GLOBAL EDITION

Systems Analysis and Design

TENTH EDITION

Kenneth E. Kendall • Julie E. Kendall

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SYSTEMS ANALYSIS AND DESIGN

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SYSTEMS ANALYSIS AND DESIGN

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To the memory of Julia A. Kendall and Edward J. Kendall,
whose lifelong example of working
together will inspire us forever.

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PREFACE

NEW TO THIS EDITION

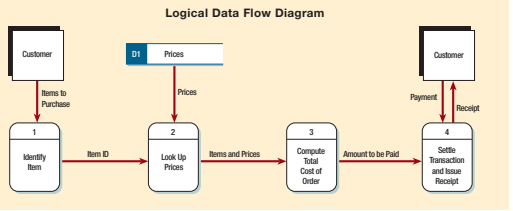
The tenth edition of *Systems Analysis and Design* includes extensive changes inspired by the rapid changes in the IS field over the past four years, and they are included as a response to the thoughtful input of our audience of adopters, students, and academic reviewers. Many new and advanced features are integrated throughout this new edition. In particular:

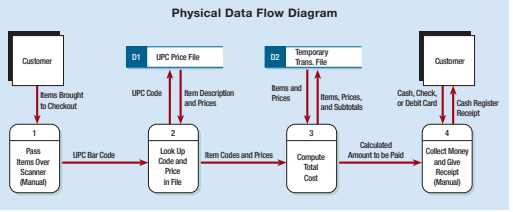
- Innovative material on using responsive design to enable systems analysts and organizations to participate in open source communities (Chapter 1)
- New coverage of the importance of security considerations right from the outset of a systems project (Chapter 1)
- New material on work-sanctioned social media sites to create productive systems development subcultures and collaborative design (Chapter 2)
- Additional material on cloud computing as a platform choice for a systems development project (Chapter 3)
- Innovative material on listening to user stories to complement other interactive information gathering methods (Chapter 4)
- New material on text analytics software to examine unstructured, soft data from customers' blogs, wikis, and social media sites to interpret qualitative material (Chapter 5)
- New and expanded content on agile methods including Scrum, Scrum planning poker, the product backlog, sprint cycle, and burndown charts (Chapter 6)
- New coverage on Kanban systems as they apply to software development (Chapter 6)
- Innovative coverage of DevOps as a cultural shift in the way to organize rapid systems development and operations (Chapter 6)
- Additional material on designing dashboards for decision makers using infographics (Chapter 11)
- New material on responsive Web design for websites that can be viewed on any device (Chapter 11)
- New material comparing and contrasting skeuomorphic design with flat design for websites (Chapter 11)
- Additional material on innovative guidelines for designing for social media (Chapter 11)
- New content on website design including use of navigational elements such as a hamburger icon and breadcrumb trail (Chapter 12)
- New material on the relationship of business intelligence to data warehouses, big data, and data analytics (Chapter 13)
- Additional coverage on database security and risk tradeoffs in securing databases (Chapter 13)
- Innovative material on developing and using blockchains to provide a verifiable electronic record for tracking any kind of business asset (Chapter 13)
- New content on UX design (user experience design) for developing customer-centered ecommerce website experiences (Chapter 14)
- Innovative coverage of designing virtual reality, augmented reality, and intelligent personal assistants (Chapter 14)
- Additional content on using QR codes for improved data entry (Chapter 15)
- Additional material on designing improved cloud security, privacy, and stability, especially for business continuity and disaster recovery (Chapter 16)

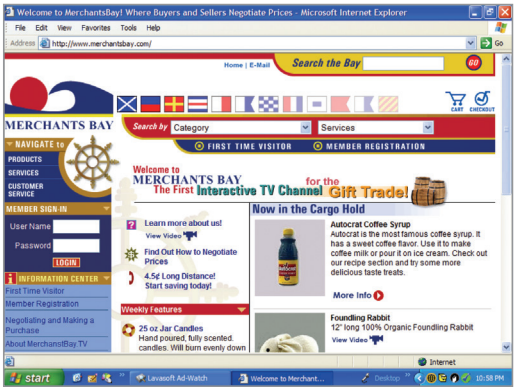
DESIGN FEATURES

Figures have a stylized look 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 students can easily distinguish among them, and their functions are clearly indicated. Many other important tools are illustrated, including use case diagrams, sequence diagrams, and class diagrams.

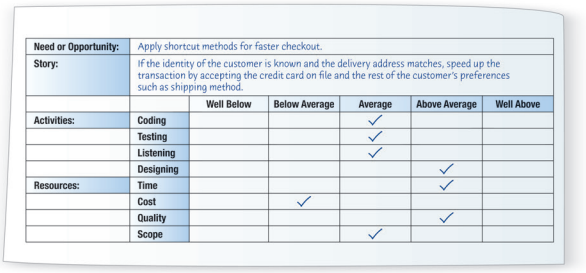






Computer displays demonstrate important software features that are useful to the analyst. In this edition we introduce UX (user experience) design. Screens are of the utmost importance when we put the user experience first. Actual screen shots show important aspects of design. Analysts are continuously 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.

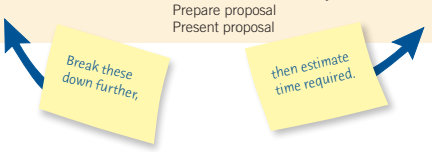
Paper forms are used throughout to show how to capture user stories, as well as for input and output design and the design of questionnaires. Blue ink is always used to show writing or data input, thereby making it easier to identify what was filled in by hand. Although most organizations have computerization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



Need or Opportunity:	Apply shortcut methods for faster checkout.					
Story:	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.					
		Well Below	Below Average	Average	Above Average	Well Above
Activities:	**Coding**			✓		
	Testing			✓		
	Listening			✓		
	Designing				✓	
Resources:	**Time**				✓	
	Cost		✓			
	Quality				✓	
	Scope			✓		

Tables are used when an important list needs special attention or when information needs to be organized or classified. In addition, tables supplement the understanding of the reader in a way that departs from how material is organized in the narrative portion of the book. Most analysts find tables a useful way to organize numbers and text into a meaningful "snapshot."

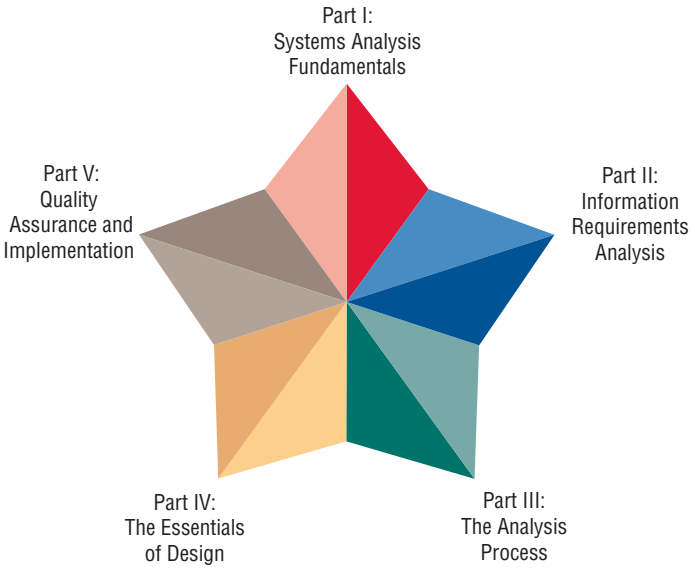
Activity	Detailed Activity	Weeks Required
Data gathering	Conduct interviews	3
	Administer questionnaires	4
	Read company reports	4
	Introduce prototype	5
	Observe reactions to prototype	3
Data flow and decision analysis	Analyze data flow	8
Proposal preparation	Perform cost-benefit analysis	3
	Prepare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



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. This book is built on the idea 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, whether they are posed by designing for multiple platforms, new types of users, or implementing cloud-based systems; and by keeping up to date in their profession through the application of new methods, software, and alternative tools.

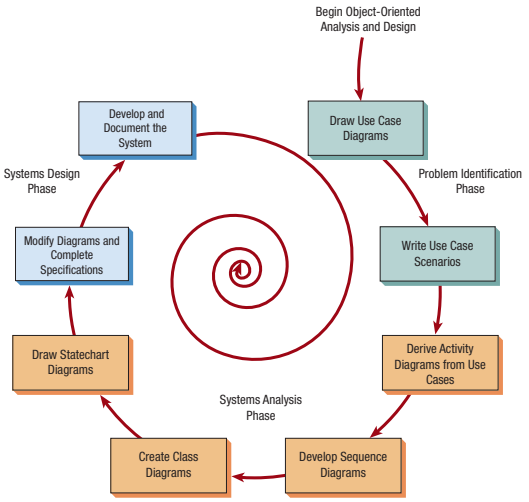
A BRIEF TOUR OF THE TENTH EDITION



Systems analysis and design is typically taught in one or two semesters. This 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, the legacy CPU Case online, or other materials available at the Pearson Instructor Resources website.

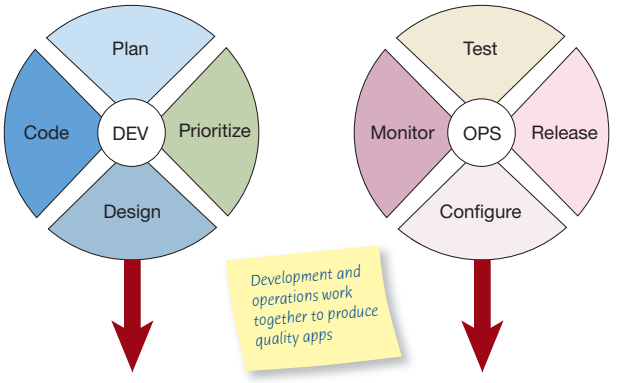
The text is divided into five major parts: Systems Analysis Fundamentals (Part I), Information Requirements Analysis (Part II), The Analysis Process (Part III), The Essentials of Design (Part IV), and Quality Assurance and Implementation (Part V).

Part I (Chapters 1–3) stresses the basics 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 universal modeling language (UML), along with reasons and situations for when to use them. Part I introduces the three roles of a systems analyst—consultant, supporting expert, and agent of change—along with ethical issues and professional guidelines for serving as a systems consultant. The importance of designing security into new systems from the beginning is noted. Material on virtual teams and virtual organizations, and the concept of human–computer interaction (HCI) is introduced as well. The use of open source software (OSS) and how analysts and organizations can participate in open source communities by using responsive design is introduced.

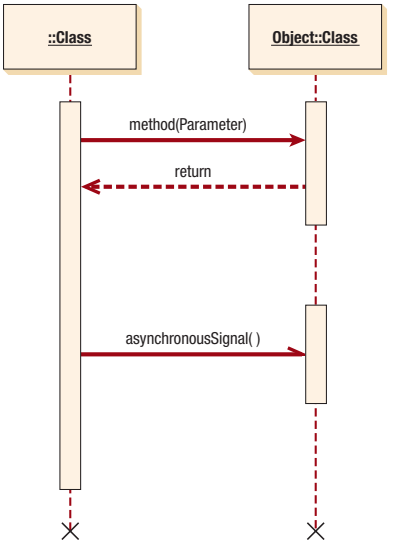


Chapter 2 includes how to initially approach an organization by drawing context-level data flow diagrams, using entity-relationship models, and developing use cases and use case scenarios. It views the organization as a system through the description of enterprise resource planning (ERP) systems. Also included is the importance of using employer-sanctioned social media to create a strong workplace culture. Chapter 3 focuses on project management. It introduces material on when to use cloud services versus purchasing hardware and software. Project management techniques including time estimation techniques for project management are discussed. Material in Chapter 3 will help students approach projects using the work breakdown structure (WBS). Creating a problem definition, developing a project charter, and determining feasibility are also covered. Chapter 3 guides students in writing and presenting a professional and effective systems proposal 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 a system. Chapter 4 introduces a group of interactive methods, including interviewing, joint application design (JAD), and constructing questionnaires. It expands material on listening to user stories in order to understand organization behaviors and values. 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. New material on the use of text analytics software to examine unstructured data from blogs, wikis, interviews, and social media sites is added. 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, and 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. New and expanded coverage of agile methods including Scrum, Scum planning poker, the product backlog, sprint cycle, and burndown charts are included. Kanban systems as they apply to software development are introduced, and innovative coverage of DevOps as a cultural shift in the way to organize rapid systems development and operations is covered.

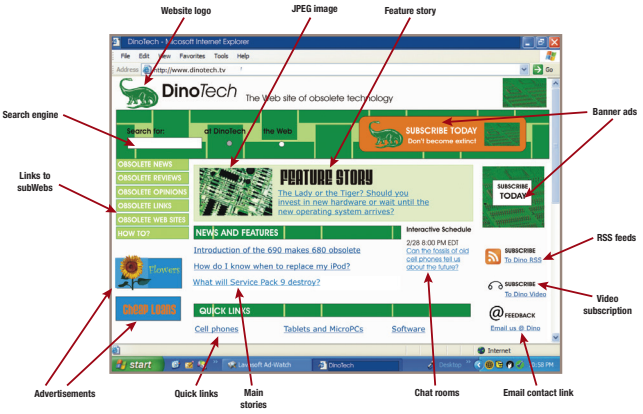


Part III (Chapters 7–10) details the analysis process. It builds on the previous two parts to move students into analysis of data flows as well as structured and semistructured decisions. It provides step-by-step details on how to use structured techniques to draw data flow diagrams (DFDs). Chapter 7 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.

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 considers output, including Web displays, audio, and electronic output such as web pages, email, and RSS feeds. Designing a website for ecommerce purposes is emphasized, and the importance of adding Web 2.0 technologies and social media to corporate and ecommerce websites is explored. Additional material on designing dashboards using infographics is provided. New material on responsive Web design is included. Flat versus skeuomorphic design is covered, as are innovative guidelines for designing for social media. Designing apps for smartphones and tablets is integrated, along with storyboarding, wireframing, and mockups. Output production and XML are covered.

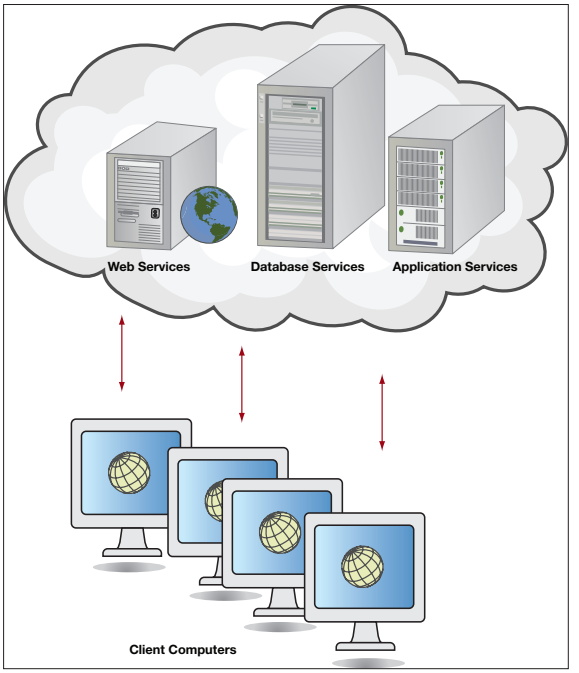
Chapter 12 includes innovative material on designing for smartphones and tablets as well as designing Web-based input forms and other electronic forms design. Also included is computer-assisted forms design. Chapter 12 also features in-depth coverage of website design, new content on how to add navigational elements to websites such as a hamburger menus and breadcrumb trails, and includes guidelines on when designers should add video, audio, and animation to website designs. There is detailed consideration of how to create effective graphics for corporate websites and ways to design effective onscreen navigation for website users.

