meeting space, such as a hotel, or may even be permanent facilities maintained by the trainers. These arrangements allow workers to be free from regular job demands, but they may not provide equipment for hands-on training.

**TRAINING MATERIALS.** In planning for the training of users, systems analysts must realize the importance of well-prepared training materials. These materials include training manuals; training cases, in which users are assigned to work through a case that incorporates most of the commonly encountered interactions with the system; and prototypes and mock-ups of output. Users of larger systems will sometimes be able to train on elaborate Web-based simulations or software that is identical to what is being written or purchased. Most COTS software vendors provide online tutorials that illustrate basic functions, and vendors may maintain Web sites that feature pages devoted to FAQ, which can be downloaded and printed. Changes to manuals can also be gleaned from many vendors' Web sites.

Because the user's understanding of the system depends on them, training materials must be clearly written for the correct audience with a minimum of jargon. Training materials should also be well indexed and available to everyone who needs them. A summary of considerations for training objectives, methods, sites, and materials is provided in Figure 16.15.

## CONVERSION TO A NEW SYSTEM

A third approach to implementation is physically converting the old information system to the new or modified one. There are many conversion strategies available to analysts, and also a contingency approach that takes into account several user and organizational variables in deciding which conversion strategy to use. There is no single best way to proceed with conversion. The importance of adequate planning and scheduling of conversion with the strategic involvement of users (which often takes many weeks), file backup, and adequate security cannot be overemphasized.

### Conversion Strategies

The five strategies for converting from the old system to the new are given in Figure 16.16 and are as follows:

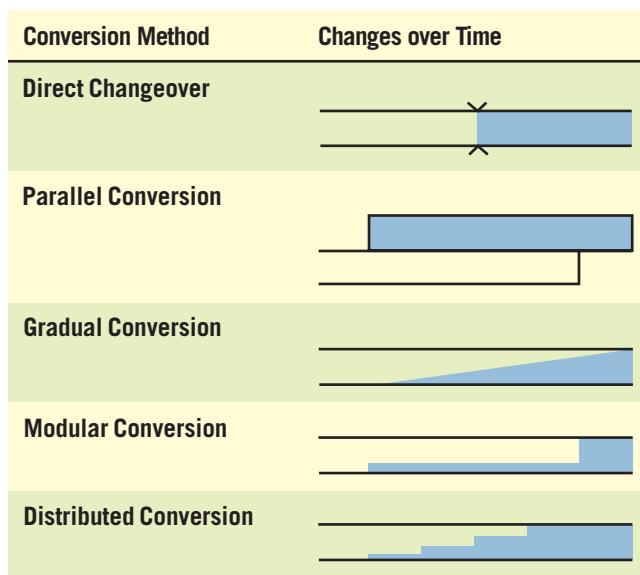
1. Direct changeover.
2. Parallel conversion.
3. Gradual, or phased, conversion.
4. Modular conversion.
5. Distributed conversion.

Each of the five conversion approaches is described separately in the following subsections.

**DIRECT CHANEOVER.** Conversion by direct changeover means that, on a specified date, users stop using the old system and the new system is put into use. Direct changeover can only be successful if extensive testing is done beforehand, and it works best when some delays in processing can be tolerated. Direct changeover is considered a risky approach to conversion. Disruption to the work environment may occur if users resent being forced into using an unfamiliar system without recourse. Finally, there is no adequate way to compare new results with old.

**FIGURE 16.16**

Five conversion strategies for information systems.



**PARALLEL CONVERSION.** Parallel conversion refers to running the old system and the new system at the same time, in parallel. When the same results can be gained over time, the new system is put into use and the old one is stopped. One advantage of running both systems in parallel is the possibility of checking new data against old data to catch any errors in processing in the new system. The main disadvantages include the cost of running two systems at the same time and the burden on employees of virtually doubling their workload during conversion.

**GRADUAL CONVERSION.** Gradual, or phased, conversion attempts to combine the best features of the two previously mentioned plans, without incurring all the risks. In this plan, the volume of transactions handled by the new system is gradually increased as the system is phased in. The advantages of this approach include allowing users to get used to the system gradually, the possibility of detecting and recovering from errors without a lot of down time, and the ability to add features one-by-one. Agile methodologies tend to use this conversion approach.

**MODULAR CONVERSION.** Modular conversion uses the building of self-contained, operational subsystems to change from old systems to new in a gradual manner. As each module is modified and accepted, it is put into use. One advantage is that each module is thoroughly tested before being used. Another advantage is that users are familiar with each module as it becomes operational. Their feedback has helped determine the final attributes of the system. Object-oriented methodologies often use this approach.

**DISTRIBUTED CONVERSION.** Distributed conversion refers to a situation in which many installations of the same system are contemplated, as is the case in banking or in franchises such as restaurants or clothing stores. One entire conversion is done (with any of the four approaches considered previously) at one site. When that conversion is successfully completed, other conversions are done for other sites. An advantage of distributed conversion is that problems can be detected and contained rather than inflicted simultaneously on all sites. A disadvantage is that even when one conversion is successful, each site will have its own people and culture, along with regional and local peculiarities to work through, and they must be handled accordingly.

### Other Conversion Considerations

Conversion also entails other details for the analyst, which include the following:

1. Ordering equipment (up to three months ahead of planned conversion).
2. Ordering any necessary materials that are externally supplied to the information system, such as toner cartridges, paper, preprinted forms, and magnetic media.
3. Appointing a manager to supervise, or personally supervising, the preparation of the installation site.

- Planning, scheduling, and supervising programmers and data entry personnel who must convert all relevant files and databases.

For many implementations, your chief role will be accurately estimating the time needed for each activity, appointing people to manage each subproject, and coordinating their work. For smaller projects, you will do much of the conversion work on your own. Many of the project management techniques discussed in Chapter 3, such as Gantt charts, PERT, function point analysis, and successfully communicating with team members, are useful for planning and controlling implementation.

### Organizational Metaphors and Their Relationship to Successful Systems

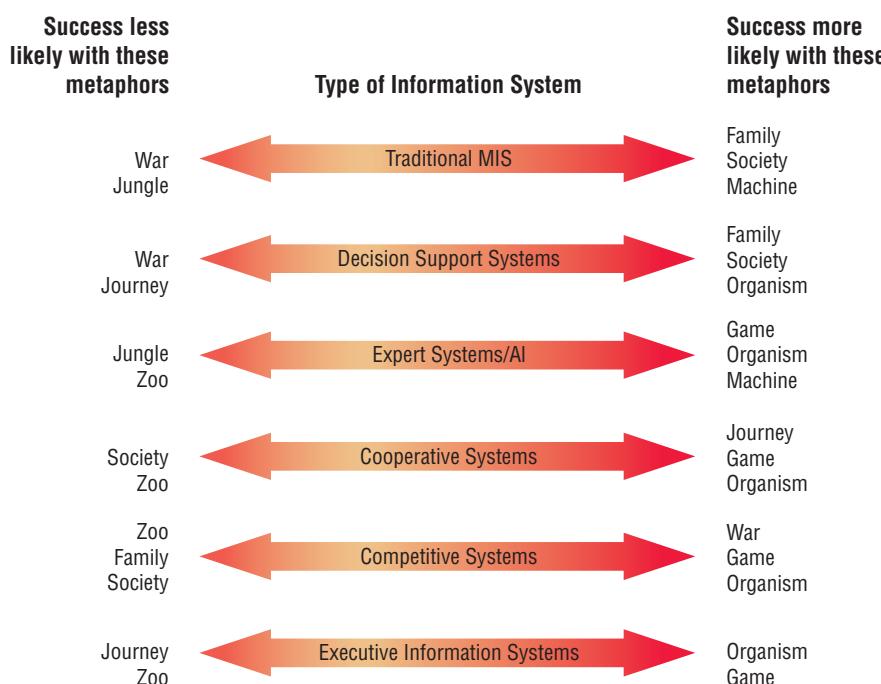
Be aware of organizational metaphors when you attempt to implement a system you have just developed. Our research has suggested that the success or failure of a system may be related to the metaphors used by organizational members.

When people in the organization describe the company as a zoo, you can infer that the atmosphere is chaotic; if it is described as a machine, everything is working in an orderly fashion. When the predominant metaphor is war, journey, or jungle, the environment is chaotic, as with the zoo. The war and journey metaphors are oriented toward an organization goal, however, whereas the zoo and jungle metaphors are not.

In addition to the machine, metaphors such as society, family, and the game all signify order and rules. Although the machine and game metaphors are goal oriented, the society and zoo metaphors do not stress the company's goal, but instead allow individuals in the corporation to set their own standards and rewards. Another metaphor, organism, appears balanced between order and chaos, corporate and individual goals.

Our research suggests that the success or failure of a system may have something to do with the predominant metaphor. Figure 16.17 shows that a traditional MIS will tend to succeed when the predominant metaphor is society, machine, or family, but it might not succeed if the metaphor is war or jungle (two chaotic metaphors). Notice, however, that competitive systems will most likely succeed if the metaphor is war.

Positive metaphors appear to be game, organism, and machine. Negative metaphors appear to be jungle and zoo. The others (journey, war, society, and family) show mixed success depending on the type of information system being developed. More research needs to be done in this area. In the meantime, the systems analyst should be aware that metaphors communicated in interviews



**FIGURE 16.17**

Organizational metaphors may contribute to the success or failure of an information system.

could be meaningful and may even be a contributing factor toward the success of the information system implementation.

## SECURITY CONCERNS FOR TRADITIONAL AND WEB-BASED SYSTEMS

Security of computer facilities, stored data, and the information generated is part of a successful conversion. Recognition of the need for security is a natural outgrowth of the belief that information is a key organizational resource, as discussed in Chapter 1. With increasingly complex transactions and many innovative exchanges, the Web has brought heightened security concerns to the IS professional's world.

It is useful to think of security of systems, data, and information on an imaginary continuum from totally secure to totally open. Although there is no such thing as a totally secure system, the actions analysts and users take are meant to move systems toward the secure end of the continuum by lessening the system's vulnerability. It should be noted that as more people in the organization gain greater computer power, gain access to the Web, or connect to intranets and extranets, security becomes increasingly difficult and complex. Sometimes, organizations will hire a security consultant to work with the systems analyst when security is crucial to successful operations.

Security is the responsibility of all those who come into contact with the system and is only as good as the most lax behavior or policy in the organization. Security has three interrelated aspects: physical, logical, and behavioral. All three must work together if the quality of security is to remain high.

### Physical Security

Physical security refers to securing the computer facility, its equipment, and software through physical means. It can include controlling access to the computer room by means of machine-readable badges, biometric systems, or a human sign-in/sign-out system, as well as using closed-circuit television cameras to monitor computer areas, backing up data frequently, and storing backups in a fireproof, waterproof area, often at a secure off-site location.