Coverage of intranet and extranet page design is included. Consideration of database integrity constraints and how the user interacts with the computer and how to design an appropriate interface are discussed. 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 an entity-relationship diagram to determine record keys and provides 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. New material on the relationship between business intelligence (BI) and data warehouses, big data, and data analytics software is added in the context of data warehouses. Additional material on database security and risk tradeoffs in securing databases is added. Innovative material on developing and using blockchains to provide a verifiable electronic record for tracking any kind of business asset is included.

Chapter 14 emphasizes human–computer interaction (HCI), especially as it relates to interface design, as well as UX design. It discusses the importance of HCI in designing systems that suit individuals and assisting them in achieving personal and organization goals through their use of information technology. The concept of usability is introduced, so that systems analysis students can knowledgeably incorporate HCI practices in their designs. Chapter 14 introduces material on how to design gesture-based (multitouch) interfaces for smartphones and tablets, as well as designing alerts, notices, and queries. Material on designing easy onscreen navigation for website visitors is included. The chapter presents innovative approaches to searching on the Web, highlights material on graphic user interface (GUI) design, and provides innovative approaches to designing dialogues. Chapter 14 articulates specialized design considerations for ecommerce websites. New material on UX design (user experience design) for developing customer-centered ecommerce websites is included. Mashups, new applications created by combining two or more Web-based application programming interfaces, are also covered. Innovative material on designing virtual reality (VR), augmented reality (AR), and intelligent personal assistants is included. Chapter 14 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. It includes suggestions for incorporating two-dimensional codes QR codes and bar codes into data entry designs. It also considers the usefulness of RFID for automatic data collection. 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 combined with ERP are significantly altering the landscape 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 includes security for firewalls, gateways, public key infrastructure (PKI), secure electronic transaction (SET), secure sockets layer (SSL), virus protection software, URL filtering products, email filtering products, and virtual private networks (VPN) is included. Additional coverage on designing improved cloud security, privacy, and stability, especially for business continuity and disaster recovery, is included.

Important coverage of how the analyst can promote and monitor a corporate website is included in this section, which features Web activity monitoring, website 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.

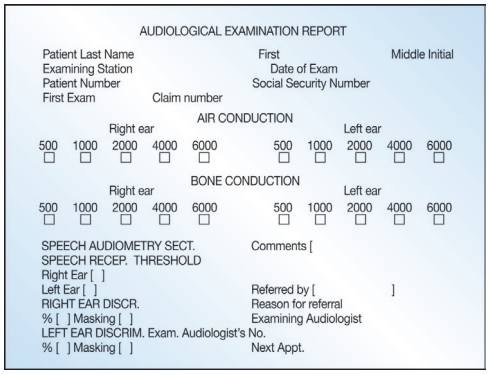
This tenth edition contains an updated **Glossary** of terms and a separate list of updated **Acronyms** used in the book and in the systems analysis and design field.

PEDAGOGICAL FEATURES

Chapters in this tenth edition contain:

- **Learning Objectives** at the beginning of each chapter
- **Summaries** at the end of each chapter that tie together the salient points of the chapter and provide an excellent source of review for exams
- **Keywords and Phrases** for each chapter
- **Review Questions** to help with learning key definitions and terms
- **Problems** that help students apply and extend the concepts and tools they are learning to practical situations
- **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 with more than 50 minicases throughout the book
- **Mac Appeal** columns that inform students about design software available on the Mac and iPhone
- **HyperCase Experiences** in each chapter simulate organizational experience and focus learning from HyperCase online

CONSULTING OPPORTUNITIES


AUDIOLOGICAL EXAMINATION REPORT

Patient Last Name First Middle Initial
Examining Station Date of Exam
Patient Number Social Security Number
First Exam Claim number

AIR CONDUCTION

Right ear					Left ear				
500	1000	2000	4000	6000	500	1000	2000	4000	6000
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

BONE CONDUCTION

Right ear					Left ear				
500	1000	2000	4000	6000	500	1000	2000	4000	6000
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

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

This tenth edition presents more than 50 Consulting Opportunities, addressing significant and emerging topics arising in information systems, including designing systems from an HCI perspective, ecommerce applications for the Web, cloud computing decisions, and using UML to model information systems from an object-oriented perspective. Consulting Opportunities can be used for motivating thoughtful in-class discussions or assigned as homework or take-home exam questions.

Not all systems work demands extended two- or three-year projects, so many Consulting Opportunities included can be solved in 20 to 30 minutes of group discussion, group writing, 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.

HYPERCASE EXPERIENCES

HYPERCASE® EXPERIENCE 3.2

"Sometimes 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. Mr. Evans 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 Department, describing all the systems you find. *Hint:* Create an inventory form to simplify your task.
2. Using the software evaluation guidelines given in the chapter, do a brief evaluation of GEMS, a software package used by the Training and Management Systems Department employees. In a paragraph, briefly critique this custom software by comparing it with COTS 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 Mr. Evans is considering for the proposed project tracking and reporting system.
5. What organizational and political factors should Mr. Evans 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, click on the small red directory if you want to visit an MRE employee.

HyperCase Experiences that pose challenging student exercises are present in each chapter. HyperCase 2.10 has organization problems featuring information systems technology. HyperCase represents an original virtual organization that allows students who access it to become immediately immersed in organization life. Students will interview people, observe office environments, analyze their prototypes, and review the documentation of their existing systems.

HyperCase 2.10 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 a 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.

Each chapter contains HyperCase Experiences that include assignments (and even some clues) to help students solve difficult organization problems including developing new systems, merging departments, hiring 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.

EXPANDED WEB SUPPORT

Systems Analysis and Design, tenth edition, features Web-based support for solid but lively pedagogical techniques in the information systems field:

- The website, located at **www.pearsonglobaleditions.com**, contains a wealth of critical learning and support tools, which keep class discussions exciting.
- **HyperCase 2.10** is an award-winning, interactive organization game. Students are encouraged to interview people in the organization, analyze problems, drill down into and modify data flow diagrams and data dictionaries, react to prototypes, and design new input and output.
- **A legacy case, the Central Pacific University (CPU) case is online**. In keeping with our belief that a variety of approaches is important, the entire legacy Central Pacific University (CPU) case, accompanied by partially solved Student Exercises, is fully available online. The legacy CPU case makes use of Microsoft Access, Microsoft Visio, and the popular CASE tool Visible Analyst by Visible Systems, Inc., for the sample screen shots and the student exercises. The legacy CPU case takes students through all phases of the systems development life cycle.

EXPANDED INSTRUCTOR SUPPLEMENTAL WEB SUPPORT

Extended support for instructors using this edition can be found at the official website located at **www.pearsonglobaleditions.com**. Resources include:

- **Instructor's Manual**—The Instructor's Manual contains answers to problems, solutions to cases, and suggestions for approaching the subject matter.
- **PowerPoint Presentations—**The PowerPoints feature lecture notes that highlight key text terms and concepts. Professors can customize the presentation by adding their own slides or by editing the existing ones.
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- **TestGen Testbank—**Pearson Education's test-generating software is available from the **TestGen website.** The software is PC/Mac and Blackboard compatible and preloaded with all the Test Gen Testbank questions. You can manually or randomly view test questions and drag and drop to create a test. You can add or modify test-bank questions as needed.
- **Image Library—**This collection of the text art is organized by chapter. This collection includes all the figures, tables, and screenshots from the book. These images can be used to enhance class lectures and PowerPoint slides.
- **Solutions to the legacy CPU Case and Student Files**—These exercises are based on the legacy CPU case, with solutions and examples stored in Visible Analyst files and Microsoft Access files.
- **eBook of *Systems Analysis and Design, 10th edition, Global Edition*** available at **mypearsonstore.com**

Arco Iris de Colores (Rainbow Colors) by *Pedro Fuller*

ACKNOWLEDGMENTS

The field of information systems was changing swiftly as we were writing the tenth edition of *Systems Analysis and Design*. We are excited that this edition is being published at the right moment for us to capture many of these innovations in systems analysis and design.

One notable change is the practice of UX design for developing customer-centered ecommerce website experiences. In this process, a systems analyst observes the behavior of customers and strives to enhance customer satisfaction and loyalty. The analyst accomplishes this by improving usability and ease of use. UX design is a design culture that chooses to give the user a good experience over maximizing short-term profit. Hand in hand with this approach is the accelerating use of responsive website design (RWD) enabling Web-based information systems to adapt and display correctly on whatever device is used to view content. In addition, cloud computing and software as a service (SaaS) are effectively altering the way analysts need to approach designing systems solutions.

Throughout the book you will learn and apply numerous techniques, methods, tools, and approaches to help visually capture a system. 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 and your values as a systems analyst and a human being.

The artist, Pedro Fuller, who created the inspiring oil painting *Arco Iris de Colores* (*Rainbow Colors*) featured on the previous page and throughout the 10th edition, states, "Every piece I complete expresses something unique. I always give careful consideration to the way color and form work together. Some of the themes in my art are spirituality, music, politics, and happiness. Because I value music for its relaxing qualities, there is a visual rhythm in my work through which I try to reach this same calmer, more spiritual place." Pedro was born in Managua, Nicaragua, and as a teenager moved with his family to Camden, New Jersey. We hope that you as a student will strive to create something unique working with color and form as you learn to design screens, forms, websites, and expressions on social media.

It is, in fact, our own students who deserve recognition for this new edition because of their comments and suggestions for enhancements and their desire for increased depth in timely topics. Students told us that they quickly put to use the new material on agile methods, especially Scrum, UX design, as well as the material on DevOps. We want to thank our coauthor, Allen Schmidt, who worked with us on HyperCase 2.10 for all his support and collaboration over the years. He is an outstanding person. Our appreciation also goes to Peter Schmidt and Jason Reed for their improvements to the early HyperCase. In addition, we want to thank the other two original authors of HyperCase, Richard Baskerville and Raymond Barnes, who contributed so much to our lives and our projects over the years and are exceptional friends.

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Julie and Ken Kendall personally thank all of our friends in the theatre and the performing arts. Here are the Kendalls at the 2012 Tony Awards afterparty with Tony-Award winning Actor James Corden (*right*). Photo by Anita & Steve Shevett.

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All the reviewers for the tenth edition deserve our thanks as well. Their thoughtful feedback and recommendations helped to strengthen the book. They are:

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SYSTEMS ANALYSIS AND DESIGN

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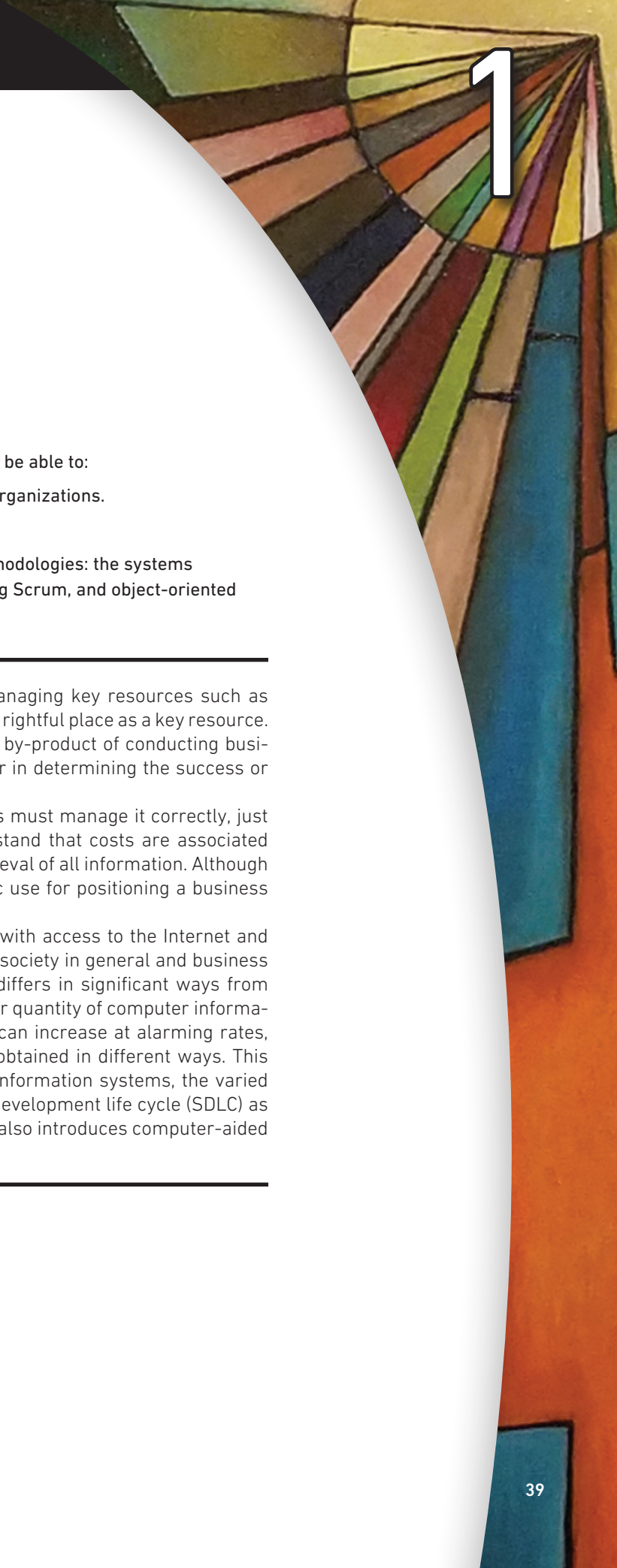


1 Systems, Roles, and Development Methodologies

LEARNING OBJECTIVES

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

1. Understand the need for systems analysis and design in organizations.
2. Realize what the many roles of a systems analyst are.
3. Comprehend the fundamentals of three development methodologies: the systems development life cycle (SDLC), the agile approach including Scrum, and object-oriented systems analysis and design.

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 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. There is usually 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.

Need for Systems Analysis and Design

Systems analysis and design, as performed by systems analysts, is used to understand what people need to be able to systematically analyze data input or data flow, process or transform data, store data, and output information in the context of a particular organization or enterprise. Systems analysts seek to identify and solve the right problems by performing a thorough analysis of the client's system. Furthermore, systems analysis and design is used to analyze, design, and implement improvements to the computerized information systems that support users and the functions of businesses.

Security is critical to the functioning of organizational information systems, and security is a challenge for everyone involved in systems development. Information systems present multiple vulnerabilities, and the idea of perfect security is a fantasy. Rather, organizations make trade-offs, weighing the value of the data they are storing with the risk that they will experience a security breach. As a systems developer, it is important that you design new systems with an awareness of what you can do to design security into a system from the very beginning. Developing privacy controls and security by design, from the outset of systems design, is much more desirable and effective than adding it to older, legacy systems. Of course, you should always examine systems you are updating or improving for ways to address vulnerabilities and improve training for security issues.

Developing 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 a 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.

Roles of a Systems Analyst

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

Systems Analyst as Consultant

A 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 bring with them a fresh perspective that 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 organization 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.

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 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 website 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 be 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 coding 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. 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 coder." Then she ponders aloud, "I wonder how important unified modeling language (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?

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, an analyst draws on professional expertise concerning computer hardware and software and their uses in the business. This work is often not a full-blown systems project and may entail only a small modification or a 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 managing it. 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).

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.

Qualities of a Systems Analyst

From the foregoing descriptions of the roles the systems analyst plays, it is easy to see that a successful systems analyst must possess a wide range of qualities. Above all, an 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, an analyst must be able to systematically tackle the situation at hand through a skillful application of tools, techniques, and experience.

An 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 when interacting with technology, and they need enough computer experience to code, to understand the capabilities of computers, to glean information requirements from users, and to communicate what is needed to coders. Analysts also need to possess strong personal and professional ethics to help them shape their client relationships.

A 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, it is an ever changing and always challenging one.

The Systems Development Life Cycle

Throughout this chapter, we refer to the systematic approach analysts take to the analysis and design of information systems. Much of this is embodied in the three approaches we describe in this book. The first approach is called the systems development life cycle (SDLC). The SDLC is a phased approach to analysis and design based on the assumption that systems are best developed through the use of a specific cycle of analyst and user activities. It has also been called the waterfall method because the system analysis completes the first phase, then moves down to the next, and so on, like water flowing steadily downward from one rock to another.

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 1.1. Although each phase is presented discretely, it is never accomplished as a separate step. Instead, several activities may occur simultaneously, and activities may be repeated.

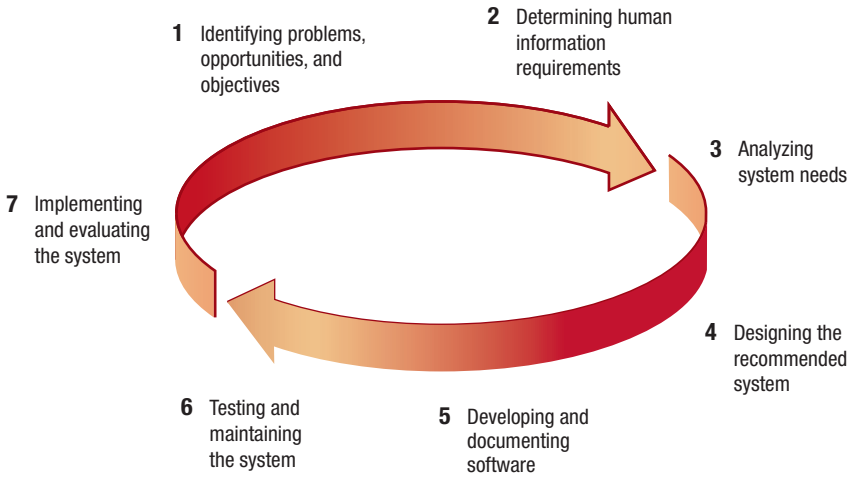


FIGURE 1.1

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

Identifying Problems, Opportunities, and Objectives

In this first phase of the SDLC, an 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 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 organization members, the analyst pinpoints problems. Others often bring up these problems, and they are the reason the analyst was initially called. 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 that contains a problem definition and summarizes 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 if it 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

In the next phase, the analyst determines 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 uses interactive methods such as interviewing, sampling and investigating hard data, and using questionnaires; 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 to be done? What new tasks are enabled by the new system that users were unable to do without it? How can the new system 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 outgrowth of the 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 OOAs 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 (DFDs) chart the input, processes, and output of the business's functions, and activity diagrams or sequence diagrams show the sequence of events, illustrating systems in a structured, graphic 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. Three major tools are used when analyzing structured decisions: structured English, decision tables, and decision trees.

MAC APPEAL

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 of the Mac options available to a systems designer. Today, 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 Fusion by VMware, 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.

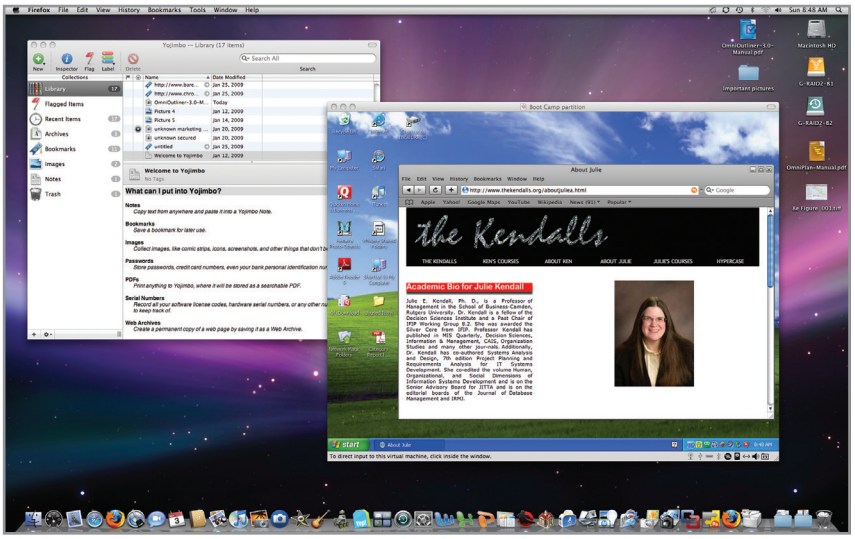


FIGURE 1.MAC

Running Windows on a Mac using virtualization called VM Fusion. (Screen shot reprinted with permission from Apple Inc. and Bare Bones Software)

At this point in the SDLC, the systems analyst prepares a systems proposal that summarizes what has been discovered 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 extremely important. The user interface is designed with the help of users to make sure 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 graphic 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.

Developing and Documenting Software

In the fifth phase of the SDLC, the analyst works with coders 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 websites featuring frequently asked questions (FAQs) or Read Me files shipped with new software. Because users are involved from the beginning, 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.

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

Testing and Maintaining the System

Before an information system can be used, it must be tested. It is much less costly to catch problems before rather than after the system is signed over to users. Coders alone complete some of the testing, and some testing is done by systems analysts in conjunction with coders. A series of tests to pinpoint problems is run, first with sample data and eventually with actual data from the current system. Test plans often 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 coder'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.

Evaluation is included as part of this final phase of the SDLC, but in fact 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 applications must be modified and kept up to date. Estimates of the time spent by departments on maintenance have ranged from 48 percent 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 a system is tested, bugs or errors creep into computer applications. Bugs in commercial PC software are often documented as "known anomalies," and they 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:

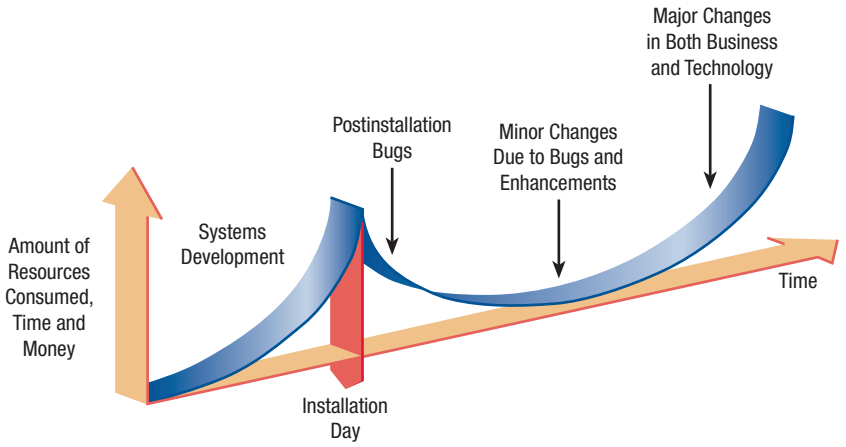
1. Users often request additional features after they become familiar with the computer system and its capabilities.
2. The business changes over time.
3. Hardware and software are changing at an accelerated pace.

Figure 1.2 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 the cost 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 software 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

FIGURE 1.2

Resource consumption over the system life.



system with a few minor enhancements. As time goes on and the business and technology change, however, the maintenance effort increases dramatically.

Using CASE Tools

Analysts who adopt the SDLC approach often benefit from productivity tools, called computer-aided software engineering (CASE) tools, 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.

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 1.3). Analysis reports may be produced using the repository information to show where the design is incomplete or contains errors.

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 software products such as Microsoft Visio or OmniGraffle

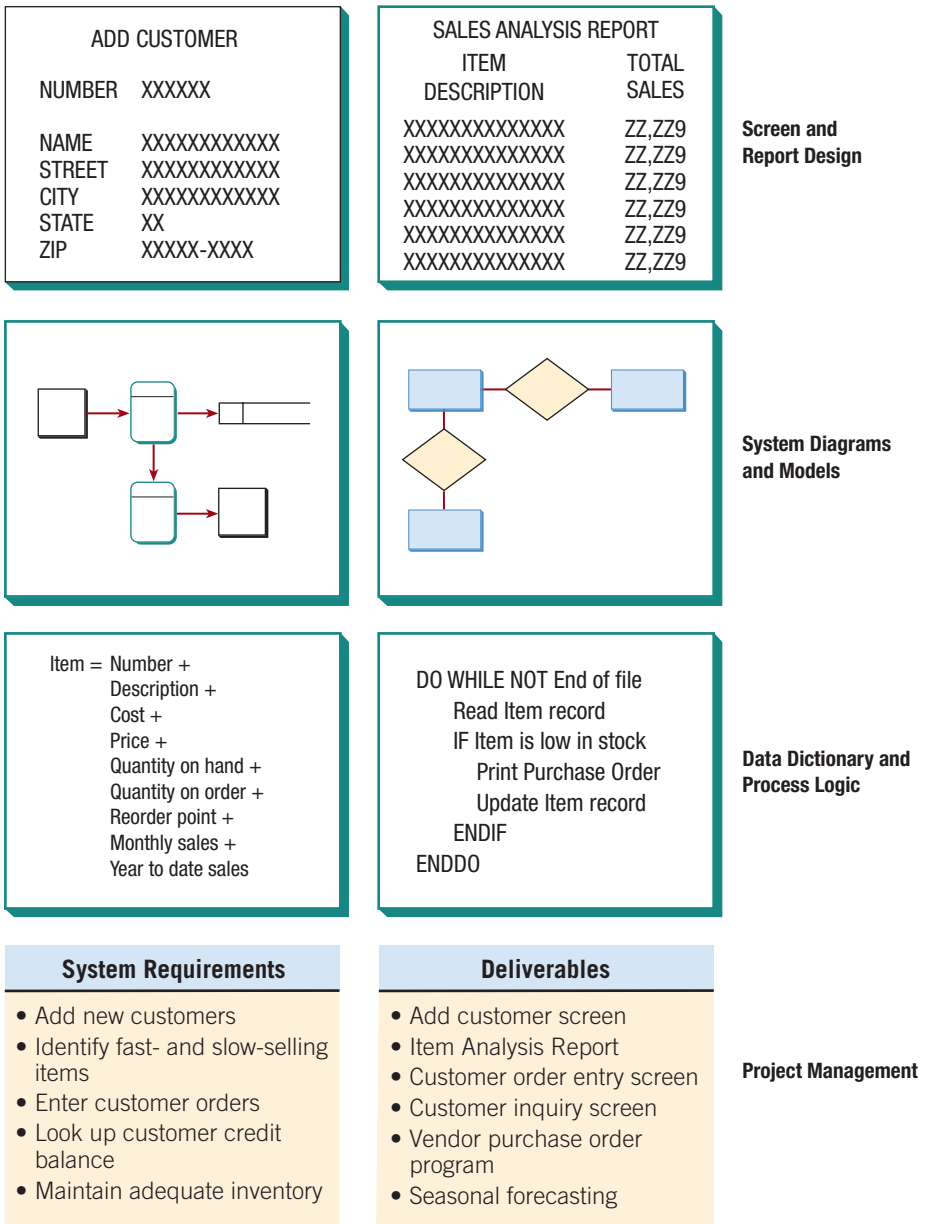


FIGURE 1.3

The repository concept.

allow users to draw and modify diagrams easily. However, VA is a full-fledged CASE tool with a repository and other features, whereas the other two are not.

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. CASE tools 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.

The Agile Approach

Although this text tends to focus on SDLC, the most widely used approach in practice, at times an analyst will recognize that his or her organization could benefit from an alternative approach. Perhaps a systems project using a structured approach has recently failed, or perhaps the organization 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 a 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 a 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.

We also explore an agile method called Scrum, which is named after a starting position in the sport of rugby. Scrum's success has much to do with its extremely quick releases. A typical sprint cycle will last between two and four weeks. At the end of that period, the team is expected to produce a potentially releasable product. That means that applications or websites are constantly changing. Each iteration boasts a new set of features produced during the sprint cycle. Scrum is also unique because team members choose what they want to work on as a team. Scrum is discussed further in Chapter 6. Let's return to discussing the agile approach in general.

Activities and behaviors 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*. Figure 1.4 illustrates the five distinct stages of the agile approach: exploration, planning, iterations to the first release, productionizing, and maintenance. Notice the three red arrows that loop back into the "Iterations" box and symbolize incremental changes created through repeated testing and feedback that eventually lead to a stable but evolving system. Also note that multiple looping arrows 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, illustrating a continuous feedback loop involving customers and the development team as they agree to alter the evolving system.

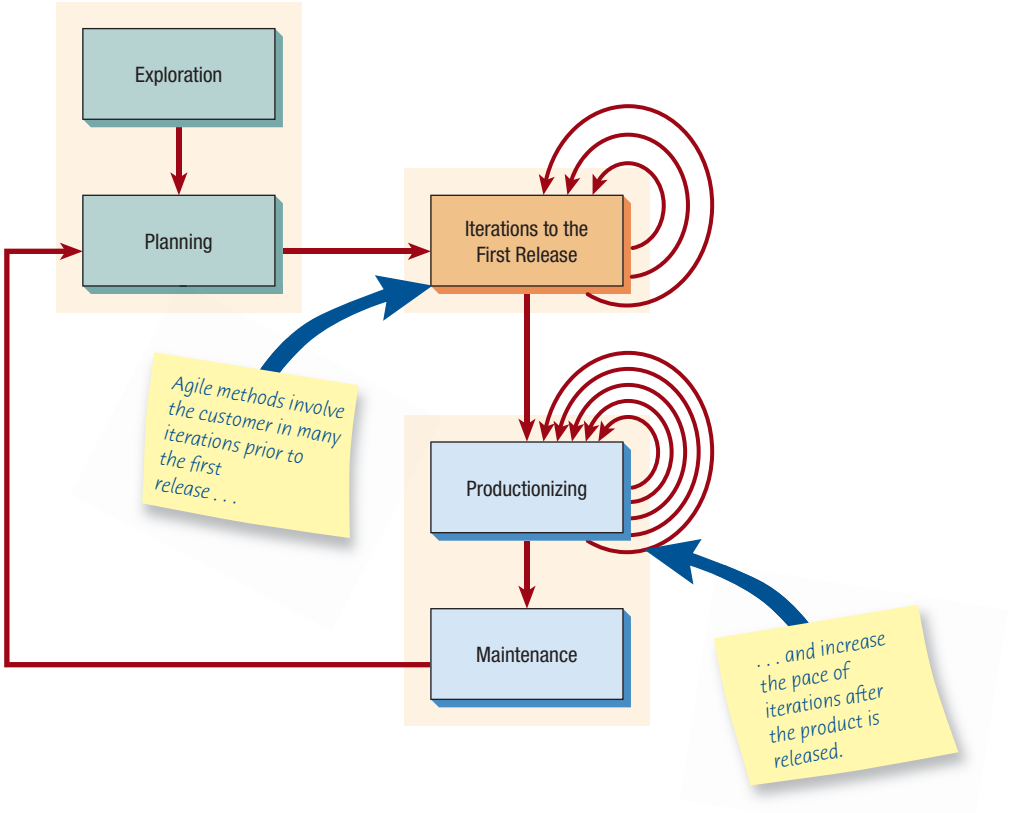


FIGURE 1.4

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

Exploration

During exploration, you 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 takes anywhere from a few weeks (if you already know 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 goal 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 take only 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 Kent Beck, the father of Extreme Programming. 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.

Using the metaphor of a game, 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. To arrive at the value, you have to deduct costs of development, and the time, expense, and uncertainty taken on so that the development project can 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.

The two main players in the planning game are 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 iterations (cycles of testing, feedback, and change) are 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 function 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 the productionizing 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 it 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 keys to the agile approach, which we heartily embrace, is that it is supposed to be fun to develop systems!

Maintenance

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

Object-oriented techniques often 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 O-O systems, called unified modeling language (UML), to break down a system into a use case model.

Object-oriented programming differs from traditional procedural programming in that it examines 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.

Object-Oriented Similarities to SDLC

The phases in UML are similar to those in the SDLC. Because these two methods share rigid and exacting modeling, they happen at a slower, more deliberate pace than the phases of agile modeling. An analyst goes through problem and identification phases, an analysis phase, and a design phase, as shown in Figure 1.5.