In addition, small computer equipment should be secured so that a typical user cannot move it, and it should be guaranteed uninterrupted power. Alarms that notify appropriate people of fire, flood, or unauthorized human intrusion must be in working order at all times.

Decisions about physical security should be made along with users when the analyst is planning for computer facilities and equipment purchases. Obviously, physical security can be much tighter if anticipated in advance of actual installation and if computer rooms are specially equipped for security when they are constructed rather than outfitted as an afterthought.

### Logical Security

Logical security refers to logical controls in the software itself. The logical controls familiar to most users are passwords or authorization codes of some sort. When used, they permit the user with the correct password to enter the system or a particular part of a database.

Passwords, however, are treated cavalierly in many organizations. Employees have been overheard yelling a password across crowded offices, taping passwords to their display screens, and sharing personal passwords with authorized employees who have forgotten their own.

Special encryption software has been developed to protect commercial transactions on the Web, and business transactions are proliferating. Internet fraud is also up sharply, however, with few authorities trained in catching Internet criminals and a "wild west," or "last frontier," mentality clearly evidenced in those instances when authorities have been able to apprehend Web criminals.

One way for networks to cut down on the risk of exposure to security challenges from the outside world is to build a firewall or firewall system. A firewall constructs a barricade between an internal organization's network and an external (inter)network, such as the Internet. The internal network is assumed to be trustworthy and secure, whereas the Internet is not. Firewalls are intended to prevent communication into or out of the network that has not been authorized and that is not wanted. A firewall system is not a perfect remedy for organizational and Internet security;

it is, however, an additional layer of security that is now widely endorsed. There is still no fully integrated way to address security problems with internal and external networks, but they do deserve analysts' attention when planning any new or improved systems.

Logical and physical controls are important but clearly not enough to provide adequate security. Behavioral changes are also necessary.

## Behavioral Security

The behavioral expectations of an organization are implicit in its policy manuals and even on signs posted in work rooms and lunch rooms, as we saw in Chapter 5. The behavior that organization members internalize, however, is also critical to the success of security efforts. (One reason firewalls are not attack-proof is because many attacks to information systems come from within the organization.)

Security can begin with the screening of employees who will eventually have access to computers, data, and information, to ensure that their interests are consistent with the organization's interests and that they fully understand the importance of carrying through on security procedures. Policies regarding security must be written, distributed, and updated so that employees are fully aware of expectations and responsibilities. It is typical that the systems analyst will first have contact with the behavioral aspects of security. Some organizations have written rules or policies prohibiting employees from surfing the Web during work hours, or even prohibiting Web surfing altogether, if company equipment is involved. Other corporations use software locks to limit access to Web sites that are judged to be objectionable in the workplace, such as game, gambling, or pornographic sites.

Part of the behavioral facet of security is monitoring behavior at irregular intervals to ascertain that proper procedures are being followed and to correct any behaviors that may have eroded with time. Having the system log the number of unsuccessful sign-on attempts of users is one way to monitor whether unauthorized users are attempting to sign on to the system. Periodic and frequent inventorying of equipment and software is desirable. In addition, unusually long sessions or atypical after-hours access to the system should be examined.

Employees should clearly understand what is expected of them, what is prohibited, and the extent of their rights and responsibilities. In the United States and European Union, employers are legally obligated to disclose all monitoring that is being done or that is being contemplated, and they must supply the rationale behind it. Such disclosure should include the use of video cameras, software, and phone monitoring.

Output generated by the system must be recognized for its potential to put the organization at risk in some circumstances. Controls for output include displays that can only be accessed via password, the classification of information (that is, to whom it can be distributed and when), and secure storage of printed and stored documents, no matter what their format.

In some cases, provision for shredding documents that are classified or proprietary must be made. Shredding or pulverization services can be contracted from an outside firm that, for a fee, will shred magnetic media, printer cartridges, and paper. A large corporation may shred upward of 76,000 pounds of output in a variety of media annually.

## Special Security Considerations for Ecommerce

It is well known that intruders can violate the integrity of any computer system. As an analyst, you need to take a series of precautions to protect the computer network from both internal and external Web security threats. A number of actions and products can help you:

1. Virus protection software.
2. Email filtering products that provide policy-based email and email attachment scanning and filtering to protect companies against both incoming and outgoing email. Incoming scanning protects against spam (unsolicited email such as advertising) attacks, and outgoing scanning protects against the loss of proprietary information.
3. URL filtering products that provide employees with access to the Web by user, by groups of users, by computers, by the time, or by the day of the week.
4. Firewalls, gateways, and virtual private networks that prevent hackers from gaining backdoor access to a corporate network.

5. Intrusion detection and antiphishing products that continually monitor usage, provide messages and reports, and suggest actions to take.
6. Vulnerability management products that assess the potential risks in a system and discover and report vulnerabilities. Some products correlate the vulnerabilities to make it easier to find the root cause of the security breach. Risk cannot be eliminated, but this software can help manage the risk by balancing security risk to the financial bottom line.
7. Security technologies such as secure socket layering (SSL) for authentication.
8. Encryption technologies such as secure electronic translation (SET).
9. Public key infrastructure (PKI) and digital certificates (obtained from a company such as VeriSign). Use of digital certificates ensures that the reported sender of the message is really the company that sent the message.

### Privacy Considerations for Ecommerce

The other side of security is privacy. To make your Web site more secure, you must ask the user or customer to give up some privacy.

As a Web site designer, you will recognize that the company for which you design exercises a great deal of power over the data its customers are providing. The same tenets of ethical and legal behavior apply to Web site design as to the design of any traditional application that accepts personal data from customers. The Web, however, allows the data to be collected faster and allows different data to be collected (such as the browsing habits of the customer). In general, information technology makes it possible to store more data in data warehouses, process that data, and distribute the data more widely.

Every company for which you design an ecommerce application should adopt a privacy policy. Here are some guidelines:

1. Start with a corporate policy on privacy. Make sure it is prominently displayed on the Web site so that all customers can access the policy whenever they complete a transaction.
2. Only ask for information the application requires to complete the transaction at hand. For example, is it necessary to the transaction to ask a person's age or gender?
3. Make it optional for customers to fill out personal information on the Web site. Some customers do not mind receiving targeted messages, but you should always give customers an opportunity to maintain the confidentiality of their personal data by not responding.
4. Use sources that allow you to obtain anonymous information about classes of customers. There are companies that offer audience profiling technology and technology solutions for management of advertisements, their targeting, and their delivery. They do so by maintaining a dynamic database of consumer profiles without linking them to individuals, thereby respecting customers' rights to privacy.
5. Be ethical. Avoid the latest cheap trick that permits your client to gather information about the customer in highly suspect ways. Tricks such as screen scraping (capturing remotely what is on a customer's screen) and email cookie grabbing are clear violations of privacy, and may prove to be illegal as well.

A coordinated policy of security and privacy is essential. It is essential to establish these policies and adhere to them when implementing an ecommerce application.

### Disaster Recovery Planning

No matter how diligently you and your organizational colleagues work to ensure the security and stability of systems, all employees and systems are inevitably vulnerable to some kind of natural or human-made disaster that threatens security as well as the very functioning of the business. Some disasters are quite common, such as power outages, and we can assess the probability of some disasters occurring, such as a hurricane or an earthquake. However many disasters are unexpected in their timing or their severity, perhaps even causing loss of life, creating chaos for people and the organization itself.

The fields of disaster preparedness and disaster recovery are interdependent, and they build on each other. Disaster preparedness includes what a company should do if it encounters a crisis. The field of disaster recovery is focused on how a business can continue in the aftermath of a disaster and how it can restore essential systems in the IT infrastructure. This section focuses on dis-

aster recovery as it relates to information systems. The traditional disaster recovery process consists of planning, a walkthrough, practice drills, and recovery from the disaster.

When hit with a disaster, a company stands to lose people, money, reputation, and their own assets, as well as those of their clients. It is important to do the right things to minimize potential losses. Analysts should determine what the organization's level of disaster planning is and how well articulated the role of information systems is in their disaster response and recovery plans. The key questions that analysts must ask early on are (1) whether employees know where to go, and (2) what to do in the face of a disaster. The answer to these questions will guide your further planning. Conventional wisdom provides seven elements to consider during and after a disaster. As you will see, many of them involve information systems and relate specifically to the planning required of you as a systems analyst.

1. Identify the teams responsible for managing a crisis.
2. Eliminate single points of failure.
3. Determine data replication technologies that match the organization's timetable for getting systems up and running.
4. Create detailed relocation and transportation plans.
5. Establish multiple communication channels among employees and consultants who are onsite, such as analyst teams.
6. Provide recovery solutions that include an off-site location.
7. Ensure the physical and psychological well-being of employees and others who may be physically present at the work site when a disaster hits.

The disaster preparedness plan should identify who, in the event of a disaster, is responsible for making several pivotal decisions. These include decisions about whether business operations will continue; how to support communications (both computer and voice); where people will be sent if the business is uninhabitable; where personnel will go in an emergency; seeing to the personal and psychological needs of the people present in the business and those who might be working virtually; and restoring the main computing and work environments.

Redundancy of data provides the key for eliminating single points of failure for servers running Web applications. As an analyst you can be especially helpful in setting up this type of backup and redundancy.

Some businesses are moving to storage area networks (SANs) to get away from some of the unreliability associated with physical tape backups and storage. Synchronous remote replication, also called data mirroring, for nearly real-time backup is also gaining favor. However, if companies are farther than 100 miles away from the site, the data mirroring process can be affected. Asynchronous remote replication sends data to the secondary storage location at designated time intervals. Online options are available for small businesses, too.

The organization should develop and distribute a one-page memo that contains evacuation routes and employee assembly points. This should be distributed to everyone in the organization. The three common choices are either to send employees home, to have them remain onsite, or to relocate them to a recovery facility that is set up to continue operations. The entire gamut of transportation options should be considered when developing this memo.

Organizational and analyst team members must be able to communicate in the event that their typical email is disrupted. If email is unavailable for broadcasting an emergency message, an emergency information Web page or emergency hotline can serve as viable alternatives. Recently, some software companies have started offering a suite of software tools that permits ad hoc communication by emergency response agencies that allows them to rapidly set up secure VoIP, Web connectivity, and Wi-Fi hot spot capabilities. Wider availability and lower prices will undoubtedly bring these important communication capabilities to other types of organizations in the future.

To better protect the organization's backup systems and to ensure the continued, uninterrupted flow of banking transactions in the event of a disaster, new regulations in the United States stipulate that bank off-site locations must be at least 100 miles away from the original site. Since paper files and backups also present a monumental problem and are highly vulnerable to natural and human-made disasters, organizations are strongly encouraged to create a plan that helps them move toward a digital documentation project that is meant to convert all of their paper documents to electronic formats within three to five years of inception (Stephens, 2003).