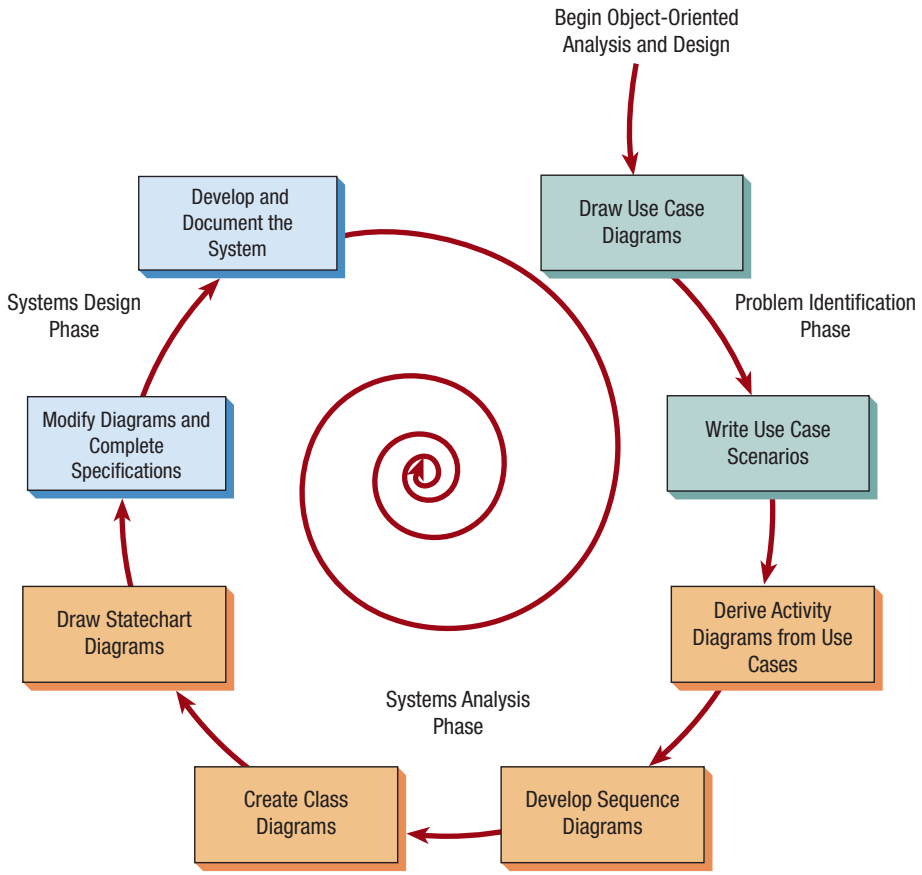


FIGURE 1.5

The steps in the UML development process.

Although the specifics are discussed in Chapters 2 and 10, the following steps provide a brief description of the UML process.

DEFINE THE USE CASE MODEL In this phase, the analyst identifies the actors and the major events initiated by the actors. Often the analyst starts 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.

DURING THE SYSTEMS ANALYSIS PHASE, BEGIN DRAWING UML DIAGRAMS In the second phase (Chapter 10), the analyst draws activity diagrams, which illustrate all the major activities in the use case. In addition, the analyst creates one or more sequence diagrams for each use case that 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.

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.

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.

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). An analyst will need to write class specifications for each class, including the attributes, methods, and their descriptions. The analyst also will develop method

specifications that detail the input and output requirements for each method, along with a detailed description of the internal processing of the method.

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 to the development team through documentation and UML diagrams is, 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 with a high-priority item or perhaps the item 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 this is repeated until the project is complete. 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 here are not as large 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 time and resources and develop a project proposal (Chapter 3). Next, they need to interview organization members and gather detailed data using questionnaires (Chapter 4) and sample data from existing reports and by observing 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 OOAs both require extensive planning and diagramming. The agile approach and the OOA both allow subsystems to be built one at a time until the entire system is complete. The agile and SDLC approaches are both concerned with 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 1.6 provides a set of guidelines to help you choose which method to use when developing your next system.

FIGURE 1.6

How to decide which development method to use.

Choose	When
The Systems Development Life Cycle (SDLC) Approach	• systems have been developed and documented using SDLC • it is important to document each step of the way • upper-level management feels more comfortable or safe using SDLC • there are adequate resources and time to complete the full SDLC • communication of how new systems work is important
Agile Methodologies	• there is a project champion of agile methods in the organization • applications need to be developed quickly in response to a dynamic environment • a rescue takes place (the system failed and there is no time to figure out what went wrong) • the customer is satisfied with incremental improvements • executives and analysts agree with the principles of agile methodologies
Object-Oriented Methodologies	• the problems modeled lend themselves to classes • an organization supports the UML learning • systems can be added gradually, one subsystem at a time • reuse of previously written software is a possibility • it is acceptable to tackle the difficult problems first

Developing 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, many users and coders can study, share, and modify the code, or computer instructions. Rules of this community include the idea that any program modifications must be shared with all the people on the project and that all licenses must be adhered to.

Development of OSS also has been characterized as a philosophy rather than simply as the process of creating new software. Those involved in OSS communities often 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 open source groups need to understand where they converge and where the potential for conflict exists.

Why Organizations Participate in Open Source Communities?

Organizations participate in open source communities for a variety of reasons. One is the rapidity with which new software can be developed and tested. It is faster to have a committed group of expert developers develop, test, and debug code than it is to have one isolated team working on software development. This cross-fertilization can be a boon to creativity.

Another reason to participate is the benefit of having many good minds working on innovative applications. Yet another reason for participating in an open source community might be the potential for keeping down development costs.

Organizations might seek to participate in an open source community due to a desire to bolster their own self-image and to contribute something worthwhile to the larger software development community. They may want to contribute generously or altruistically to a higher good beyond developing profitable proprietary software, and doing so may make them appear as "good guys" to the external public.

Organizations may ask or even require that their software developers become involved in one or more open source projects or communities, but individual developers must interact with the community in a meaningful and knowledgeable way first to prove themselves worthy members of the group based on their merits and then to strike up and maintain relationships that are mutually beneficial.

Organizations and the design teams within them interact with Open Communities. Companies are taking advantage of an entire range of options that help them strike a harmonious equilibrium so that their contributions to the open community and their differentiation from the open community become clear strategically. Reasons for contribution to and differentiation from include cost, managing resources, and the time it takes to bring a new product to the market.

The Role of the Analyst in Open Source Software

As an analyst you may find yourself, at the request of your chief employer, participating in an open source community. One widely known open source community is that surrounding the Linux kernel. This is a large, mostly virtual community of developers who all have different levels or types of participation and who all have different reasons for being involved. Other well-known open source projects include Mozilla Firefox, Android, Apache projects, and many more. Even NASA, the U.S. National Aeronautics and Space Administration, has a lively open source community (see http://ti.arc.nasa.gov/opensource/).

One reason your company may ask you to participate in an open source community is curiosity about what the software benefits to the organization might be. This may be a result of a sort of bandwagon effect, for when it becomes known that competitors are already

HYPERCASE EXPERIENCE 1

"Welcome 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 Mr. 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 website www.pearsonglobaleditions.com. 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 website contains useful information about the project as well as files that can be downloaded to your computer. There is a set of Visible Analyst (VA) data files, and there is 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 website 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.

participating, your organization may want to get involved. With competitors actively participating in an open community, an organization may calculate that it is something that should at least be investigated seriously, not dismissed summarily. Another reason your company might ask you to participate as a developer in an open community is to achieve what researchers have labeled "responsive design." *Responsive design* means that while you are participating in the open source community, you are at the same time employed by an organization that wants to leverage your participation in the open source community to incorporate OSS designs into proprietary products, processes, knowledge, and IT artifacts that it is developing and that it hopes to eventually sell as a product that is differentiated from what the open source community has produced. Through a process of *responsive design* the IT artifact is imbued with both community and organization structures, knowledge, and practices.

Summary

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 problems. 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. It is important that you design new systems with an awareness of what you can do to design security into a system from the very beginning.

Analysts possess a wide range of skills. First and foremost, an 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 enable 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. Scrum is an agile method that emphasizes short releases and allows teams to choose what they want to work on. 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 typical in object-oriented analysis and design.

Analysts will have increasing opportunities to participate in open source development communities, often through their primary organization. Organizations participate in development of open source for many reasons. One of the well-known open source communities maintains the Linux kernel and is supported by the Linux Foundation.

Keywords and Phrases

agent of change
agile approach
agile methods
Ajax
bespoke software
computer-assisted software engineering (CASE)
CASE tools
exploration phase
human–computer interaction (HCI)
iterations to the first release phase
Linux kernel
maintenance phase
object-oriented systems analysis and design
open source communities
open source software (OSS)
planning game
planning phase
productionizing phase
prototyping
Scrum
security
systems analysis and design
systems analyst
systems consultant
systems development life cycle (SDLC)
unified modeling language (UML)

Review Questions

1. Why does a lack of proper training often result in the failure of a new system?
2. Why has the importance of the user in systems development changed?
3. List three roles that a systems analyst is called upon to play. Provide a definition for each one.
4. List the three primary roles of the systems analyst.
5. List and briefly define the seven phases of the systems development life cycle (SDLC).
6. Why is human–computer interaction (HCI) important for systems analysis?
7. What are the four values of the *agile approach*?
8. What is the meaning of the phrase *the planning game*?
9. Discuss the importance of the maintenance phase in designing new systems.
10. What is Scrum?
11. Describe a situation in which an analyst would use object-oriented systems analysis and design rather than the systems development life cycle.
12. What are class diagrams in the object-oriented approach (OOA)?
13. What are the conditions for choosing a systems development method?
14. What is the role of a systems analyst in the iterations and the productionizing phase of the agile approach?
15. List two reasons an organization may want its analysts to participate in an open source community.

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2

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, use cases, and use case scenarios.
3. Recognize that different levels of management require different systems.
4. Comprehend that organizational culture influences the design of information systems.

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: 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. To understand organizations properly, systems analysts start depicting them graphically as soon as they begin working with a company. These different ways of seeing the organization include drawing context-level data flow diagrams and entity-relationship (E-R) models, developing use cases, and writing use case scenarios. Collaborative design can help systems analysts include users from many parts of the organization. Organizational cultures and subcultures influence the way people in subsystems interrelate. Many technologies are available to support the creation of productive cultures and subcultures, including work-sanctioned social media sites such as Slack. 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, and so on) that serve specialized functions. Typical functions include accounting, marketing, production, IT support, operations, legal, 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 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 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 organization's 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.

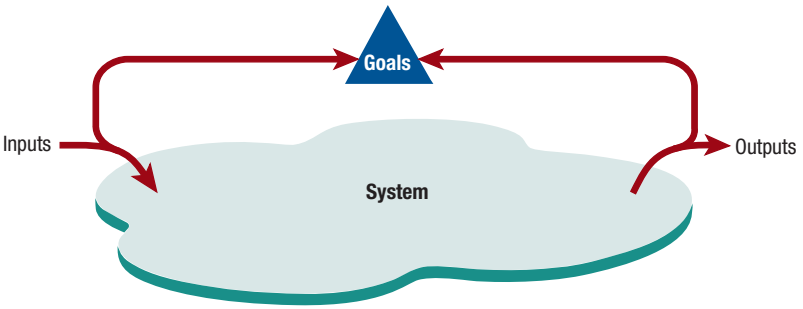
Another aspect of organizations as systems is that all systems are contained by boundaries separating them from their environments. Organizational boundaries exist on a continuum ranging from extremely permeable to almost impermeable. To continue to adapt and survive, organizations must be able first 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 gunmetal-gray sets. The company finds that one year after the summer Olympics, very few red-white-and-blue sets are purchased. Production managers use this 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, 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

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

"Our 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 website." 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 website and asking customers to order off the website. 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 website
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 website
7. Arranging for the delivery of goods and services
8. Personalizing the look and feel of the website 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. 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.

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 undyed white shades, 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 environment status can be planned for, they often cannot be directly controlled by the organization.

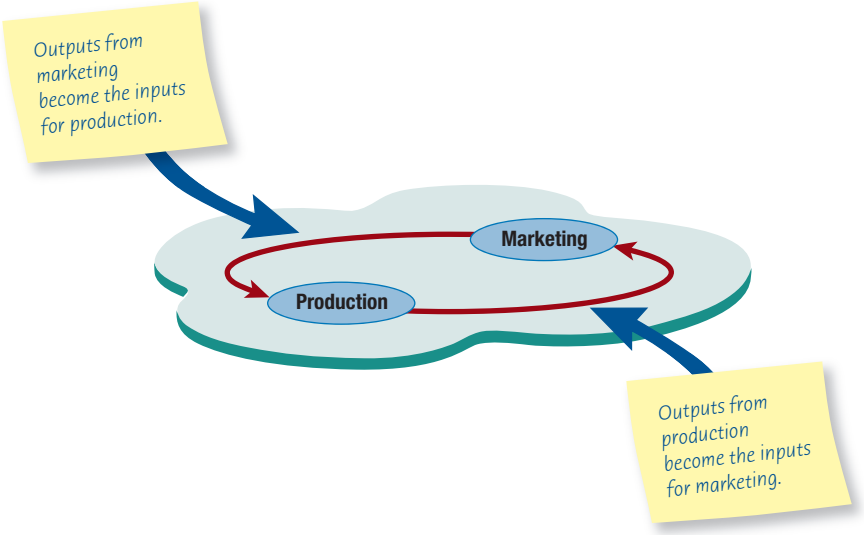
Related and similar to the concept of external boundary permeability is the concept of internal openness or closedness of organizations. Openness and closedness also exist on a continuum because there is no such thing as an absolutely open or a completely closed organization.

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. Virtual teams often 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.

FIGURE 2.2

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



The potential benefits of virtual organizations include 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 the user.

Taking a Systems Perspective

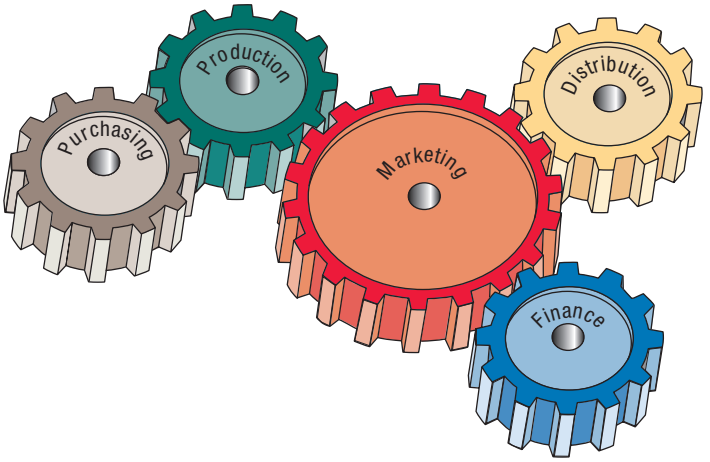
Taking a systems perspective allows systems analysts to start broadly clarifying and understanding the various businesses with which they will come into contact. It is important that members of subsystems realize that their work is interrelated. Notice in Figure 2.2 that the outputs from the production 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.

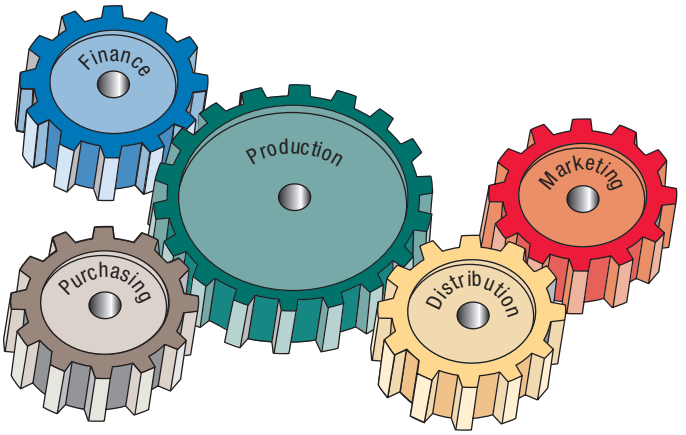
The relative importance of functional areas as revealed in the personal perspectives of managers takes on added significance when managers rise to the top through the ranks, becoming strategic managers. They can create problems if they overemphasize their prior functional information requirements in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

Enterprise Systems: Viewing the Organization as a System

Enterprise system, or *enterprise resource planning (ERP) system*, describes an integrated organization (enterprise) information system. Specifically, ERP is software that helps the flow of information between the functional areas in the organization. Rather than being developed in-house, the system is usually purchased from one of the software development companies well known for its



How a Marketing Manager May View the Organization



How a Production Manager May See the Organization

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.

ERP packages, such as SAP or Oracle. The product is then customized to fit the requirements of a particular company. Typically, the vendor requires commitment from the organization in terms of specialized user or analyst training. Over the last few years, ERP systems are moving to cloud computing.

ERP has taken root in many large companies and is spreading to small and medium-sized enterprises as well. Most of the lessons systems analysts have learned are applicable to implementing enterprise systems. However, as an analyst you need to recognize and act on the similarities and differences between implementing networked information systems and implementing an ERP.

One of the major differences is that rather than redesigning business processes based on a logical analysis of those processes and how they support the business strategy, and then choosing the IT to support those processes, a large installation of ERP can reverse this by requiring the implementation of new business processes that are embedded in the technology provided. Oftentimes you will be part of an internal systems team whose main job is to look after the interface between legacy systems and the ERP being installed.

Enterprise implementations are complex and intense endeavors that result in tremendous organization change. They can affect every aspect of the organization, including the design of employees' work, the skills required to become competent in one's job, and even the strategic positioning of the company. Implementing an ERP has become increasingly complex. Many issues present important hurdles to clear if the ERP installation is to be declared a success; these include user acceptance, integration with legacy systems, and the supply chain; upgrading functionality (and complexity) of ERP modules; reorganizing work life of users and decision makers;

expanded reach across several organizations (as part of the IT supply chain); and strategic repositioning of the company adopting an ERP.

New research has shown that ERP implementations can result in making employees more effective and efficient two or three years after the installation, but it is in the planning and early stages of ERP that a deep analysis examines how the new enterprise system will affect the daily lives and jobs of employees involved in the new system (such as discussed in Chapter 14 on HCI and usability issues). ERP systems are best considered as real game changers when it comes to the job design of employees (including systems analysts) and as a moving force that can alter the strategic approaches to change that the organization takes.

Depicting Systems Graphically

A system or subsystem as it exists within a 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

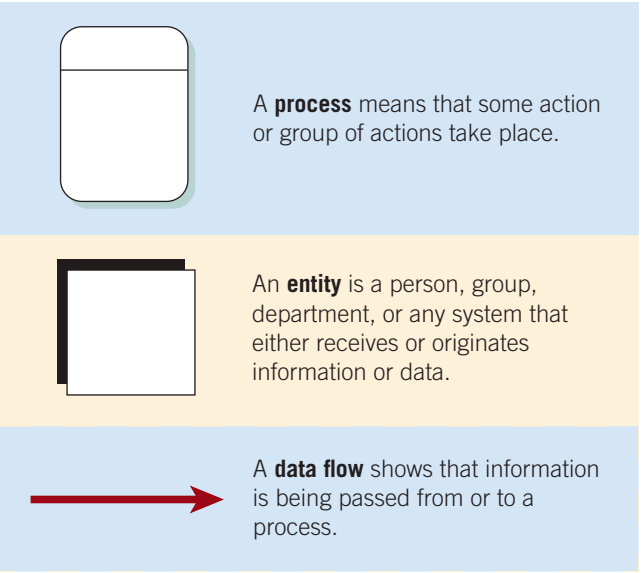
The first model is the context-level data flow diagram. Data flow diagrams focus on the data flowing into and out of the system and the processing of the data. These basic components of every computer program can be described in detail and used to analyze a system for accuracy and completeness.

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 movement data.

An example of a context-level data flow diagram is found in Figure 2.5. This example represents the most basic elements of an airline reservation system and shows the system before (when a travel agent acted as intermediary) and after direct online booking was made possible. In the before diagram, 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, which sends ticketing information back to the process. We can also see that the passenger reservation is sent to the airline. The second context-level diagram show what happens when the

FIGURE 2.4

The basic symbols of a data flow diagram.



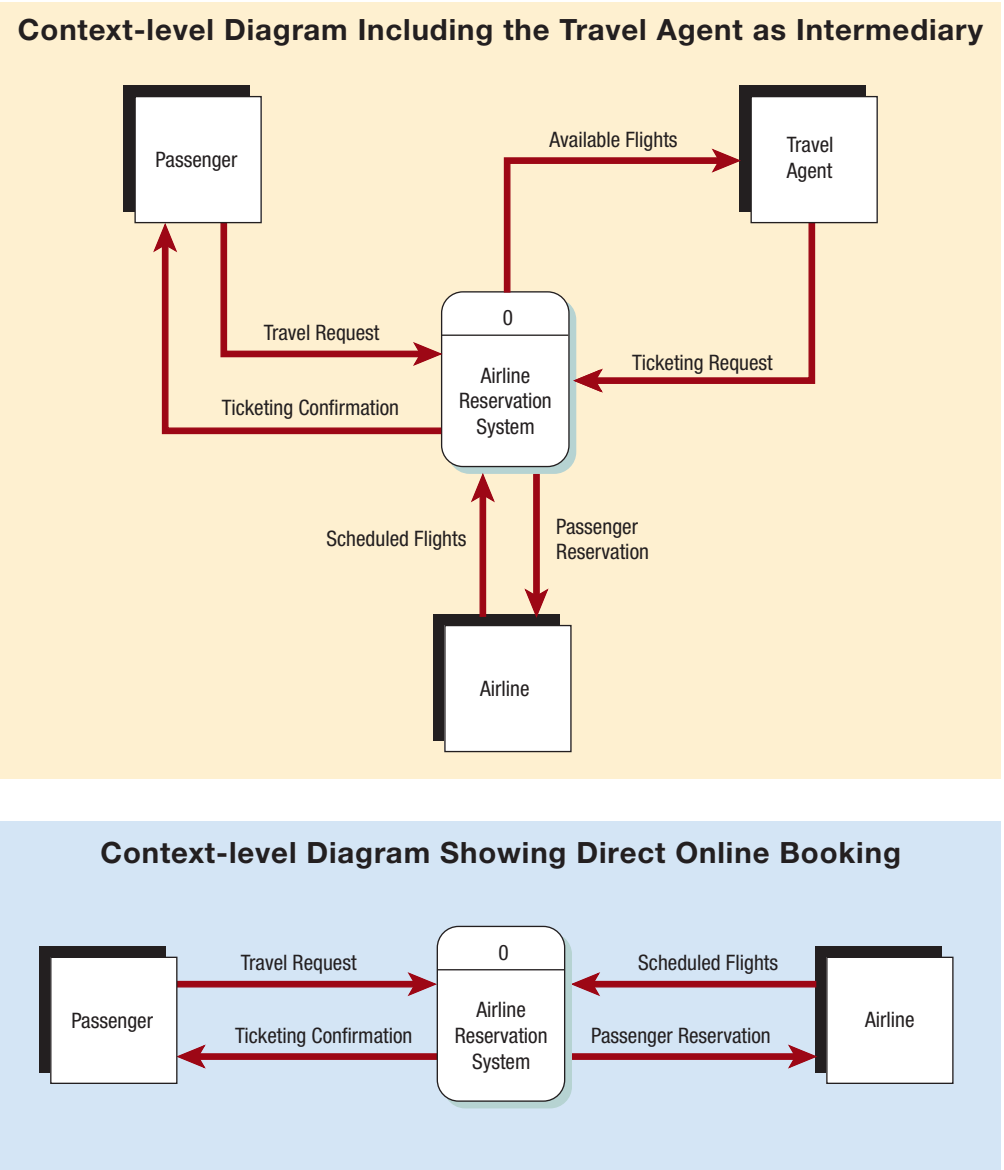


FIGURE 2.5

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

passenger books directly with an online system. 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 will 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 data flow diagram 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, and hiring additional flight crew members) are not part of this system.

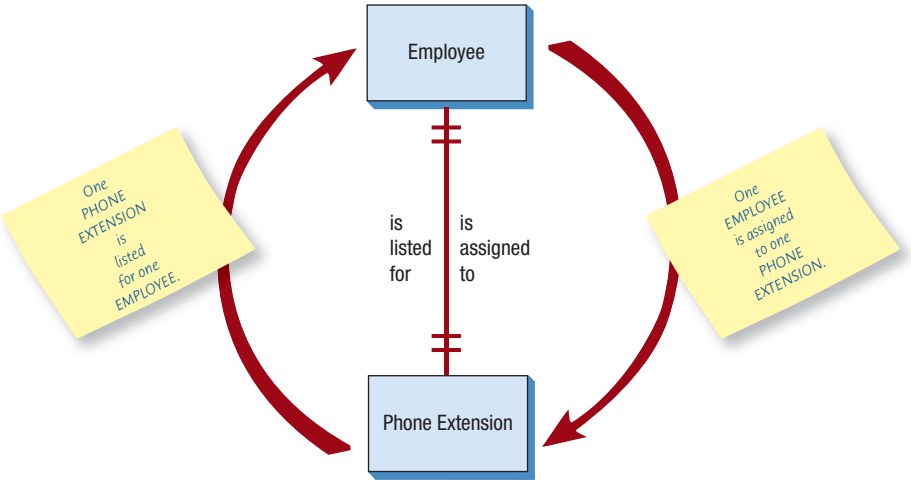
The context-level data flow diagram is one way to show the scope of the system, or what is to be included in the system. The external entities are outside the scope and something over which the system has no control.

Systems and the Entity-Relationship Model

Another way a systems analyst can show the scope of a system and define proper system boundaries is to use an entity-relationship (E-R) 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

FIGURE 2.6

An E-R diagram showing a one-to-one relationship.



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 E-R diagrams (with names such as 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.

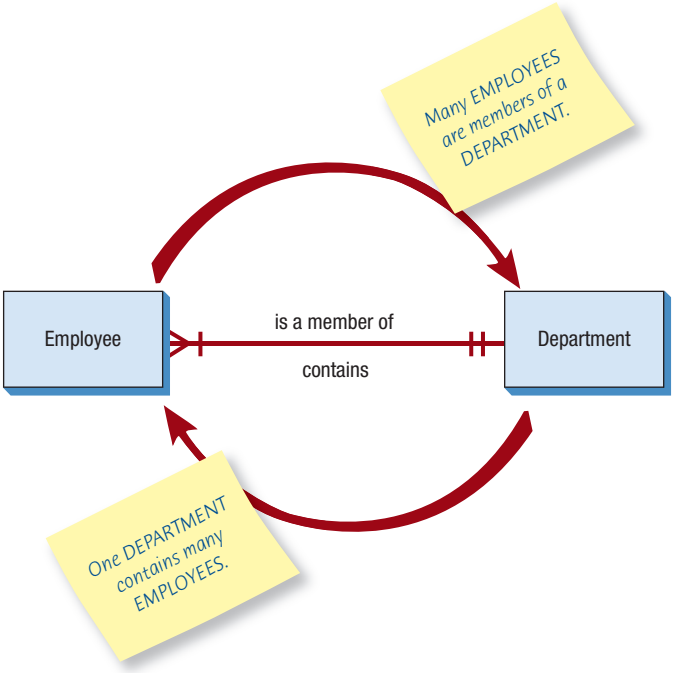
Figure 2.6 illustrates a simple E-R diagram. Two entities are linked together by a line. In this example, the end of the line is marked with two short parallel marks (| |), signifying that this relationship is one-to-one. Thus, exactly one employee is assigned to one phone extension. No one shares the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

The red arrows are not part of the E-R diagram; they are present to demonstrate how to read the 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 the left side, as you read from bottom to top, the arrow says, "One PHONE EXTENSION is listed for one EMPLOYEE."

Figure 2.7 shows another relationship. The crow's foot notation (>—+) 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."

FIGURE 2.7

An E-R diagram showing a many-to-one relationship.



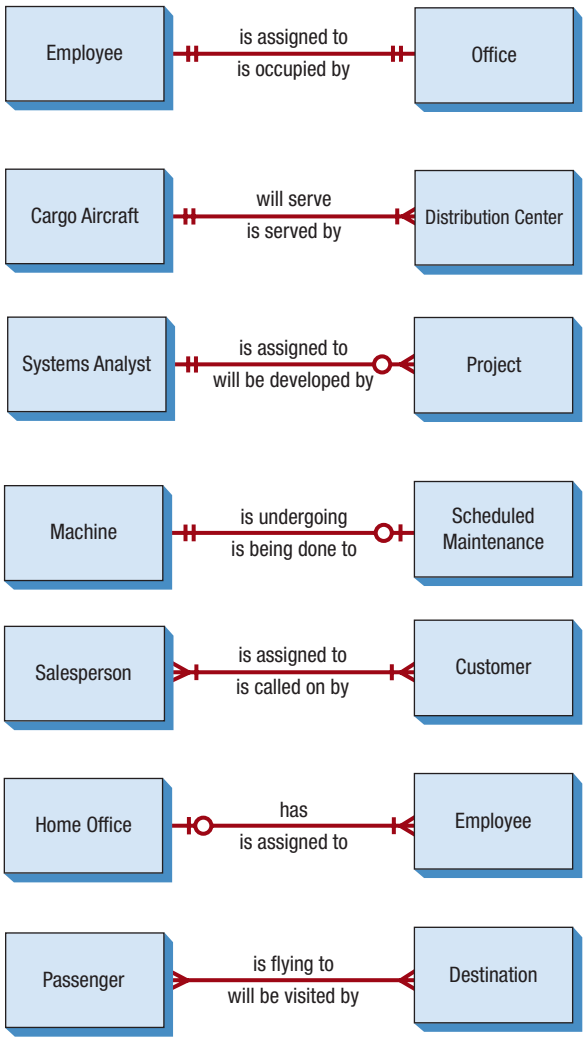


FIGURE 2.8

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

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 does 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.

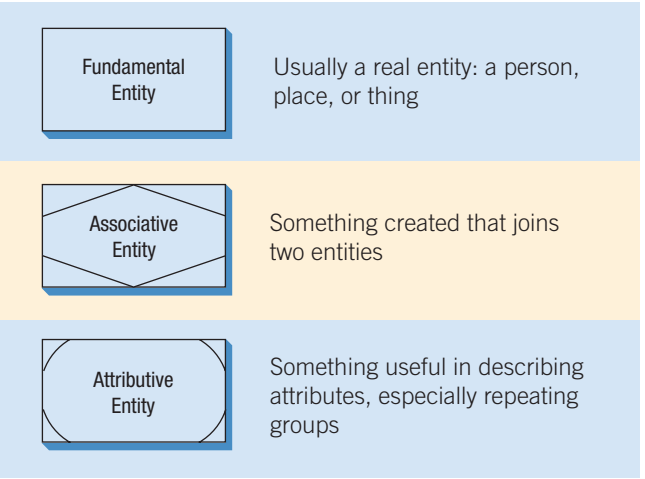
Figure 2.8 elaborates on this scheme. Here we have listed a number of typical entity relationships. The first is a one-to-one relationship: "An EMPLOYEE is assigned to an OFFICE." The second is a one-to-many relationship: "One CARGO AIRCRAFT will serve one or more DISTRIBUTION CENTERs." The third one 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 project, 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." Some people prefer this symbol [>—+]to indicate a mandatory "many"

FIGURE 2.9

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



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.