## CONSULTING OPPORTUNITY 16.5

### The Sweet Smell of Success

Recall that in Consulting Opportunity 3.1, “The Sweetest Sound I’ve Ever Sipped,” you met Felix Straw. Devise a systems solution that will address the problems discussed there. (*Hint:* The technology is important, but so is the way people can use it.) Your solution

should stress collaboration, flexibility, adaptability, and access. Use network diagramming to illustrate your solution. In a few paragraphs, write a rationale for why your solution should be chosen.

Support for humans working at an organization that experiences a disaster is paramount. There must be plentiful and easily available water, especially if employees are unable to leave the site for a number of days due to outside weather conditions or partial building collapses. While food is important, water is more so. Employees should also be issued a safety kit containing water, a dust mask, a flashlight, glow sticks, and a whistle. One way to learn what should comprise a personal workspace disaster supplies kit is to go to The American Red Cross Web site ([www.redcross.org](http://www.redcross.org)), which provides details for supporting humans during disasters and providing for them in the aftermath.

## EVALUATION

Throughout the systems development life cycle, the analyst, management, and users have been evaluating the evolving information systems and networks to give feedback for their eventual improvement. Evaluation is also called for following system implementation.

### Evaluation Techniques

In recognition that the ongoing evaluation of information systems and networks is important, many evaluation techniques have been devised. These techniques include cost-benefit analysis (as discussed in Chapter 3); models that attempt to estimate the value of a decision based on the effects of revised information using information theory, simulation, or Bayesian statistics; user evaluations that emphasize implementation problems and user involvement; and information system utility approaches that examine the properties of information.

Each type of evaluation serves a different purpose and has inherent drawbacks. Cost-benefit analysis may be difficult to apply, because information systems provide information about objectives for the first time, making it impossible to compare performance before and after implementation of the system or distributed network. The revised decision evaluation approach presents difficulty, because all variables involved with the design, development, and implementation of the information system cannot be calculated or quantified. The user involvement approach yields some insight for new projects by providing a checklist of potentially dysfunctional behavior by various organizational members, but it stresses implementation over other aspects of IS design. The information system utility approach to evaluation can be more comprehensive than the others if it is expanded and systematically applied.

### The Information System Utility Approach

The information system utility approach for evaluating information systems can be a comprehensive and fruitful technique for measuring the success of a developed system. It also can serve as a guide in the development of any future projects the analyst might undertake.

Utilities of information include possession, form, place, and time. To evaluate the information system comprehensively, these utilities must be expanded to include actualization utility and goal utility. Then the utilities can be seen to address adequately the questions of who (possession), what (form), where (place), when (time), how (actualization), and why (goal). An example of this information utility approach can be seen in the evaluation of a blood inventory system in Figure 16.18.

Information Systems Modules	Form Utility	Time Utility	Place Utility	Possession Utility	Actualization Utility	Goal Utility
Inventory Lists <b>Success</b>	<b>Good.</b> Acronyms used were the same as shipping codes. As systems grew, too much information was presented; this overload called for summary information.	<b>Good.</b> Reports were received at least one hour before scheduled shipments on a daily basis.	<b>Good.</b> Inventory lists were printed at the regional blood center. Lists were delivered to hospitals with the current shipments.	<b>Good.</b> The same people who originally kept manual records received these reports.	<b>Good.</b> Implementation was easy because hospitals found the inventory lists to be extremely useful.	<b>Good.</b> Information about the location of particular units was made available.
Management Summary Reports <b>Success</b>	<b>Good.</b> Summary report was designed to exact format specifications of manual summary reports developed by the blood administrator for city hospitals.	<b>Good.</b> Same as listings.	<b>Good.</b> Summary reports were printed at the center where they were needed.	<b>Good.</b> Blood administrators who originally kept manual reports received these reports.	<b>Good.</b> Blood administrators participated in the design of the reports.	<b>Good.</b> Summary reports helped reduce outdated and prevent shortages.
Short-Term Forecasting <b>Success</b>	<b>Good.</b> A forecast was issued for each blood type.	<b>Good.</b> Forecasts were updated daily.	<b>Good.</b> Printed at blood center.	<b>Good.</b> Administrators concerned with distribution and collections received the report.	<b>Good.</b> Output design could have been more participative.	<b>Good.</b> Shortages were prevented by calling in more donors.
Heuristic Allocation <b>Failure</b>	<b>Poor.</b> The people who allocated blood mistrusted the mysterious numbers produced by the computer.	<b>Good.</b> Reports were provided one hour before allocation decisions were made.	<b>Good.</b> Printed at blood center.	<b>Fair.</b> Administrators responsible for daily blood allocation received the original.	<b>Poor.</b> Too many people were involved with blood inventories to be able to participate in the design of the system.	<b>Poor.</b> This was not an immediate goal of the blood region. Shipping costs were passed on to patients.

An information system can be evaluated as successful if it possesses all six of these utilities. If the system module is judged as “poor” in providing one of the utilities, the entire module will be destined to fail. A partial or “fair” attainment of a utility will result in a partially successful module. If the information system module is judged as “good” in providing every utility, the module is a success.

**POSSESSION UTILITY.** Possession utility answers the question of who should receive output, or, in other words, who should be responsible for making decisions. Information has no value in the hands of someone who lacks the power to make improvements in the system or someone who lacks the ability to use the information productively.

**FORM UTILITY.** Form utility answers the question of what kind of output is distributed to the decision maker. The documents must be useful for a particular decision maker in terms of the document’s format and the jargon used. Acronyms and column headings must be meaningful to the user. Furthermore, information itself must be in an appropriate form. For example, the user should not have to divide one number by another to obtain a ratio. Instead, a ratio should be calculated and prominently displayed. At the other extreme is the presentation of too much irrelevant data. Information overload certainly decreases the value of an information system.

**PLACE UTILITY.** Place utility answers the question of where the information is distributed. Information must be delivered to the location where the decision is made. More detailed reports or previous management reports should be filed or stored to facilitate future access.

**TIME UTILITY.** Time utility answers the question of when information is delivered. Information must arrive before a decision is made. Late information has no utility. At the other extreme is the delivery of information too far in advance of the decision. Reports may become inaccurate or may be forgotten if delivered prematurely.

**ACTUALIZATION UTILITY.** Actualization utility involves how the information is introduced and used by the decision maker. First, the information system has value if it possesses the ability to

**FIGURE 16.18**

Evaluating a blood inventory information and decision support system using the information system utility approach.



## CONSULTING OPPORTUNITY 16.6

### Mopping Up with the New System

“I don’t know what happened. When the new system was installed, the systems analysts made a clean getaway, as far as I can tell,” says Marc Schnieder, waxing philosophic. Recall that he is owner of the Marc Schnieder Janitorial Supply Company. (You last met Marc in Consulting Opportunity 13.1, in which you helped him with his data storage needs. In the interim, he has had a new information system installed.)

“The systems analysis team asked us some questions about how we liked the new system,” Marc supplies eagerly. “We didn’t really know how to tell them that the output wasn’t as spotless as

we’d like. I mean, it’s confusing. It isn’t getting to the right people at the right time or anything. We never really did get into the nitty-gritty about the finished system with that consulting team. I feel as if we had to hire your group just to mop up after what they left.”

After further discussions with Stan Lessink and Jill Oh, the company’s chief programmers, you realize that the team that did the initial installation had no evaluation mechanism. Suggest a suitable framework for evaluating the kinds of concerns that Mr. Schnieder raised about the system. What are the problems that can occur when a system is not evaluated systematically? Respond in a paragraph.

be implemented. Second, actualization utility implies that an information system has value if it is maintained after its designers depart, or if a one-time use of the information system obtains satisfactory and long-lasting results.

**GOAL UTILITY.** Goal utility answers the “why” of information systems by asking whether the output has value in helping the organization obtain its objectives. The goal of the information system must not only be in line with the goals of decision makers, but it must also reflect their priorities.

### EVALUATING CORPORATE WEB SITES

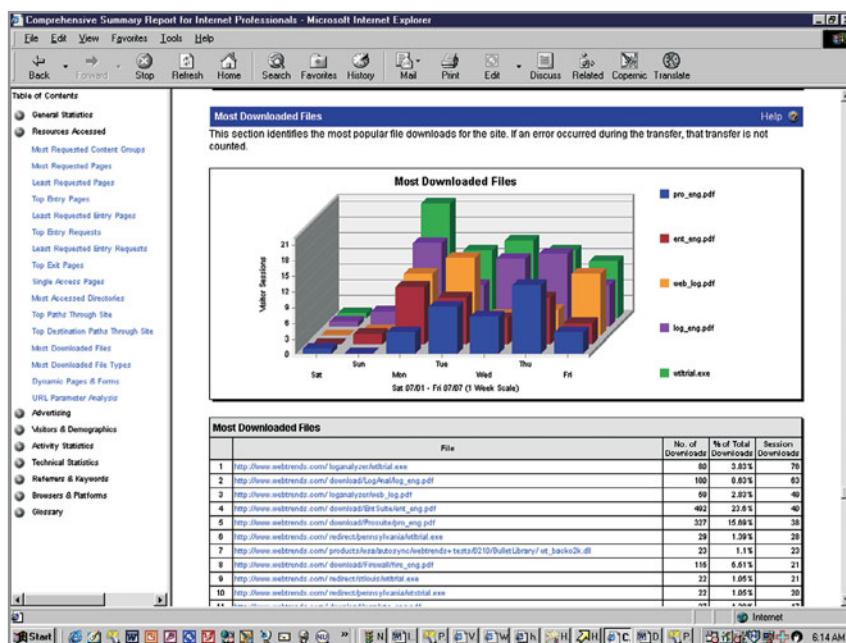
Evaluating the corporate Web site that you are developing or maintaining is an important part of any successful implementation effort. Analysts can use the information system utility approach previously described to assess the aesthetic qualities, content, and delivery of the site. As an analyst or Webmaster, you should go one step further and analyze Web traffic.

A visitor to your Web site can generate a large amount of useful information for you to analyze. This information can be gathered automatically by capturing information about the source, including the previous Web site the user visited and the keywords used to find the site; the information can also be obtained through using cookies (files left on a user’s computer about when they last were on the site).

A leading Web activity monitoring package is Webtrends. Figure 16.19 is a sample report showing the most downloaded files on the Web site by day of the week. The graph displays the top five downloaded files, and the table at the bottom is a sorted list of all downloads.