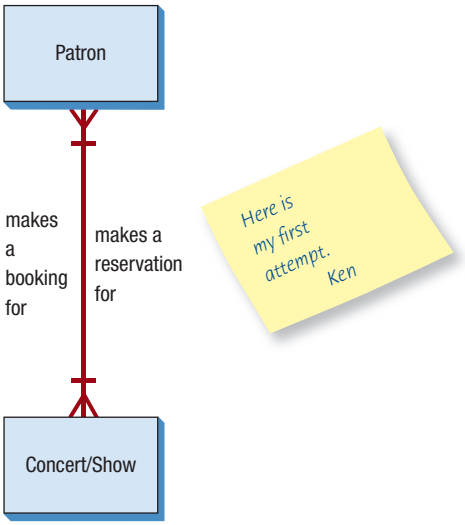
Up to now we have modeled all our relationships using one simple rectangle and a line. This method works well when we are examining the relationships of real things such as real people, places, and things. Sometimes, though, we create new items in the process of developing an information system. Some examples are invoices, receipts, files, and databases. When we want to describe how a person relates to a receipt, for example, it becomes convenient to indicate the receipt in a different way. There are three different types of entities; the fundamental entity, the associative entity, and the attributive entity are depicted in Figure 2.9.

An associative entity can exist only 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 an attributive entity. When an analyst wants to show data that are completely dependent on the existence of a fundamental entity, an attributive entity should be used. For example, if a library has multiple copies of the same book, an attributive entity can 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 a show. The entities seem obvious at first: "a PATRON and a CONCERT/SHOW," as shown in Figure 2.10. What sort of relationship exists?

FIGURE 2.10

The first attempt at drawing an E-R diagram.



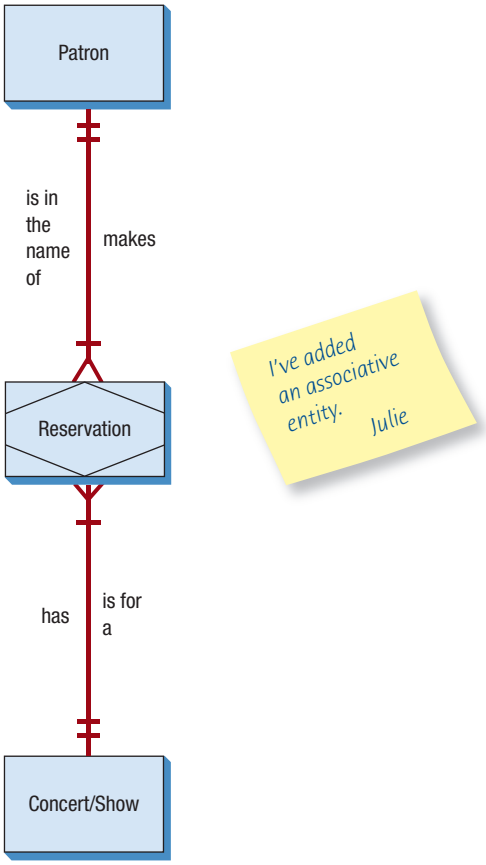


FIGURE 2.11

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

At first glance, we see that 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.

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.

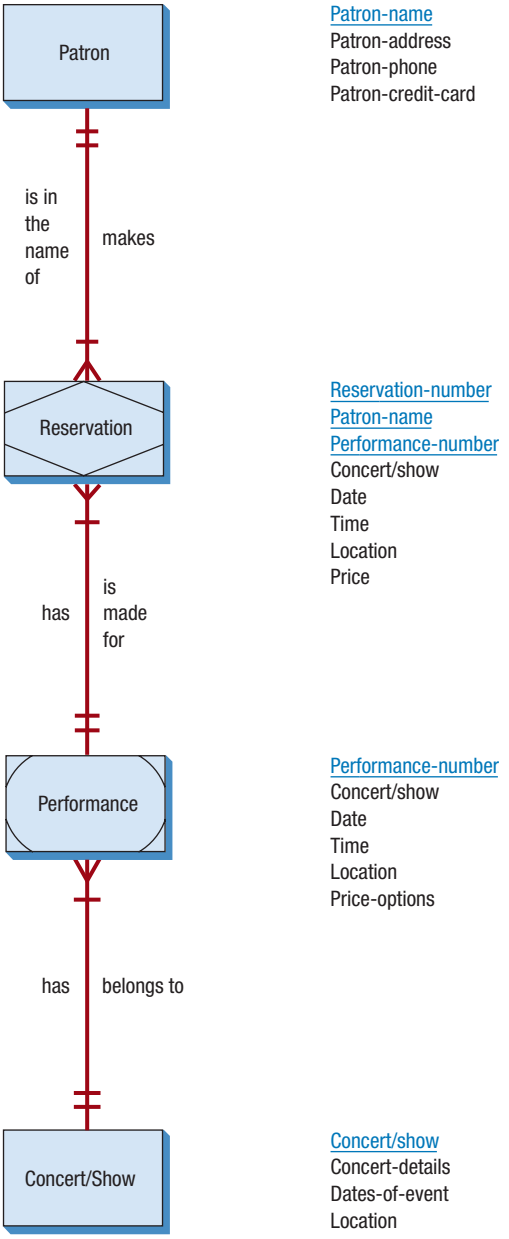
To the right of this E-R diagram is a set of data attributes that make up each of the entities. Some entities may have attributes in common. The attributes that are underlined can be searched for. The attributes are referred to as keys and are discussed in Chapter 13.

Systems designers often use E-R diagrams to help model a file or a database. It is even more important, however, that a systems analyst understand both the entities and relationships in the organizational system very early. 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.
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.

FIGURE 2.12

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



It is critical that a systems analyst begin to draw E-R diagrams upon entering an organization rather than waiting until the database needs to be designed. These 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 unified modeling language (UML), use cases are now being used regardless of the approach to systems development. A use case diagram can be used as part of the systems development life cycle (SDLC) approach 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 and conceptual models are further discussed in Chapter 7.) A use case model reflects the view of a system from the perspective of a user outside the system (that is, the system requirements).

MAC APPEAL

Microsoft Visio makes it easy for a systems analyst to draw E-R diagrams as well as most of the other 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, such as 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.

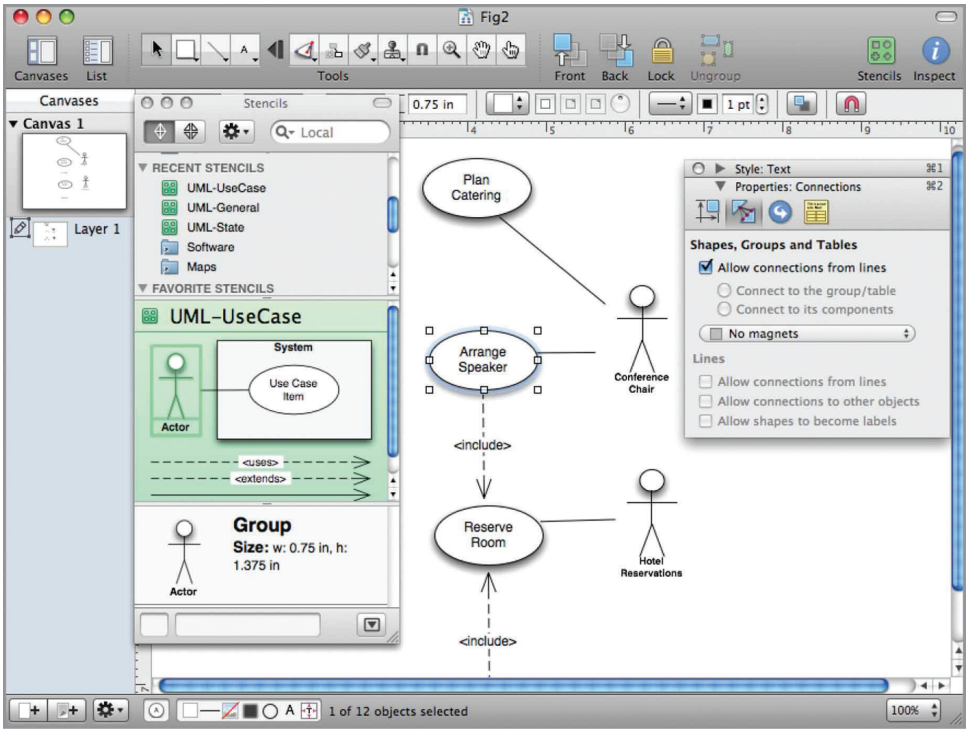


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FIGURE 2.MAC

OmniGraffle from The Omni Group is an easy-to-use and powerful drawing package. (Used by permission of the Omni Group.)

An analyst develops use cases in a cooperative effort with the business experts who help define the requirements of the system. A 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 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 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 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 a 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 also may 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 also can 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 analysts, coders, people who run the help desk, 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. A use case documents 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 also may 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,

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."

FIGURE 2.13

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

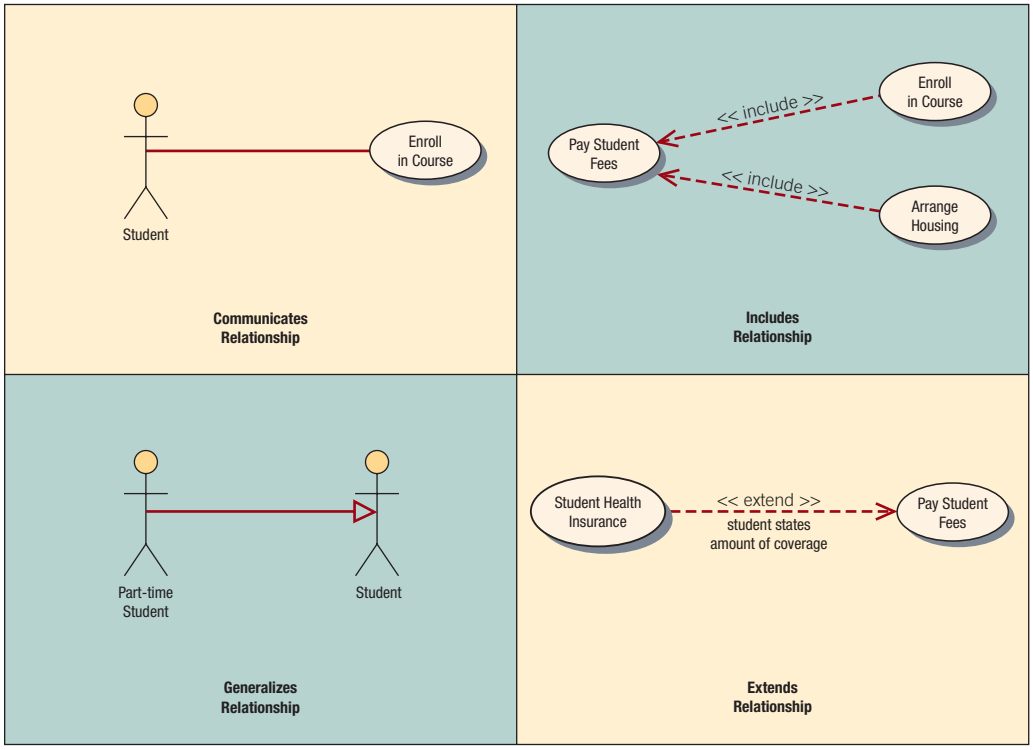

FIGURE 2.14

Examples of use cases and behavioral relationships for student enrollment.

extends, and generalizes. Notice that all of these terms are action verbs. Figure 2.13 shows the arrows 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 a 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 the 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. **Pay Student Fees** 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 an exception from the basic use case. 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, as well as start and end times. 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. Because a use case diagram is created early in the system's 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 whether 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 because 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 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 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 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 be only four to five use cases at this level for the entire organization. Examples might be to advertise goods, sell goods to customers, manage inventory, manage the supply chain, and optimize shipping.

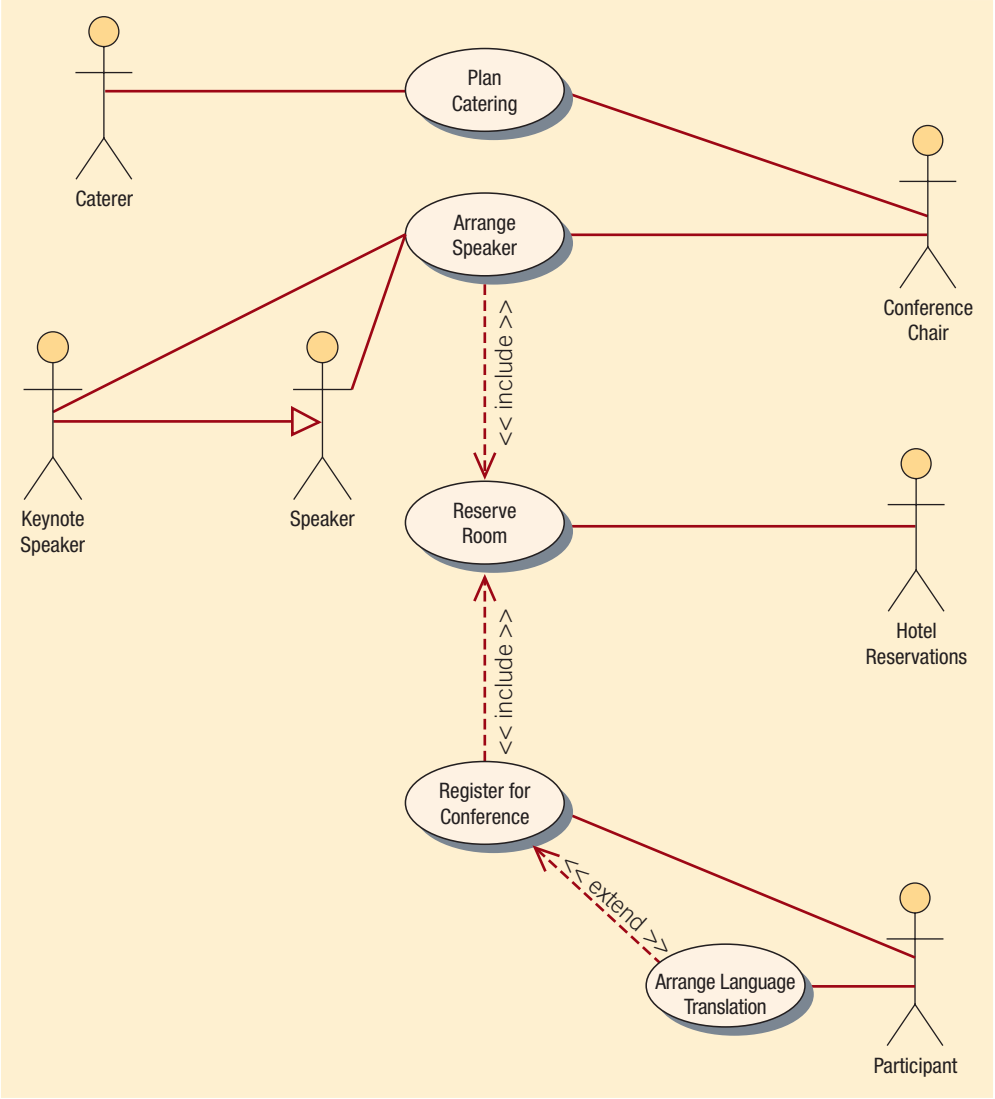

FIGURE 2.15

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

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, to make an airline, hotel, car, or cruise reservation.
3. Blue is at sea level and is customarily used to depict user goals. This level 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 to validate secure logon, add a new field using dynamic HTML, or use 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 that contains case identifiers and initiators
2. Steps performed
3. A footer area that contains 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.

Use case name:	Register for Conference	**UniqueID:**	**Conf RG 003**
Area:	Conference Planning		
Actor(s):	Participant		
Stakeholder:	Conference Sponsor, Conference Speakers		
Level:	Blue		
Description:	Allow conference participant to register online for the conference using a secure website.		
Triggering Event:	Participant uses Conference Registration website, enters userID and password, and clicks the logon button.		
Trigger type:	External Temporal		
Steps Performed (Main Path)		**Information for Steps**	
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 **Submit** 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	
Preconditions:	Participant has already registered and has created a user account.		
Postconditions:	Participant has successfully registered for the conference.		
Assumptions:	Participant has a browser and a valid userID and password.		
Success Guarantee:	Participant has registered for the conference and is enrolled in all selected sessions.		
Minimum Guarantee:	Participant was able to logon.		
Requirements Met:	Allow conference participants to be able to register for the conference using a secure website.		
Outstanding Issues:	How should a rejected credit card be handled?		
Priority:	High		
Risk:	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 is not listed in the stakeholder area. The first area should therefore 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 they 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

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.

are preceded by an "if." These are still on the main path but occur only 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 appear here as well. 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, which include 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. Netflix requires cookies. 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, which is the minimum promised to the users. They may not be happy with this result, and it may be that nothing happens.
- Success guarantee, which 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 that must be answered before implementation of the use case.
- 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 the use case scenario in Figure 2.16, 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.

Reasons for Writing Use Cases
• 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

Reasons for writing use cases.

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 valuable. The use case diagrams identify all the actors in the problem domain, and a systems analyst can concentrate on what people want and need to use the system, extend their capabilities, and enjoy their interaction with technology. The main reasons for writing use cases are shown in Figure 2.18.

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 with business executives.

The use case scenario is worthwhile. A lot of the information the users impart to the analyst already takes the form of stories, and 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 trace the steps that led to other use cases. Because 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 also may help to determine whether to build or buy the software.

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

FIGURE 2.19

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

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 supervisor, 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?

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.

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. 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 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 has different 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 frequent users of online, real-time information resources. The need of operations managers for past

CONSULTING OPPORTUNITY 2.3

Pyramid Power

"We really look up to you," says Paul Le. As a systems analyst, you have been invited to help Pyramid, Inc., a small, independent book-publishing firm that specializes in paperback books outside 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 Pyramid employees can still obtain the sales and inventory figures they need.

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 managing strategically 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. They also need accurate assessments of risk, including those posed to security of information system. Strategic managers also exhibit strong needs for periodically reported information as they seek to adapt to fast-moving changes.

Collaborative Design

Collaborative design has many meanings in many fields, such as architecture, engineering, and information systems. In systems analysis and design, collaborative design means that stakeholders who are external (outside clients) as well as those who are internal to the company follow processes to share in designing a system that meets their goals. Internally, collaborators can come from different levels of the organization's hierarchy, including strategic, managerial, and operations or from different departments of the same organizational level.

Researchers have found that many internal design collaborations rely on power relationships and information flows, which could be based in part on hierarchical relationships in the organization (Levina, 2005; Phelps, 2012). Information systems projects may go more smoothly if those in lower ranks of the organization, say graphics designers, are given the opportunity to

use their expertise to create initial designs that are then examined by those who are not directly in graphic design but are higher up in the IT department or organization. Researchers also found that giving power to those who possess technical or strategic expertise in preference to graphic designers when using structured methods to begin a project may cause problems in the collaboration (Levina, 2005; Phelps, 2012). For external collaborations, it is suggested that attention be paid to including relevant stakeholders in appropriate information flows as well as emphasizing the relationships that are formed between external and internal participants.

Organizational Culture

Organizational culture is an established area of research that has grown remarkably in the past decades. 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 think 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 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 a 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.

Technology's Impact on Culture

Technology is changing the culture of organizations and teams. Slack is an employer-sanctioned social media platform, or workplace-messaging app. Conversations between coworkers can be public, private, or something in between. Conversations can be put together as a group or as a person-to-person conversation. Channels can be devoted to seemingly trivial concernssuch as popular snacks or employee cafeteria food, but its main purpose is to foster collaboration and communication among officer workers. It is less formal that email and might be more popular with those in the millennial age group. Slack can shape a culture, and it can become an office culture complete with programmable pranks, featuring less formal interactions that email, and helping team members to avoid the difficulty of expressing themselves face-to-face in a meeting or even one to one.

Slack has both public and private channels. Public channels are open to all Slack team members, and messages posted to them are archived (stored and kept) and are searchable by the entire work team. Private channels are circumscribed so that they are available to a limited number of team members and are joined via invitation only. You must be a private channel member to be able to view and search the contents of the private channel. Slack also has direct messages (DM) or group messages (group DMs) that are used for rapid, private messaging between two or more members of a work team. Their searchability depends on whether you are a recipient of the DM, in which case you can view and search the contents. Slack and many other technology-based tools can be very helpful in team communication.

HYPERCASE EXPERIENCE 2

"You seem to have already made a good start at MRE. I'm glad you met Mr. Evans. As you know, you'll be reporting directly to him during your consulting project. As his administrative assistant for the past 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 website 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 because 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 that 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!"

FIGURE 2.HC1

Click on keywords in HyperCase to find out more detail.

HYPERCASE Questions

1. What major organization change recently took place at MRE? What department(s) was (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 affects the information systems it uses.
4. What type of organization structure does MRE have? What are the implications of this structure for MRE?
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 website to obtain your basic information.)

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 also can be organized virtually, with remote members who are not in the same physical workspace connected electronically. Enterprise resource planning systems are integrated organization (enterprise) information systems developed with customized, proprietary software that help the flow of information between the functional areas in the organization.

There are many ways to graphically depict the system. An 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 E-R diagrams, and 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.

E-R diagrams help a systems analyst understand the entities and relationships that comprise an 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.

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. Technology such as the work-based social platform Slack can be used to create or reinforce elements of the organization's culture or subculture.

Keywords and Phrases

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

Review Questions

1. Discuss the importance of conceptualizing organizations as complex systems and the role of systems principles.
2. What is meant by saying that organizational subsystems are interrelated and interdependent?
3. How can a process be identified in a system?
4. What are the two main purposes of feedback in organizations?
5. Define *openness* in an organization environment.

6. Define *closedness* in an organizational environment.
7. Define "virtual enterprises," and discuss why systems analysts should adopt a systems perspective.
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 resource planning (ERP) systems?
11. What is the main difference between doing business process analysis for ERP and for other types of systems?
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 are the three symbols in a context-level data flow diagram, and what do they represent?
19. Is a context-level diagram sufficient for defining the scope of a system?
20. What is meant by the term *entity-relationship diagram*?
21. Describe the elements of an E-R diagram depicting the relationship between a person and a t-shirt. This description should show the following relationship: each person can have many t-shirts, but each shirt can only be owned by a single person.
22. List the types of E-R diagrams.
23. How do an entity, an associative entity, and an attributive entity differ?
24. How would three levels of management have different implications for information systems development?
25. Who should be involved in collaborative design of information systems?
26. How can understanding organizational subcultures help in the design of information systems?
27. List the features of public and private channels in Slack and its function in team communication.

Problems

1. A childcare service provider offers crèche and preschool facilities, career counselling, and employment services. Each of these services is implemented through a distinct IT solution. Often, candidates who are enrolled in the preschool after being in the crèche have to be registered again, creating data redundancy in the system. Recently, the firm has noticed disparities in the functions of the system, such as difficulty in keeping track of the candidates who have enrolled in career counselling and also opted for employment services, redundancy in enrolment data across applications, and frequent complaints from parents about delays in responses to their queries on childcare facilities. The management has realized that most of these issues have occurred due to a lack of data integration and a poor interface.

   In a paragraph, apply various systems concepts provided in the text to discuss how the problems faced by the management can be solved.
2. Are the relationships in Figure 2.8 justified when read both from left to right and from right to left?
3. Draw an E-R diagram for scheduling exams for different courses in different rooms.
   a. What are the types of entities used in the diagram?
   b. Briefly explain the relationships in the diagram.
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.
   a. In a paragraph, persuade your team member that early use of E-R diagrams is worthwhile.
   b. Write a brief tutorial or create a brief Microsoft PowerPoint presentation explaining how to draw an E-R diagram to the project manager of the health maintenance organization. Define any technical terms to help them understand E-R diagrams.
5. Gwen is a bus operator and issues tickets using a handheld device. Every day, she generates a report at the start of her shift with all values on the device set to zero and a report at the end of her shift containing trip details and information on the collected fare. She submits the report and the collected fare to the transport company and then transfers the data from the device to a server. This data is periodically accessed by an auditor to review the pattern of collection and look for disparities.
   a. At which level of management does Gwen work? Justify your answer.
   b. How does Gwen's information needs differ from that of the auditor?
6. In a bid to expand, the transport company (Problem 5) is planning a major merger with a bigger service provider, integrating the use of advanced information systems to facilitate better operations. Gwen and some of her coworkers are optimistic that the merger will make the firm more competitive, but other coworkers dislike the company's plan. Discuss the role of subcultures in this scenario and what the company can do to manage this change.

7. Carson, a member of the human resources department at the Elrod Manufacturing Company 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 Carson.

   He would like the company to have a Web system that would allow employees to use a secure logon to view the information. Carson wants the system to interface with health and dental insurance companies to obtain the amount remaining in the employee's medical accounts for the year. He would also like to obtain retirement amounts saved, along with investment results. Carson 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 this employee benefits system.
8. Write up a use case scenario for the use case diagram you constructed for Elrod Manufacturing.
9. At what level are you creating your use case for Elrod Manufacturing? Choose one of the five altitude metaphors and explain why you chose it.
10. Create a context-level data flow diagram for the employee benefits system in Problem 7. Make any assumptions you need about the data to and from the central process.
    a. Do you find this to be better than or not as good at explaining the system to Carson compared to the use case and use case scenarios? Explain your view in a paragraph.
    b. Write a brief tutorial or create a short Microsoft PowerPoint presentation for Carson on how to draw context level diagrams. Be sure to define any technical terms, as well as the reasons for drawing a context level diagram early in your visits to Elrod Manufacturing.
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.
12. Draw a use case and write up a use case scenario for a user who is trying to logon to a secure site that they subscribe to, but who has forgotten their password.
13. Research work-sanctioned social media platforms that are available in your area. Choose one (*Slack*, for example) and write two paragraphs discussing (1) the benefits and (2) the drawbacks. Finally, in a paragraph, write an opinion about whether you would like to work in a company that uses *Slack* or another work-sanctioned social media solution, and state why or why not.

Group Projects

1. Break up into groups of five. Assign one person to act as the website 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 beach towel, a box of candy, or a specialty travel hat (rainproof or sunblocker). Now spend 20 minutes trying to explain to the website designer what to include on the website. Include ideas for product descriptions; including photos or graphics and other content. Describe in about three paragraphs what experience your group had in coordinating. Elaborate on the interrelatedness of subsystems in the organization (your group).
2. Develop a use case and a use case scenario for generating immunization plans based on government-run health missions for babies registered with a hospital.
3. Change your answer in Group Project 2 to include a moderator who manually authenticates completed immunizations or generates warning messages if they are incomplete.
4. With your group, draw a context-level data flow diagram of your school's or university's registration system.
   a. Label each entity and process.
   b. Discuss with your group 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.
   c. Now, working with your group, follow the appropriate steps for developing an E-R diagram and create one for your school or university registration system. Make sure your group labels the relationship you depict as to whether it is one-to-one, one-to-many, many-to-one, or many-to-many.
5. Research *Slack,* the work group social media platform, with your group.
   a. In a paragraph, answer the questions: How does an organization subscribe to it? What are the benefits? What are the drawbacks?
   b. Have your group write two paragraphs: One on the benefits and one on the drawbacks of using work-sanctioned social media such as *Slack*.
   c. In a third paragraph conclude your write-up by offering a recommendation on whether or not to adopt *Slack* for your in-class group (assume that the necessary hardware and software resources are available to support it).

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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. Evaluate hardware and software alternatives by addressing the trade-offs.
3. Forecast and analyze tangible and intangible costs and benefits.
4. Manage a project by preparing a budget, creating a work breakdown structure, scheduling activities, and controlling the schedule and costs.
5. Build and manage a project team.
6. Write an effective systems proposal, concentrating on both content and design.

Initiating projects, determining project feasibility, scheduling projects, estimating costs, budgeting, and planning and then managing activities and team members for productivity are all important capabilities for a 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 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 and external relationships to the Internet. Changes that require a systems solution occur in the legal environment as well as in the industry's environment. A systems analyst works with users to create a problem definition that reflects current business systems and concerns.

Once a project is suggested, the systems analyst works quickly with decision makers to determine whether the project is feasible. When 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 Technique (PERT) diagrams so that the project can be completed on time. Part of ensuring 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 a variety of 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. Both situations can arise as an organization adapts to and copes with natural, evolutionary change.

Problems in an Organization

Managers do not like to conceive of their organization as having problems, let alone talk about those problems 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. In some instances, problems 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 a sufficient reason to request the help of a systems analyst.

Although difficulties such as those just described occur in an 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, as well as lost or unexpectedly low 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.

Defining the Problem

Whether using the classic systems development life cycle (SDLC) approach or an object-oriented approach, an analyst first defines the problems and objectives of the system. These form the foundation for determining what needs to be accomplished by the system.

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 as a general statement.

To Identify Problems	Look for These Specific Signs:
Check output against performance criteria.	• Too many errors • Work completed slowly • Work done incorrectly • Work done incompletely • Work not done at all
Observe behavior of employees.	• High absenteeism • High job dissatisfaction • High job turnover
Listen to external feedback from: Vendors and service providers. Customers. Suppliers.	• Complaints • Suggestions for improvement • Loss of sales • Lower sales

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 the weather app on his smartphone, which shows a map of the United States saturated with dark red, indicating that most of the country is experiencing an early spring heat wave, with no signs of a letup. Holding up the screen of his smartphone as he speaks to the assembled systems group, he says, "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 hung 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 email our orders to 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 served chilled or with ice, and it is particularly popular when the weather is hot. Sipps has sold briskly in Europe and grown in popularity in the United States since its introduction five years ago, but the company 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. A network of local distributors located throughout the United States and Canada distributes Sipps.

As one of the systems analysts assigned to work with the U.S. distributors of Sipps, you 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*, 14, 2 (January 13, 1997): 31 and 34.

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

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

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

Finally, 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 number 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, a topic, or a theme that is repeated several times, sometimes by different people in several interviews.
2. Users may communicate using the same metaphors, such as saying the business is a journey, a war, a game, an organism, a machine, a family, and so on.

3. Users may tell a story to illustrate a problem that includes a beginning, a middle, and an ending; a hero; obstacles to overcome; and a successful (or hoped for) resolution.
4. Users may speak at length on a topic.
5. Users may tell you outright, "This is a major problem."
6. Users may communicate importance using body language or may speak emphatically on an issue.
7. The problem may be the first thing the user mentions.

Once the issues have been identified, the objectives must be stated. An 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 critical objectives must be completed first. Users are the best people to identify critical objectives (with the support of analysts) because users are domain experts in their business area and know how they work best with technologies in the organization. In addition to looking through data and interviewing people, a systems analyst should try to witness the problem firsthand.

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 luncheon meetings and weddings. It was inspired by Catherine's love of cooking and 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 types of meals, and other information necessary to cater an event. As her company's reputation for creating superb food and the quality of the service began to blossom, the number of events started to increase. A new convention center built in the city and a prospering business community increased the number of catering events.

Catherine was able to manage the business using spreadsheets and word processing but had difficulty keeping up with the 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, gluten-free, and so on. Catherine hired a number of part-time employees to cook and cater the events, however 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 to occur.
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 to help guide customers in their choice of meals.
6. Events that include service for sit-down meals are often held in banquet rooms and at other meeting halls. There are problems with scheduling sufficient wait staff and responding to changes in 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.