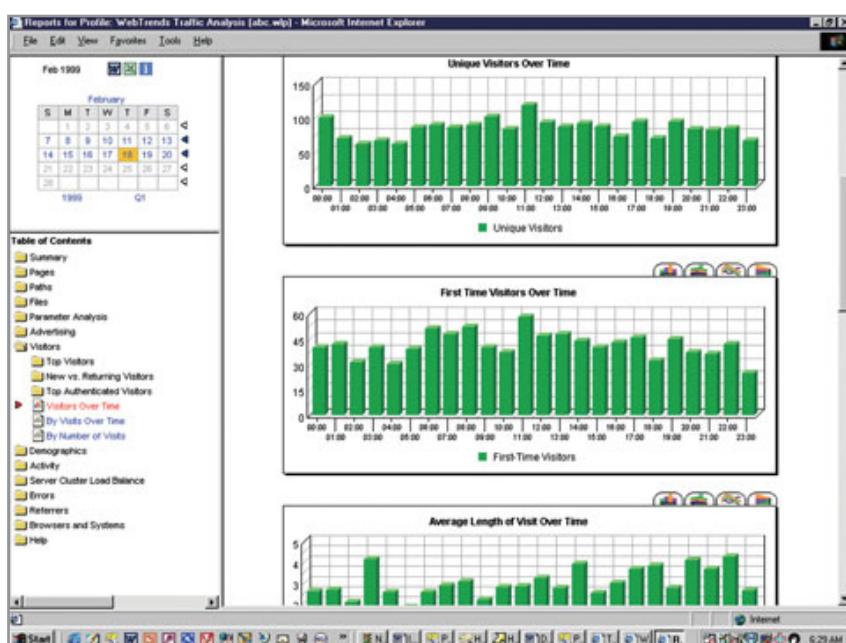
An analyst or Webmaster can gain valuable information by using a service such as Webtrends. (Although some services are free, the pay services usually provide the detail needed to evaluate the site in depth. The cost is an ongoing budget item for maintaining the Web site.) Information to help you evaluate your client’s site and make improvements is plentiful and easy to obtain. The seven essential items are described next.

1. ***Know how often your client’s Web site is visited.*** The number of hits a Web site had in the last few days, the number of visitor sessions, and the number of pages visited are a few of the general things you need to know.
2. ***Learn details about specific pages on the site.*** It is possible to get statistics on the most requested pages, most requested topics, top paths a visitor takes through the client’s Web site, or even the most downloadable files. If the Web site is a commercial one, shopping cart reports can show how many visitors were converted into buyers and how many abandoned their carts or failed to complete the checkout process.

**FIGURE 16.19**

A sample report from Webtrends Corporation showing the most downloaded files on the corporate Web site.

3. **Find out more about the Web site's visitors.** Visitor demographics and information such as the number of visits by a particular visitor in a period of time, whether the visitor is a new or a returning one, and who the top visitors are—all are valuable information when evaluating a Web site. The display in Figure 16.20 shows the number of unique visitors (top graph), the number of first-time visitors (middle graph), and the average length of visits over time (bottom graph).
4. **Discover if visitors can properly fill out the forms you designed.** If the error rate is high, redesign the form and see what happens. Analysis of the statistics will reveal whether bad form design was to blame for errors in response.
5. **Find out who is referring Web site visitors to the client's site.** Find out which sites are responsible for referring visitors to the client's Web site. Get statistics on the top referring site, the top search engines leading to the site, and even the keywords visitors used to

**FIGURE 16.20**

A report comparing statistics on visitors generated by Commerce Trends (from Webtrends Corporation).

locate your client's Web site. After promoting a site, you can use Web traffic analysis to track whether the site promotion really made a difference.

6. **Determine what browsers visitors are using.** By knowing what browsers are being used, you can add browser-specific features that improve the look and feel of the site and encourage visitors to stay longer, thereby improving the stickiness of the site. It helps to know whether visitors are using current or outdated browsers.
7. **Find out if the client's Web site visitors are interested in advertising.** Finally, find out if visitors to the site are interested in the ad campaigns you have on your site, such as offering a product for sale for a specific period.

Web activity services can be helpful in evaluating whether the site is meeting its stated objectives in terms of traffic, advertising effectiveness, employee productivity, and return on investment. It is one of the ways an analyst can evaluate whether the corporate Web presence is meeting management goals and whether it accurately portrays the organization's vision.

## SUMMARY

The systems analyst can ensure total quality management (TQM) for analyzing and designing information systems in many ways. Six Sigma is a culture, philosophy, methodology, and approach to quality that has as its goal the elimination of all defects. A tool for designing a top-down, modular system is called a structure chart. Service-oriented architecture is an approach that uses independent services to perform various functions. Two of the structured techniques that can aid the systems analyst are procedure manuals and FOLKLORE. Systems analysts must choose a technique that fits in well with what was previously used in the organization and that allows flexibility and easy modification.

Testing of specific programs, subsystems, and total systems is essential to quality. System maintenance is an important consideration. Both internal and external auditors are used to determine the reliability of the system's information. They communicate their audit findings to others so as to improve the usefulness of the system's information.

Implementation is the process of ensuring that information systems and networks are operational and then involving well-trained users in their operation. In large systems projects, the primary role of the analyst is overseeing implementation by correctly estimating the time needed and then supervising the installation of equipment for information systems.

Distributed systems take advantage of telecommunications technology and database management to interconnect people manipulating some of the same data in meaningful but different ways. As hardware and software are evaluated, the systems analyst also needs to consider the costs and benefits of employing a distributed system to fulfill user requirements. One of the most popular ways to approach distributed systems is through the use of a client-server model. Cloud computing allows commerce, applications, and data storage to be served using the Internet. Standard types of organizational networks include the local area network (LAN) and the wide area network (WAN). Using a top-down approach, analysts can use five symbols to help draw network decomposition and hub connectivity diagrams.

Training users and personnel to interact with the information system is an important part of implementation, because users must usually be able to run the system without the intervention of the analyst. Conversion is the process from changing from the old information system to the new. The five conversion strategies are direct changeover, parallel conversion, phased or gradual conversion, modular conversion, and distributed conversion. Research suggests that systems analysts can improve the chances that newly implemented systems will be accepted if they develop systems with predominant organizational metaphors in mind.

Security of data and systems has taken on increased importance for analysts who are designing more ecommerce applications. Security has several facets—physical, logical, and behavioral—that must all work together. Analysts can take a number of precautions, such as virus protection software, email filtering, URL filters, firewalls, gateways, virtual private networks, intrusion detection products, secure socket layering, secure electronic translation, and the use of a public key infrastructure, to improve privacy, confidentiality, and the security of systems, networks, data, individuals, and organizations. In addition, every company for which you design an ecommerce application should adopt a privacy policy following five guidelines.

Even though you take all possible measures to ensure system security, privacy, and stability, all employees and systems are vulnerable to natural or human-made disaster. Disaster recovery is focused on how a business can continue after a disaster has hit and how it can restore essential IT infrastructure.

Many different evaluation approaches are available, including cost-benefit analysis, the revised decision evaluation approach, and user involvement evaluations. The information system utility framework is a direct way to evaluate a new system based on the six utilities of possession, form, place, time, actualization, and goal.



## HYPERCASE® EXPERIENCE 16.2

“As you know, Snowden is determined to implement some kind of computerized tracking for the Training people. Even after having you and your team here at MRE for all of this time, though, it isn’t clear to me how that will ever come about. You’ve probably noticed by now that people such as Tom Ketcham are pretty set in their ways, but so is Snowden, and he definitely has the upper hand. I’m not telling you anything you don’t know already, am I?”

“Also, please check with Jack O’Malley and Kate Eckert to make sure that what you’re planning will be covered by their latest disaster recovery plan. I think when Snowden comes back from Poland, you should be ready to show him how we can implement an automated tracking system for the Training group, but it really has to be acceptable to the new users. After all, they’re the ones who have to live with it. I’ll pencil you in for a meeting with Snowden two weeks from today.”

### HYPERCASE Questions

1. Develop an implementation plan that would be useful to the Training group in changing to a computerized project tracking system. Use a paragraph to explain your approach. Be sure that what you are doing also meets Snowden’s expectations.
2. In two paragraphs, discuss what *conversion* approach is appropriate for adopting a new automated project tracking system for the Training group.
3. Create a bulleted list of the measures you would take to secure and back up the new project tracking system you are proposing for the Training group.

## KEYWORDS AND PHRASES

behavioral security  
bottom-up design  
client-server model  
control flag (switch)  
corporate privacy policy  
data couple  
desk check  
direct changeover  
disaster preparedness  
disaster recovery  
distributed conversion  
distributed processing  
email filtering products  
encryption software  
firewall or firewall system  
FOLKLORE  
full systems testing with live data  
full systems testing with test data  
gradual or phased conversion  
hub connectivity  
information system utility  
internal auditor  
IS quality circle  
link testing with test data (string testing)

local area network (LAN)  
logical security  
modular conversion  
modular design and development  
network decomposition  
network modeling  
organizational metaphors  
parallel conversion  
program testing with test data  
public key infrastructure (PKI)  
Six Sigma  
software documentation  
software maintenance  
storage area networks (SANs)  
structure chart  
structured walkthrough  
top-down design  
total quality management (TQM)  
URL filtering products  
virus protection software  
Web traffic analysis  
wide area network (WAN)  
wireless local area network (WLAN)

## REVIEW QUESTIONS

1. What are the three broad approaches available to the systems analyst for attaining quality in newly developed systems?
2. Who or what is the most important factor in establishing and evaluating the quality of information systems or decision support systems? Why?
3. Define the total quality management (TQM) approach as it applies to the analysis and design of information systems.

4. What is meant by the term *Six Sigma*?
5. What is an IS quality circle?
6. Define what is meant by doing a structured walkthrough. Who should be involved? When should structured walkthroughs be done?
7. List the advantages of taking a top-down approach to design.
8. Define modular development.
9. List four guidelines for correct modular programming.
10. Name the two types of arrows used in structure charts.
11. What is service-oriented architecture?
12. Give two reasons that support the necessity of well-developed systems and software documentation.
13. In what four categories does the FOLKLORE documentation method collect information?
14. List six guidelines for choosing a design and documentation technique.
15. Whose primary responsibility is it to test computer programs?
16. What is the difference between test data and live data?
17. What are the two types of systems auditors?
18. List the four approaches to implementation.
19. Describe what is meant by a distributed system.
20. What is the client-server model?
21. Describe how a client is different from a user.
22. What are the advantages of using a client/server approach?
23. What are the disadvantages of using a client/server approach?
24. Who should be trained to use the new or modified information system?
25. List the five possible sources of training for users of information systems.
26. List the five conversion strategies for converting old information systems to new ones.
27. List the nine organizational metaphors and the hypothesized success of each type of system given their presence.
28. Define the terms *physical*, *logical*, and *behavioral security*, and give an example of each one that illustrates the differences among them.
29. Define what encryption software means.
30. What is a firewall or firewall system?
31. List five of the several measures an analyst can take to improve the security, privacy, and confidentiality of data, systems, networks, individuals, and organizations that use ecommerce Web applications.
32. List five guidelines for designing a corporate privacy policy for ecommerce applications.
33. Briefly give the differences between disaster preparedness and disaster recovery.
34. List and describe the utilities of information systems that can be used to evaluate the information system.
35. What are seven essential items that the analyst should include in performing a Web site traffic analysis?

## PROBLEMS

1. One of your systems analysis team members has been discouraging user input on quality standards, arguing that because you are the experts, you are really the only ones who know what constitutes a quality system. In a paragraph, explain to your team member why getting user input is critical to system quality. Use an example.
2. Write a detailed table of contents for a procedure manual that explains to users how to log onto your school's computer network, as well as the school's network policies (who is an authorized user, and so on). Make sure that the manual is written with the user in mind.
3. Your systems analysis team is close to completing a system for Meecham Feeds. Roger is quite confident that the programs that he has written for Meecham's inventory system will perform as necessary, because they are similar to programs he has done before. Your team has been very busy and would ideally like to begin full systems testing as soon as possible. Two of your junior team members have proposed the following:
  - a. Skip desk checking of the programs (because similar programs were checked in other installations; Roger has agreed).
  - b. Do link testing with large amounts of data to prove that the system will work.
  - c. Do full systems testing with large amounts of live data to show that the system is working.Respond to each of the three steps in their proposed test schedule. Use a paragraph to explain your response.
4. Propose a revised testing plan for Meecham Feeds (Problem 3). Break down your plan into a sequence of detailed steps.

5. Draw a local area network or some other configuration of distributed processing using the client/server approach to solve some of the data sharing problems that Bakerloo Brothers is having. It wants to be able to allow teams of architects to work on blueprints at headquarters, let the construction supervisor enter last-minute changes to plans under construction from the field, and permit clients to view plans from almost anywhere. Currently, the company has a LAN for the architects who are in one city (Philadelphia) that lets them share some drawing tools and any updates that team members make with architects in other cities (New York, Terre Haute, Milwaukee, Lincoln, and Vancouver). The supervisor uses a notebook computer, cannot make any changes, and is not connected to a database. Clients view plans on displays, but sales representatives are not able to enter modifications to show them what would happen if a wall were moved or a roof line altered. (*Hint:* List the problems that the company is encountering, analyze the symptoms, think of a solution, and then start drawing.) More than one network may be necessary, and not all problems will be amenable to a systems solution.
6. Create a disaster recovery plan for one of the networks you recommended to Bakerloo Brothers in Problem 5.
7. Cramtrack, the regional commuter train system, is trying to train users of its newly installed computer system. For the users to get the proper training, the systems analysts involved with the project sent a memo to the heads of the four departments that include both primary and secondary users. The memo said in part, “Only people who feel as if they require training need to make reservations for off-site training; all others should learn the system as they work with it on the job.” Only 3 of a possible 42 users signed up. The analysts were satisfied that the memo effectively screened people who needed training from those who did not.
  - a. In a paragraph, explain how the systems analysts got off the track in their approach to training.
  - b. Outline the steps you would take to ensure that the right people at Cramtrack are trained.
  - c. Suggest in a paragraph how the Web might be used to assist in training for Cramtrack.
8. A beautiful, full-color brochure arrived on Bill Cornwell’s desk describing the Benny Company’s off-site training program and facilities in glowing terms; it showed happy users at PCs and professional-looking trainers leaning over them with concerned looks. Bill ran excitedly into Roseann’s office and told her, “We’ve got to use these people. This place looks terrific!” Roseann was not persuaded by the brochure, but didn’t know what to say in defense of the onsite training for users that she had already authorized.
  - a. In a few sentences, help Roseann argue the usefulness of onsite training with in-house trainers in contrast to off-site training with externally hired trainers.
  - b. If Bill does decide on Benny Company training, what should he do to verify that this company is indeed the right place to train the company’s information system users? Make a list of actions he should take.
9. “Just a little longer . . . I want to be sure this is working correctly before I change over,” says Buffy, the owner of three bathroom accessories boutiques called Tub ‘n Stuff. Her accountant, who helped her set up a new accounting information system, is desperately trying to persuade Buffy to change over completely to the new system. Buffy has insisted on running the old and new systems in parallel for an entire year.
  - a. Briefly describe the general problems involved in using a parallel conversion strategy for implementing a new information system.
  - b. In a paragraph, try to convince the owner of Tub ‘n Stuff that a year of running a system in parallel is long enough. Suggest a way to end Tub ‘n Stuff’s dual systems that will provide enough reassurance to Buffy. (Assume the new system is reliable.)
10. Draft a plan to perform Web traffic analysis for the ecommerce application developed for Marathon Vitamin Shops. (See Consulting Opportunities 1.1, 13.2, and 14.6 for more information about the organization, their products, and their goals.) Your plan should take the form of a written report to the owner of the chain, Bill Berry. Be sure to indicate what statistics you will monitor and why they are important for Marathon Vitamin Shops to know.
11. FilmMagic, a chain of video rental stores, is experimenting with adding a new Web-based service to its store (similar to [www.netflix.com](http://www.netflix.com)) that would, for a monthly fee, permit customers to choose a list of DVDs, have them sent to their home, and return them in prepaid mailers when they had finished viewing them. Based on what you know about FilmMagic, write a corporate privacy policy that would work well on their newly proposed Web site. Create a prototype screen (either with a graphics package or on a word processor) that includes appropriate language, fonts, and icons to show how your policy will appear as a page on FilmMagic’s Web site.
12. Ayman’s Office Supplies Company recently had a new information system installed to help its managers with inventory. In speaking with the managers, you notice that they seemed disgruntled with the system output, which is a series of displays that show current inventory, customer and supplier addresses, and so on. All screens need to be accessed through several special commands and

the use of a password. The managers had several opinions about the system but had no systematic way to evaluate it.

- a. Devise a checklist or form that helps Ayman's managers evaluate the utilities of an information system.
- b. Suggest a second way to evaluate the information system. Compare it with what you did in Problem 12a.

## GROUP PROJECTS

1. Nicholas Ventola is the General Manager for the world famous Le Corked restaurant. His information system was developed over time and, as it exists now, it consists of two computer systems that do not communicate with one another. One system handles reservations and maintains a database of customers' preferences (likes and dislikes), birthdates and anniversaries, and other information. The other system assigns each party to a table on a given night. In your group use a top-down approach to identify the modules that would be necessary to accomplish everything Nicholas wants to do using only one computer system, from making reservations to ordering food. From your own experience, determine what systems are necessary to operate a fine dining establishment, then describe the modules and how and when you would use them.
2. Divide your group into two subgroups. One subgroup should interview the members of the other subgroup about their experiences encountered in registering for a class. Questions should be designed to elicit information on customs, tales, sayings, and art forms that will help document the registration process at your school.
3. Reunite your group to develop a Web page for a short excerpt for a FOLKLORE manual that documents the process of registering for a class, one based on the FOLKLORE passed on in the interviews in Group Project 2 above. Remember to include examples of customs, tales, sayings, and art forms.

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## EPISODE 16

### CPU CASE

ALLEN SCHMIDT, JULIE E. KENDALL, AND KENNETH E. KENDALL

# Semper Redundate

Mack Roe walks to Anna's desk where Chip is standing and says, "The last program has been tested and incorporated into the system test. The results indicate that the system is finally complete. Every program and subsystem is working as planned. The whole system checks out. Testing has been thorough and exacting, with all the problems and program bugs satisfactorily resolved. I've reviewed the deliverables, and each one has been developed into programs. I'll leave you two to install it and then celebrate."

"That's fantastic!" Anna replies as Mack leaves. "We've been anticipating this moment for a long time. We now have the task of installing the system. I've checked with Mike Crowe, and all the hardware has arrived and has been installed. The computers have been connected, and the network software has been installed. Why don't we make a list of the tasks to be completed?"

"Sure," answers Chip. "We'll need to train the users on the operation of the system. It would be good to provide some general training, followed by specific training for each user. We might want to train several people—the user and a backup person—for each specific operation."

"That's all right with me," responds Anna, "but I don't think we should have a backup person for Paige Prynter. Somehow I don't think she would be fond of the idea."

"Speaking of backup," says Chip, "what about creating backups of master database tables and other tables? We should design an automated procedure for creating these copies."

"Yes," replies Anna. "Great idea. We also need to be concerned with system security: Who can access the data, and who has clearance to update various database elements. We should also create a disaster recovery plan, just in case of things like power outages or other human-made or natural disasters."

"I agree," remarks Chip. "You never know when things might go awry. Another consideration is converting the production files from the old system to the new format. We don't want to rekey all the records from the hardware and software master files."

"Why don't we have one of the programmers write a one-time program that will convert each file from the old format to the new?" suggests Anna. "The indexes could be automatically updated, and additional fields initialized to spaces or zeros."

The programmers complete the file conversion programs in a short time. The new database tables are created and painstakingly verified for accuracy. This effort is rewarded with new tables that contain all the necessary rows loaded with correct information.

Training is scheduled to start in the Information Center. Hy Perteks is more than willing to reserve a block of time for installing the software and providing the training sessions. Chip and Anna alternate in providing instruction, each for the portions of the system they had created.

With the training sessions concluded, the last task is the conversion of the old system to the new. The phased method is selected as the best approach. First, the computer hardware programs are installed. Records are updated with information for the additional elements included in the system design.

Next, the software update programs are installed. Again, updates to database tables are entered. When the records contain complete information, the inquiry screens are installed. Finally, report and menu programs are added to the system.

"The installation is a great success," exults Chip. "Everything is working correctly, without a bug in the system. I guess we should knock on wood. Have you heard any comments from the users?"

"Yes," replies Anna. "They are happy and relieved to have their new system. Mike Crowe has already started to use the preventive maintenance feature and has his students helping to tackle one lab room at a time. Cher and Dot were running through the various displays and several times commented on how easy it is to perform tasks. I paid a visit to Paige Prynter, and she asked me what she should do with all her free time."

"I understand that the Web system is available through the faculty portal. Notices are being sent out via email about the availability of the Web system and training sessions."

The analysts smile at each other. Chip says, "It has been a really great project to work on."

"It certainly has," answers Anna. "The best system we've ever created here at CPU."

"I've learned a lot about the university in my short time here, too. It's a great place to work," Chip muses.

"And as long as you remember our motto, you should do fine," Anna replies. "Semper redundate," she says to Chip.

"Yeah, I see it on all the letterhead. I must admit, though, that I never took Latin in school. What does the motto actually mean?" Chip asks.

"Always back up!" Anna says securely.

**EXERCISES**

- E-1. Describe procedures that should be designed to create automatic backup. In a paragraph, be sure to consider the pros and cons of these procedures.
- E-2. List security measures that should be taken to prevent unauthorized persons from using the computer system.
- E-3. Outline a disaster recovery plan for the new computer system you have created for CPU. In particular focus on the teams that will be responsible for managing a crisis.
- E-4. Explain in a paragraph why a phased conversion would be used to install the computer system.

# GLOSSARY

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Numbers in parentheses refer to the chapter in which that term is defined.

**ACTOR** In UML, a particular role of a user of the system. The actor exists outside the system and interacts with the system in a specific way. An actor can be a human, another system, or a device such as a keyboard. (10) *See also* use case.

**AGGREGATION** Often described as “has a” relationship when using UML for an object-oriented approach.

Aggregations provide a means of showing that the whole object is composed of the sum of its parts (other objects). (10)

**AGILE APPROACH (OR AGILE MODELING)** A systems development approach which has values, principles, and practices useful for systems analysts who desire a flexible, interactive, and participative approach. (6) *See also* extreme programming.

**AJAX** A method using JavaScript and XML to dynamically change Web pages without displaying a new page by obtaining small amounts of data from the server. (12)

**ALIAS** Alternative name for a data element used by different users. Recorded in a data dictionary. (8)

**APPLICATION SERVICE PROVIDER (ASP)** A company that hosts application software, which is leased by other organizations for use on the Web. Applications include traditional ones as well as collaboration and data management. (16)

**ASSOCIATIVE ENTITY** An entity type that associates the instances of one or more entity types and contains attributes that are peculiar to the relationship between those entity instances. (2)

**ATTRIBUTE** Some characteristic of an entity. There can be many attributes for each entity. (13) *See also* data item.

**ATTRIBUTIVE ENTITY** One of the types of entities used in entity-relationship diagrams. Something useful in describing attributes, especially repeating groups. (2)

**BEHAVIOR** How an object acts and reacts. (10)

**BESPOKE SOFTWARE** Another term for custom software, it is the opposite of commercial-off-the-shelf (COTS) software. It is software developed to serve a particular function, or to support a unique organizational feature. (1)

**BIPOLAR QUESTION** A subset of closed questions that can be answered in two ways only, such as yes or no, true or false, and agree or disagree. (4) *See also* closed question, open-ended question.

**BROWSER** Special software that runs on an Internet-connected computer enabling users to view hypertext-based Web pages on the Internet. Microsoft Internet Explorer and Mozilla’s Firefox are examples of graphical browsers. (11)

**BUBBLE DIAGRAM** A simple diagram that shows data associations of data elements. Each entity is enclosed in an ellipse, and arrows are used to show the relationships. Also called a data model diagram. (13)

**BUSINESS RULES** Statements specific to an organization’s functioning that provide a logical description of business activities. Used to help create data flow diagrams. (7)

**CASE TOOLS** Computer-aided software engineering tools that include computer-based automated diagramming, analyzing, and modeling capabilities. (1)

**CHILD DIAGRAM** The diagram that results from exploding the process on Diagram 0 (called the parent process). (7)

**CLASS** A common template for a group of individual objects with common attributes and common behavior in object-oriented analysis and design and UML. (10)

**CLASS DIAGRAM** Used to graphically model the static structural design view of a system; illustrates the functional requirements of the system gathered by way of analysis, as well as the physical design of the system. (10)

**CLIENT/SERVER ARCHITECTURE** A design model that features applications running on a local area network (LAN). Computers on the network divide processing tasks among servers and clients. Clients are networked machines that are points of entry into the client/server system. (16)

**CLOSED QUESTION** A type of question used in interviews or on surveys that closes the possible response set available to respondents. (4) *See also* bipolar question, open-ended question.

**CLOSED SYSTEM** Part of general systems theory; a system that does not receive information, energy, people, or raw materials as input. Systems are never totally closed or totally open, but exist on a continuum from more closed to more open. (2) *See also* open system.

**CLOUD COMPUTING** Organizations and individual users use Web services, database services, and application services over the Internet (the cloud), without having to invest in corporate or personal hardware, software, or software tools beyond the Web. Businesses use Web browsers to access applications and servers store software and data for businesses. (16)

**COMMAND LANGUAGE INTERFACE** A type of interface that allows users to control the application with a series of keystrokes, commands, phrases, or some sequence of these three methods. (14)

**COMPUTER-AIDED SOFTWARE ENGINEERING (CASE)** Specialized software tools that include computer-based automated diagramming, analyzing, and modeling capabilities. (1)

**CONCATENATED KEY** A composite key created when it is not possible to identify a record uniquely by using one of the data items found in a record; a key can be constructed by choosing two or more data items and combining them. (13)

**CONTEXT-LEVEL DATA FLOW DIAGRAM** The most basic data flow diagram of an organization showing how processes transform incoming data into outgoing information. Also called an environmental model. (2) *See also* data flow diagram.

**CONTROL FLAG** Used in structure charts to govern which portion of a module is to be executed, associated with IF, THEN, ELSE, and other similar types of statements. (16)

**CONVERSION** Physically converting the old information system to the new one. There are five conversion strategies: direct changeover, parallel conversion, phased or gradual

conversion, modular prototype conversion, and distributed conversion. (16)

**CRC CARDS** The analyst creates Class, Responsibilities, and Collaborators cards to represent the responsibilities of classes and the interaction between the classes when beginning to model the system from an object-oriented perspective. Analysts create the cards based on scenarios that outline system requirements. (10)

**CRITICAL PATH** The longest path calculated using the PERT scheduling technique; the path that will cause the whole systems project to fall behind if even one day's delay is encountered on it. (3)

**DASHBOARD** Display for decision makers including a variety of displays of relevant performance measurements. (11)

**DATA COUPLE** Depiction of the passing of data between two modules on a structure chart. (16)

**DATA DICTIONARY** A reference work of data about data (metadata) created by the systems analyst based on data flow diagrams; collects and coordinates specific data terms, confirming what each term means to different people in the organization. (8)

**DATA ELEMENT** A simple piece of data, can be base or derived; should be defined in the data dictionary. (8)

**DATA FLOW** Data that move in the system from one place to another; input and output are depicted using an arrow with an arrowhead in data flow diagrams. (7)

**DATA FLOW DIAGRAM (DFD)** Graphical depiction of data processes, data flows, and data stores in a business system. (7)

**DATA ITEM** The smallest unit in a file or database. Used interchangeably with the word *attribute*. (13)

**DATA MINING** Techniques that apply algorithms for extracting patterns from data stored in data warehouses that are typically not apparent to human decision makers. Also known as knowledge data discovery (KDD). (14)

**DATA REPOSITORY** A centralized database that contains all diagrams, form and report definitions, data structures, data definitions, process flows and logic, and definitions of other organizational and system components; provides a set of mechanisms and structures to achieve seamless data-to-tool and data-to-data integration. (8)

**DATA STORE** Data that are at rest in the system; depicted using an open-ended rectangle in data flow diagrams. (7)

**DATA STRUCTURE** Structures composed of data elements, typically described using algebraic notation to produce a view of the elements. The analyst begins with the logical design and then designs the physical data structures. (8)

**DATA WAREHOUSE** A collection of data in support of management decision processes that is subject oriented, integrated, time variant, and nonvolatile. (14) *See also* data mining.

**DATABASE** A formally defined and centrally controlled store of electronic data intended for use in many different applications. (13)

#### **DATABASE MANAGEMENT SYSTEM**

**(DBMS)** Software that organizes data in a database providing information storage, organization, and retrieval capacities. (13)

**DECISION SUPPORT SYSTEM (DSS)** An interactive information system that supports the decision-making process through the presentation of information designed specifically for the decision maker's problem-solving approach and application needs. It does not make a decision for the user. (1)

**DECISION TABLE** A way to examine, describe, and document structured decisions. Four quadrants are drawn to describe the conditions, identify possible decision alternatives, indicate which actions should be performed, and describe the actions. (9)

**DECISION TREE** A method of decision analysis for structured decisions; an appropriate approach when actions must be accomplished in a certain sequence. (9)

**DEFAULT VALUE** A value that a field will assume unless an explicit value is entered for it. (13)

**DELIVERABLES** Any of the software, documentation, procedures, user manuals, or training sessions that a systems analyst delivers to a client based on specific contractual promises. (3)

**DENORMALIZATION** Defining physical records not in third or higher normal forms; includes joining attributes from several relations together to avoid the cost of accessing several files. Partitioning is an intentional form of denormalization. (13)

**DIGITAL SUBSCRIBER LINE (DSL)** Protocols that allow high-speed data transmission over regular telephone wire. (16)

**DISASTER RECOVERY PLANNING** Strategic and tactical plans to aid people and systems to recover in the face of natural and human-made disasters. (16)

**DISPLAY** Any one of a number of display alternatives that users employ to view computer software, including monitors and liquid plasma screens. (11)

**DISTRIBUTED SYSTEMS** Computer systems that are distributed geographically, as well as having their processing, data, and databases distributed. One common architecture for distributed systems is a LAN-based client/server system. (16)

**DOCUMENTATION** Written material created by the analyst that describes how to run the software, gives an overview of the system, or details the program code used. Analysts can use a CASE tool to facilitate documentation. (16)

**DROP-DOWN LIST** One of many GUI design elements that permits users to click on a box that appears to drop down on the screen and list a number of alternatives, which can be subsequently chosen. (11)

**ECOMMERCE** Doing business electronically, including via email, Web technologies, BBS, smart cards, EFT, and EDI, among suppliers, customers, governmental agencies, and other businesses to conduct and execute transactions in business, administrative, and consumer activities. (1)

**ENCAPSULATION** In object-oriented analysis and design, an object is encapsulated by its behavior. An object maintains data about the real-world things it represents in a true sense. An object must be asked or told to change its own data with a message. (10)

**ENCRYPTION** The process of converting a message into an encrypted message by using a key so that the message cannot be read by a person. The intended receiver of the message can then use a key to decode and read the encrypted message. (13)

**END USERS** In an organization, noninformation system professionals who specify the business requirements for and use software applications. End users often request new or modified applications, test and approve applications, and may serve on project teams as business experts. (1)

**ENTERPRISE SYSTEMS** Information systems that are integrated organization-wide (enterprise-wide) that help companies in the coordination of critical organizational processes. (1)

**ENTITY** A person, group, department, or system that either receives or originates information or data. One of the primary symbols on a data flow diagram. (2) *See also* data flow diagram, external entity.

**ENTITY-RELATIONSHIP (E-R) DIAGRAM** A graphical representation of an E-R model. (8)

**ENTITY TYPE** A collection of entities that share common properties or characteristics. (8)

**ENVIRONMENT** Anything external to an organization. Multiple environments exist, such as the physical, economic, legal, and social environments. (2)

**EXECUTIVE SUPPORT SYSTEM (ESS)** A computer system that helps executives organize their interactions with the external environment by providing graphical and communication support. (1)

**EXPERT SYSTEM (ES)** A computer-based system that captures and uses the knowledge of an expert for solving a

particular problem. Basic components are the knowledge base, an inference engine, and the user interface. (1)

**EXPLORATION PHASE** This is the beginning phase of agile development where the analyst asserts his or her conviction that the agile approach is the correct one, then assembles the development team, and assesses their skills. It can last for a few weeks or up to a few months. (1)

**EXTERNAL ENTITY** A source or destination of data considered to be external to the system being described. Also called an entity. (7) *See also* data flow diagram.

**EXTREME PROGRAMMING (XP)** Extreme programming (XP) is a systems development approach that accepts what we know as good systems development practices and takes them to the extreme. Genesis of agile approaches. (3)

**FAVICON** A small icon displayed next to any bookmarked address in a browser. Copying the bookmarked link to a desktop results in a larger version of the icon being placed there. Unique favicons can be generated with a Java icon generator or with other graphics programs. (11)

**FIELD** A physical part of a database that can be packed with several data items; the smallest unit of named application data recognized by system software. (13)

**FIREWALL** Computer security software used to erect a barrier between an organization's LAN and the Internet. Although it prevents hackers from getting into an internal network, it also stops organizational members from getting direct access to the Internet. (16)

**FIRST NORMAL FORM (1NF)** The first step in normalizing a relation in data used in a database so that it contains no repeating groups. (13) *See also* second normal form, third normal form.

**FIT** Describes the way that HCI elements of the human, the computer, and the task that needs to be performed work together to improve performance and well-being. (14)

**FOLKLORE** A system documentation technique based on traditional methods used in gathering information about people and legends. (16)

**FORECASTING** Systems analysts are required to predict certain key variables before the systems proposal is submitted to the client. Forecasting is the art and science of predicting key variables, often assisted with mathematical forecasting models. (3)

**FORM-FILL INTERFACE** Part of GUI design elements that automatically prompt the user to fill in a standard form. Useful for ecommerce applications. (14)

**FUNCTION POINT ANALYSIS** A way to estimate project size, considering the five main components of computer systems: external inputs, external outputs, external log queries, internal logical files, and external interface files. (3)

**GANTT CHART** A graphical representation of a project that shows each task activity as a horizontal bar, the length of which is proportional to its time for completion. (3)

**GRAPHICAL USER INTERFACE (GUI)** An icon-based user interface, with features such as pull-down menus, drop-down lists, and radio buttons. (14)

**HUMAN-COMPUTER INTERACTION (HCI)** The aspect of a computer that enables communications and interactions between humans and the computer; the layer of the computer between humans and the computer. (14)

**HYPERLINK** Any highlighted word in a hypertext system that will display another document when clicked on by the user. (11)

**ICON** Small picture that represents an activity and function available to users when they activate it, often with a mouse click. Frequently used in GUI design. (14)

**IMPLEMENTATION** The last phase of the systems development life cycle, in which the analyst ensures that the system is in operation and then allows users to take over its operation and evaluation. (16)

**INDEXED FILE ORGANIZATION** A type of file organization that uses separate index files to locate records. (13)

**INHERITANCE** In object-oriented analysis and design, classes can have children. The parent class is known as the base class, and the child class is called a derived class. The derived class can be created to inherit all the attributes and behaviors of the base class. (10)

**INPUT** Any data, either text or numbers, that are entered into an information system for storage or processing via forms, screens, voice, or interactive Web fill-in forms. (12)

**INTANGIBLE BENEFITS** Benefits that accrue to the organization as a result of a new information system and that are difficult to measure, such as improving decision making, enhancing accuracy, and becoming more competitive. (3) *See also* intangible costs, tangible benefits, tangible costs.

**INTANGIBLE COSTS** Costs that are difficult to estimate and may not be known, including losing a competitive edge, losing a reputation for innovation, and declining company image, due to untimely or inaccessible information. (3) *See also* intangible benefits, tangible benefits, tangible costs.

#### **INTEGRATED SERVICES DIGITAL NETWORK (ISDN)**

A switched network service that provides end-to-end digital connectivity for transmitting voice, data, and video simultaneously over a single line versus multiple lines. (16)

**INTERNET SERVICE PROVIDER (ISP)** A company that provides access to the Internet and that may provide other services, such as Web hosting and Web traffic analysis, for a fee. (12)

**IP (INTERNET PROTOCOL) ADDRESS** The number used to represent an individual computer on a network. The format for an IP address is 999.999.999.999. (16)

**JAVA** An object-oriented programming language that allows dynamic applications to be run on the Internet. (11)

**JOINT APPLICATION DESIGN (JAD)** IBM's proprietary approach to panel interviews conducted with analysts, users, and executives to accomplish requirements analysis jointly. (4)

**KEY** One of the data items in a record that is used to identify a record. (13) *See also* primary key, secondary key.

**LEVEL 0 DIAGRAM** The explosion (or decomposition) of the context-level data flow diagram, showing from three to nine major processes, important data flows, and data stores of the system under study. (7)

**LOCAL AREA NETWORK (LAN)** The cabling, hardware, and software used to connect workstations, computers, and file servers located in a confined geographical area (typically within one building or campus). (15)

**LOGICAL DATA FLOW DIAGRAM** A diagram that focuses on the business and how the business operates; describes the business events that take place and the data required and produced by each event. (7) *See also* data flow diagram, physical data flow diagram.

**LOWER CASE TOOLS** CASE tools used by analysts to generate computer source code, eliminating the need for programming the system. (1) *See also* CASE tools.

**MAINTENANCE** Maintaining the information system to improve it or to fix problems begins in this phase of the SDLC and continues through the life of the system. Some maintenance can be done automatically through connecting to the vendor's Web site. (1)

**MANAGEMENT INFORMATION SYSTEM (MIS)** A computer-based system composed of people, software, hardware, and procedures that share a common database to help users interpret and apply data to the business. (1)

**MASHUPS** A new application created by combining two or more Web-based APIs (application programming interfaces) together. (14)

**METHOD** In UML, an action that can be requested from any object of the class; the processes that a class knows how to carry out. (10)

**MNEMONIC CODE** Any code (often using a combination of letters and symbols) that helps the data entry person remember how to correctly enter data or helps the user remember how to use the information. (15)

**NATURAL-LANGUAGE INTERFACE** An interface that permits the user to speak or write in human language to interact with the computer. (14)

**NORMALIZATION** The transformation of complex user views and data stores to a set of smaller, stable data structures. Normalized data structures are more easily maintained than complex structures. (13)

**OBJECT** In the object-oriented approach, an object is a computer representation of some real-world thing or event; can have both attributes and behaviors. (10)

**OBJECT CLASS** A category of similar objects. Objects are grouped into classes. A class defines the set of shared attributes and behaviors found in each object in the class. (10)

**OBJECT DIAGRAM** A diagram that is similar to class diagrams but that portrays the state of class instances and their relationships at a point in time; shows objects and their relationships. Also shows optionality (customer can have zero or more rental contracts) and cardinality (rental contract can have only one customer). (10)

**OBJECT THINK** Elementary statements the analyst writes on CRC cards to begin thinking in an object-oriented way. (10)

**OPEN-ENDED QUESTION** A type of question used in interviews or on surveys that opens up the possible response set available to respondents. (4) *See also* bipolar question, closed question.

**OPEN SOURCE SOFTWARE (OSS)** A development model and philosophy of distributing software free and publishing its source code, which can then be studied, shared, and modified by users and programmers. The Linux operating system is an example. (1)

**OPEN SYSTEM** Part of general systems theory; a system that freely receives information, energy, people, or raw materials as input. Systems are never totally closed or totally open, but exist on a continuum from more closed to more open. (2) *See also* closed system.

**OUTPUT** Information delivered to users through the information system by way of intranets, extranets, or the Web, on printed reports, on displays, or via audio. (11)

**PACKAGE** In UML, things can be grouped together in packages, which can be considered physical subsystems. Systems are implemented and deployed in packages. (10)

**PAIR PROGRAMMING** A core practice of the agile approach wherein two programmers who choose to work together both do the programming, run the tests, and talk to one another about ways to efficiently and effectively get the job done. (6)

**PERT DIAGRAM** A tool used to determine critical activities for a project. It can be used to improve a project schedule and evaluate progress. It stands for Program Evaluation Review Technique. (3)

**PHYSICAL DATA FLOW DIAGRAM** A DFD that shows how a system will be implemented, including the hardware, software, people, and files involved. (7) *See also* logical data flow diagram.

**PLANNING GAME** Used in agile development, the planning game spells out rules that can help formulate the agile development team's relationship with their business customers. (1)

**PLUG-IN** Additional software (often developed by a third party) that can be used with another program; for example, RealNetworks' Real Player or Macromedia Flash are used as plug-ins in Web browsers to play streaming audio or video and view vector-based animation. (11)

**PODCASTING** The technique of putting downloadable audio files on the Web. (11)

**POLYMORPHISM** Alternative behaviors among derived classes in object-oriented approaches. When several classes inherit both attributes and behaviors, the behavior of a derived class might be different from its base class or its sibling-derived classes. (10)

**PRESENT VALUE** The total amount that a series of future payments is worth now; a way to assess the economic outlays and revenues of the information system over its economic life and compare costs today with future benefits. (10)

**PRIMARY KEY** A key that uniquely identifies a record. (13) *See also* key, secondary key.

**PROBES** Follow-up questions primarily used during interviews between analysts and users. (4) *See also* closed question, open-ended question.

**PROBLEM DEFINITION** A formal statement of the problem, including (1) the issues of the present situation, (2) the objectives for each issue, (3) the requirements that must be included in all proposed systems, and (4) the constraints that limit system development. (3)

**PROCESS** The activities that transform or change data in an information system. They can be either manual or automated. Signified by a rounded rectangle in a data flow diagram. (2)

**PRODUCTIONIZING PHASE** The phase in agile development when the software is released and feedback to improve the software product is received. Product releases can happen as often as every week. (1)

**PROJECT CHARTER** A written document describing the expected results of the systems project (deliverables) and the time frame for delivery; it essentially becomes a contract between the chief analyst (or project manager) and his or her analysis team with the organizational users requesting the new system. (3)

**PROJECT MANAGEMENT** The art and science of planning a project, estimating costs and schedules, managing risk, and organizing and overseeing a team. Many software packages exist to support project management tasks. (3)

**PROJECT MANAGER** A person responsible for overseeing the planning, costing, scheduling, and team organization of a (often systems) project. Frequently, it is a role played by a systems analyst. (3)

**PROTOTYPING** A rapid, interactive process between users and analysts to create and refine portions of a new system; it can be used as part of the systems development life cycle (SDLC) for requirements determination or as an alternative to the SDLC. (6) *See also* rapid application development.

**PSEUDOCODE** A technique to create computer instructions that are the intermediate step between English and program code; used to represent the logic of each module on a structure chart. (16) *See also* structure chart.

**PULL-DOWN MENU** One of many GUI design elements that provides an onscreen menu of command options that appear after the user selects the command name on a menu bar. (14) *See also* drop-down list.

**QUERIES** Questions users pose to the database concerning data within it. Each query involves an entity, an attribute, and a value. (14)

**RADIO BUTTON** One of many GUI design elements that provides a round option button in a dialog box. Buttons are mutually exclusive, because a user can choose only one radio button option within the group of options displayed. (11)

**RAPID APPLICATION DEVELOPMENT (RAD)** An object-oriented approach to systems development that includes a method of development as well as software tools. (6) *See also* prototyping.

**RECORD** A collection of data items that have something in common with the entity described. (13)

**RELATIONAL DATABASE MODEL** Represents data in the database as two-dimensional tables called relations. As long as both tables share a common data element, the database can relate any one file or table to data in another file or table. (13)

**RELATIONSHIP** Association between entities (sometimes referred to as data association); can take the form of one-to-one, one-to-many, many-to-one, or many-to-many. (13)

**REPEATING GROUP** The existence of many of the same elements in the data structure. (8) *See also* data structure.

**RUBY ON RAILS** A combination programming language and code generator for creating Web applications. (11)

**SAMPLING** Systematically selecting representative elements of a population. Analysts sample hard data, archival data, and people during information requirements determination. (5)

**SECOND NORMAL FORM (2NF)** When normalizing data for a database, the analyst ensures that all nonkey attributes are fully dependent on the primary key. All partial dependencies are removed and placed in another relation. (13) *See also* first normal form, third normal form.

**SECONDARY KEY** A key that cannot uniquely identify a record; can be used to select a group of records that belong to a set. (13)

**SEQUENCE DIAGRAM** In UML, a sequence diagram illustrates a succession of interactions between object instances over time. Often used to illustrate the processing described in use case scenarios. (10)

#### **SERVICE-ORIENTED ARCHITECTURE**

**(SOA)** Making individual software services that are unassociated or only loosely coupled to one another available as applications or parts of applications to users, often using the Web as a platform. (16)

**SIX SIGMA** A culture built on quality; the goal is to eliminate all defects. (16)

**STATECHART DIAGRAM** In UML, a way to further refine requirements. (10)

**STICKINESS** A property of Web pages, particularly discussed in ecommerce. Features that increase the stickiness of a Web page are those that entice customers to stay on the page longer, help them to navigate back to the page if they click on a link, and increase the likelihood they will complete a purchase. (14).

**STRUCTURE CHART** A tool for designing a modular, top-down system consisting of rectangular boxes and connecting arrows. (16). *See also* control flag, data couple.

**STRUCTURED ENGLISH** A technique for analyzing structured decisions based on structure logic and simple English statements, such as add, multiply, and move. (9)

**STRUCTURED OBSERVATION OF THE ENVIRONMENT (STROBE)** A systematic observational method for classifying and interpreting organizational elements that influence decision making. Based on mise-en-scène film criticism. (5)

**STRUCTURED WALKTHROUGH** A systematic peer review of the system's programming and overall development that points out problems and allows the programmer or analyst to make suitable changes. (16)

**SUPPLY CHAIN MANAGEMENT** An organization's effort to integrate their suppliers, distributors, and customer management requirements into one unified process.

Ecommerce applications can improve supply chain management. (16)

**SWIMLANES** Zones used in activity diagrams to indicate partitioning; can show which activities are done on which platform and by which user group; can also depict system logic. (10)

**SYSTEM** A collection of subsystems that are interrelated and interdependent, working together to accomplish predetermined goals and objectives. All systems have input, processes, output, and feedback. Examples are a computer information system and an organization. (2) *See also* closed system, open system.

**SYSTEMS ANALYST** The person who systematically assesses how businesses function by examining the inputting and processing of data and the outputting of information with the intent of improving organizational processes and the quality of work life for users. (1)

**SYSTEMS DEVELOPMENT LIFE CYCLE (SDLC)** A seven-phase approach to systems analysis and design that holds that systems are best developed through the use of a specific cycle of analyst and user activities. (1)

**SYSTEMS DEVELOPMENT METHODOLOGY** Any accepted approach for analyzing, designing, implementing, testing, maintaining, and evaluating an information system. SDLC, agile approaches, and object-oriented systems analysis and design are examples of methodologies. (1) *See also* systems development life cycle.

**SYSTEMS PROPOSAL** A written proposal that summarizes the systems analyst's work in the business up to that point and includes recommendations and alternatives to solve the identified systems problems. (3)

**SYSTEMS TESTING** The sixth phase in the SDLC (along with maintenance). Uses both test data and eventually live data to measure errors, timeliness, ease of use, proper ordering of transactions, acceptable down time, understanding procedure manuals, and other aspects of the new system. (16)

**TANGIBLE BENEFITS** Advantages measurable in dollars that accrue to the organization through the use of the information systems. (3) *See also* intangible benefits, intangible costs, tangible costs.

**TANGIBLE COSTS** The costs in dollars that can be accurately projected by the systems analyst, including the cost of computers, resources, analysts' and programmer's time, and other employees' salaries, to develop a new system. (3) *See also* intangible benefits, intangible costs, tangible benefits.

**TECHNOLOGY ACCEPTANCE MODEL (TAM)** A research-based way for analysts to organize their thinking about whether users will accept and use information

technology, typically including perceived usefulness and perceived ease of use. (14)

**THINGS** In UML, things describe the objects of object-oriented analysis and design. The two most often used groupings of things are structural things and behavioral things. (10)

**THIRD NORMAL FORM (3NF)** A form in which any transitive dependencies are removed. A transitive dependency is one in which nonkey attributes are dependent on other nonkey attributes. (13) *See also* first normal form, second normal form.

**TRANSACTION PROCESSING SYSTEM (TPS)** A computerized information system developed to process large amounts of data for routine business transactions, such as payroll and inventory. (1)

**UNIFIED MODELING LANGUAGE (UML)** UML provides a standardized set of tools to document the object-oriented analysis and design of a software system. (10)

**USABILITY** A way for designers to evaluate the systems and interfaces they create with an eye toward addressing as many HCI concerns as they can as thoroughly as possible. (14)

**USE CASE** In UML, a sequence of transactions in a system; the purpose is to produce something of value to an

actor in the system; focuses on what the system does rather than on how it does it. The use case model is based on the interactions and relationships of individual use cases. In a use case, an actor using the system initiates an event that begins a related series of interactions in the system. (10)

**VALIDATION SOFTWARE** Software that checks whether data input to the information system is valid. Although validating input is largely done through software that is the programmer's responsibility, it is the analyst's responsibility to know what common problems might invalidate a transaction. (15)

**VOICE-OVER INTERNET PROTOCOL (VoIP)** The routing of voice data over the Internet. (15)

**WEBMASTER** The person responsible for updating and maintaining a Web site; often initially the systems analyst during development of ecommerce applications. (12)

**XML SCHEMAS** A precise way to define the content of an XML document; may include the exact number of times an element can occur, the type of data within elements, limits on the data, and the number of places to the left and right of a decimal number. (8)

**XP** *See* agile approach and extreme programming. (6)

# ACRONYMS

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<b>1NF</b>	first normal form	<b>LAN</b>	local area network
<b>2NF</b>	second normal form	<b>MICR</b>	magnetic ink character recognition
<b>3NF</b>	third normal form	<b>MIS</b>	management information system
<b>AJAX</b>	asynchronous JavaScript and XML	<b>MRP</b>	materials requirements planning
<b>API</b>	application programming interface	<b>OAS</b>	office automation systems
<b>ASP</b>	application service provider	<b>OCR</b>	optical character recognition
<b>B2B</b>	business-to-business	<b>OID</b>	object identifier
<b>B2C</b>	business-to-consumer	<b>OLAP</b>	online analytic processing
<b>CARE</b>	computer-assisted reengineering	<b>OLE</b>	object linking and embedding
<b>CASE</b>	Computer-Aided Software Engineering	<b>OOA</b>	object-oriented approach
<b>CHUI</b>	character-based user interface	<b>OSS</b>	open source software
<b>COTS</b>	commercial off-the-shelf	<b>PERT</b>	Program Evaluation and Review Techniques
<b>CRUD</b>	create, read, update, and deleted	<b>PHP</b>	hypertext preprocessor; an open source
<b>CSCWS</b>	computer-supported collaborative work system	<b>PKI</b>	programming language
<b>CSS</b>	cascading style sheets	<b>QBE</b>	public key infrastructure
<b>DBMS</b>	database management system	<b>RAD</b>	query by example
<b>DDE</b>	dynamic data exchange	<b>SAAS</b>	rapid application development
<b>DFD</b>	data flow diagram	<b>SAN</b>	software as a service
<b>DHTML</b>	dynamic HTML	<b>SDLC</b>	storage area network
<b>DLL</b>	dynamic link library	<b>SET</b>	systems development life cycle
<b>DSL</b>	digital subscriber line	<b>SLA</b>	secure electronic translation
<b>DSS</b>	decision support system	<b>SOA</b>	software license agreement
<b>DTD</b>	document type definition	<b>SQL</b>	service-oriented architecture
<b>EDI</b>	electronic data interchange	<b>SSL</b>	structured query language
<b>E-R</b>	entity-relationship	<b>STROBE</b>	secure socket layering
<b>EIS</b>	executive information system	<b>TAM</b>	structured observation of the environment
<b>ERD</b>	entity-relationship diagram	<b>TPS</b>	technology acceptance model
<b>ERP</b>	enterprise resource planning	<b>TQM</b>	transaction processing system
<b>ES</b>	expert system	<b>UML</b>	total quality management
<b>ESS</b>	executive support system	<b>URL</b>	unified modeling language
<b>FAQ</b>	frequently asked questions	<b>VB.NET</b>	uniform resource locator
<b>FPC</b>	function point count	<b>VOIP</b>	Visual Basic .NET, a Microsoft programming
<b>FTP</b>	file transfer protocol	<b>VPN</b>	environment
<b>GIF</b>	graphic interchange format	<b>WAN</b>	Voice-over Internet Protocol
<b>GUI</b>	graphical user interface	<b>WAP</b>	virtual private network
<b>HCI</b>	human-computer interaction	<b>WIMAX</b>	wide area network
<b>HTML</b>	hypertext markup language	<b>WLAN</b>	wireless application protocol
<b>http://</b>	hypertext transfer protocol	<b>WMP</b>	worldwide interoperability for microwave
<b>ICTS</b>	information communication technologies	<b>WWW</b>	access
<b>ISDN</b>	Integrated Services Digital Network	<b>XP</b>	wireless local area networks
<b>ISP</b>	Internet service provider	<b>XSLT</b>	Windows Media Photo
<b>JAD</b>	joint application design		World Wide Web
<b>JPEG</b>	Joint Photographic Experts Group		extreme programming
<b>KDD</b>	knowledge data discovery		extensible stylesheet language
<b>KWS</b>	knowledge work systems		transformations



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**Note:** Page numbers followed by an italic f indicate figures.

## SYMBOLS

- # (pound), 297
- \* (asterisk), 246, 304, 414, 455
- [ ] (brackets), 232
- { } (braces), 231
- + (plus sign), 231, 246, 298, 383
- <<>> (chevrons, guillemots), 308
- < (less than), 244
- = (equal sign), 231, 298
- > (greater than), 244, 262, 266, 276, 455, 471
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