User requirements are then used to create either use cases and a use case diagram or processes on a data flow diagram. Each objective may have one or more user requirements,

FIGURE 3.2

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

Catherine's Catering

Problem Definition

Catherine's Catering is experiencing problems with handling the number of routine calls with customers, as well as coordinating with external partners such as suppliers and meeting facilities. The growth in the number of part-time staff is leading to scheduling conflicts and understaffed events.

Issues	Weight
1. Customer contact takes an inordinate amount of time for routine questions.	10
2. Managing part-time employees is time consuming and leads to scheduling errors.	9
3. It is difficult to accommodate last-minute changes for events.	7
4. Supplies are ordered for each event. Often shipments are received several times a day.	6
5. There are often problems communicating changes to event facilities.	5
6. There is little historical information about customers and meals.	3

Objectives

1. Provide a Web system for customers to obtain pricing information and place orders.
2. Create or purchase a human resources system with a scheduling component.
3. After customers have signed an event contract, provide them with Web access to their account and a means for them to update the number of guests. Notify management of changes.
4. Provide a means to determine overall quantities of supplies for events occurring within a concurrent time frame.
5. Provide a system for communicating changes to key personnel at event facilities.
6. Store all event data and make summary information available in a variety of formats.

Requirements

1. The system must be secure.
2. Feedback must be entered by event managers at the close of each event.
3. There must be a means for event facilities to change their contact person.
4. The system must be easy to use by nontechnical people.

Constraints

1. Development costs must not exceed $50,000.
2. The initial website for customer orders must be ready by March 1 to accommodate requests for graduation parties and weddings.

several objectives may lead to the creation of one or perhaps no use cases (use cases are not often created for simple reports), or each requirement may lead to the creation of one data flow diagram process. The user requirements for Catherine's Catering are to:

1. Create a dynamic website 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 each a userID and a password for access to their projects.
4. Create a website for clients to view and update the number of guests for an event and restrict changes in the number of guests when the event is less than five days in the future.
5. Obtain or create software to communicate directly with event facility personnel.
6. Develop or purchase a human resources system for scheduling part-time employees that allows 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. Few details are available at this time, so the test plan will be revised as the project progresses.

A simple test plan for Catherine's Catering is:

1. Design test data to 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 confirm that clients are able to view event information. Test that updates may not be made within five days of the event. Design test data 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 and 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 poorly accepted.

As outlined in Chapter 2, prospective projects need to be examined from a systems perspective, considering the impact of the proposed change on the entire organization. Recall that the various subsystems of an 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 a 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 questions that need to be asked regarding project selection:

1. Does it have backing from management?
2. Is the timing of the project commitment appropriate?
3. Is it possible to improve attainment of strategic organization goals?
4. Is it practical in terms of resources for the systems analyst and organization?
5. Is it a 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 will eventually 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; however, management backing is essential.

Another important criterion for project selection is timing for you and the organization. Ask yourself and the others who are involved whether 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 strategic organization 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) improving 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 whether the selected projects are feasible. Our definition of *feasibility* goes much deeper than the common usage of the term. Systems project feasibility is assessed in three principal ways: operationally, technically, and economically. A feasibility study is not a full-blown systems study. Rather, a feasibility study is used to gather broad data for the members of management that enables them to make a decision about whether to proceed with a systems study.

Determining Whether It Is Possible

After an analyst determines reasonable objectives for a project, the analyst needs to determine whether 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, that are technically impossible, or that have no economic 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 (see Figure 3.3).

FIGURE 3.3

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

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 put in service Whether the system will be used

TECHNICAL FEASIBILITY An analyst must find out whether it is possible to develop a 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 to 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 staff who are technically proficient to accomplish the objectives. If not, can the organization hire additional coders, testers, experts, or others who may have different coding skills from theirs, or perhaps outsource the project completely? In addition, are software packages available that can accomplish the objectives, and how significantly does that 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, software development, or software customization.

The organization 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 if the project produces no immediate reduction in operating costs, the system is not economically feasible and should not proceed further.

OPERATIONAL FEASIBILITY Suppose for a moment that technical and economic resources are both judged adequate. The systems analyst must now 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 put into service.

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. The new system has a low chance of becoming operational.

Alternatively, if users themselves have expressed a need for a system that is operational more of the time and is more efficient and more accessible, 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.

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 be capable of handling current and future workloads.

If estimates are accurate, 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 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 3.4 compares the time required by existing and proposed information systems 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 reduce the required human and computer time significantly.

FIGURE 3.4

Comparisons of workloads between existing and proposed systems.

	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	Daily: Enter shipments on Excel spreadsheet; verify accuracy of spreadsheet manually; and then write files to backup media. Monthly: Run program that summarizes daily records and prints report; get report and make evaluations.	Daily: Enter shipments on the Web-based system using drop-down boxes. Data are automatically backed up to remote location. Monthly: Compare warehouses online using the performance dashboard; print only if needed.
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

Ascertaining Hardware and Software Needs

Assessing technical feasibility includes evaluating the ability of computer hardware and software to handle workloads adequately. Figure 3.5 shows the steps a 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.

A systems analyst needs to work with users to determine what hardware will be needed. Hardware determinations can be made only in conjunction with determining human information requirements. Knowledge of the organization structure and how users interact with technologies in an organization setting also can 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

A systems analyst needs to inventory 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 one up quickly and carry through on it. It is important to know the following:

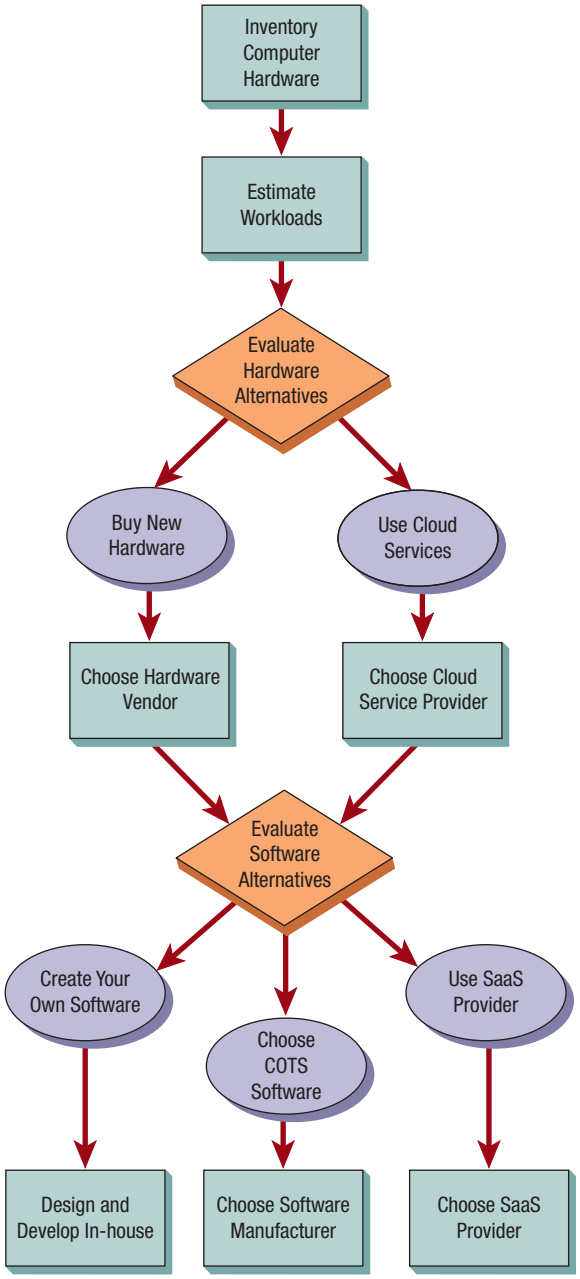


FIGURE 3.5

Steps in choosing hardware and software.

1. The type of equipment, including model number and manufacturer
2. The operational status of the equipment, such as on order, operating, in storage, or 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, such as owned, leased, or 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 have been 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.

Evaluating Computer Hardware for Purchase

Evaluating new 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' or service providers' 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 products currently available are comprehended and compared with what already exists in the organization, the systems analysts in conjunction with users and management can make decisions about whether obtaining new hardware is necessary.

ADVANTAGES OF BUYING COMPUTER HARDWARE If the organization purchases its own computers, it will have full control regarding the type of hardware and software. The company will decide when to purchase it and when to replace it. Often it is cheaper in the long run to buy computer equipment outright, but only if the organization buys the appropriate computer equipment. Buying computers often has tax advantages in the United States because of the depreciation rules.

DISADVANTAGES OF BUYING COMPUTER HARDWARE Purchasing computers presents a problem because the initial cost of buying the equipment is often very high. Phasing in computer equipment over time doesn't always work due to compatibility problems that exist with different models and legacy devices, but buying everything at once means tying up capital or borrowing money. The risk of equipment obsolescence is a serious concern, and getting stuck with equipment that is not useful because someone made the wrong decision is a very large risk. Finally, the organization needs to remember that the full responsibility for the operation and maintenance stays with the company that buys the equipment. This can be a big disadvantage because it ties up people and money.

Renting Time and Space in the Cloud

Instead of purchasing their own equipment, companies can use cloud services. Some of the services available are Web hosting, email hosting, application hosting, backup, storage and processing of databases, archiving, and ecommerce support. The advantages and disadvantages to buying hardware versus using cloud services are shown in Figure 3.6.

Cloud services are scalable, which means if the business grows, the organization can easily add computing power without procuring new hardware. Although few organizations save money

	Advantages	Disadvantages
Buying computer hardware	• Full control over hardware and software • Often cheaper in long run • Provides tax advantages through depreciation	• Initial cost is high • Risk of obsolescence • Risk of being stuck if choice was wrong • Full responsibility for operation and maintenance
Using cloud services	• Maintenance and upgrades performed by provider • Ability to change software and hardware rapidly • Scalable—can grow quickly • Consistent over multiple platforms • No capital is tied up	• Company doesn't control its own data • Data security is at risk • Reliability risks of the Internet platform • Proprietary APIs and software may make switching providers difficult

FIGURE 3.6

Comparing the advantages and disadvantages of buying computer resources versus using cloud services.

by purchasing cloud services, they prize the agility afforded by being able to add or stop cloud services as needed.

Three main categories of cloud computing are Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS). With SaaS, the cloud vendor sells access to applications (discussed later in this chapter, when we discuss software). With IaaS, also called Hardware as a Service (HaaS), an organization outsources its hardware operations needs to the service provider. Using the PaaS approach, companies use the Internet to rent all manner of hardware, operating systems, storage, and even network capacity. Another option is to use a hybrid approach in which some of the hardware is maintained in the local organization and some of the software is cloud-based. This includes public and private cloud services.

Decisions on cloud computing can first be addressed on a strategic level. Cearley (2010) states that a business should (1) define a high-level business case that focuses on the high-level benefits of cloud computing for the organization; (2) define core requirements (perhaps making a quick list to start) that support the migration of IT to the cloud, including dimensions such as system performance, security desired in cloud relationships, IT governance, and predicted growth of the enterprise; and (3) define core technologies for the enterprise, starting with a list of cloud computing technologies that are helpful. As an analyst, you may be asked to facilitate any or all of these steps, or your help might be solicited at some point in the process of moving computing services to the cloud.

BENEFITS OF CLOUD COMPUTING Some of the benefits of cloud computing include less time spent maintaining legacy systems or even performing routine tasks such as maintenance or upgrading of present systems. Using the cloud may make it simpler to acquire IT services and may also make it easier and quicker to separate from or discontinue services that are no longer necessary. Using cloud services makes your applications scalable, which means you can grow them easily by adding more cloud resources. Cloud computing also has the potential to offer consistency across multiple platforms that were previously disjointed or difficult to integrate. Finally, no capital is tied up, and no financing is required.

DRAWBACKS OF CLOUD COMPUTING As with any other innovation, there are some disadvantages of adopting cloud computing for organizations. Loss of control of data stored in the cloud is perhaps the most striking concern when relying on cloud computing; if the cloud services provider ceased to exist, it is unclear what would happen to the organization's data. Looming almost as large are potential security threats to data that is not stored on premises or even on the organization's own computers. Reliability of the Internet as a platform forms the third main concern for organizations.

Furthermore, something that could dampen an organization's maneuverability when it comes to cloud computing is the prospect that the company could get stuck using application

programming interfaces (APIs) that are proprietary with the cloud provider. This might make switching among cloud computing providers more difficult. Another development in cloud computing of which analysts should be aware is that some countries are now mandating that any company that does business there must use cloud service providers based in that country. For example, Apple is now obeying legislation like this in China.

Evaluation of Vendor Support for Computer Hardware

Several key areas need to be evaluated when weighing the support services vendors offer to businesses. Most hardware 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. Cloud service providers offer 30- or 60-day money-back guarantees. Vendors of comparable quality frequently distinguish themselves from others in 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 3.7. Support services include routine and preventive maintenance of hardware, specified response time (within six hours, next working day, and so on) 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. Cloud providers make claims for uptime and promises to get back to you on a question within a certain amount of time, such as 24 hours. Peruse the support services documents accompanying the purchase of equipment and remember to involve appropriate legal staff before signing contracts for equipment or services.

Unfortunately, the process of evaluating computer hardware and cloud providers is not as straightforward as simply comparing costs and choosing the least expensive option. Before becoming convinced that buying cheaper compatibles is the way to endow your system with add-on capability, you need to do enough research to feel confident that a hardware vendor or cloud provider is a stable corporate entity.

Understanding the Bring Your Own Device (BYOD) Option

Bring your own device (BYOD) or bring your own technology (BYOT) is a trend appearing in a variety of organizations in different industries. These organizations range in size and have employees of differing skills. In general, BYOD or BYOT means that rather than using a smartphone or tablet issued by the organization, the employee uses his or her own device to access corporate networks, data, and services remotely when working outside the office. The BYOD approach is often presented

FIGURE 3.7

Guidelines for vendor selection.

Vendor Services	Specifics Vendors Typically Offer
Hardware Support	Full line of hardware Quality products Warranty
Software Support	Complete software needs Custom programming Warranty
Installation and Training	Commitment to schedule In-house training Technical assistance
Maintenance	Routine maintenance procedures Specified response time in emergencies Equipment loan while repair is being done
Cloud Services	Web hosting Email hosting Data storage
Software as a Service	Automatic software upgrades Support services Security and antivirus protection

as a way to keep the organization's hardware costs down and improve morale among employees who, on average, already bring one or more mobile devices to work for personal tasks.

As a systems analyst, you will work to discover through a combination of interviews, surveys, and observation what personal technology is being used by the majority of the group. For example, if you observe that all the executives in the decision-making group already bring in iPads every day, you might conclude that designing dashboards for the iPad has some merit. They are devices you want to include in your original design rather than as an afterthought. If your observations show that most executives prefer face-to-face meetings, but they use their handheld devices (such as mobile phones) to check other corporate data and emails during meetings, then you might want to consider supporting corporate email on their personal phones.

BENEFITS AND DRAWBACKS OF BYOD The benefits of BYOD computing include building employee morale, a potential for lowering the initial cost of organization IT hardware purchase, facilitating remote, round-the-clock access to corporate computer networks regardless of location, and building on a familiar user interface to access corporate computing services, applications, databases, and storage. Security risks posed by untrained users are probably the biggest drawback. Identified threats are loss of the device itself, theft of the device and its data, unauthorized access to corporate networks using personal mobile devices, and so on. Other threats are posed by commonly occurring behavior with mobile devices that may be fine on the private side but not on the corporate side, such as using free Wi-Fi hotspots, using apps such as Dropbox, and others.

Creating Custom Software

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. Analysts have three choices: creating their own software, purchasing commercial off-the-shelf (COTS) software, or using software from a SaaS provider. Figure 3.8 summarizes the advantages and disadvantages of each of these options.

	Advantages	Disadvantages
Creating Custom Software	• Specific response to specialized business needs • Innovation may give firm a competitive advantage • In-house staff available to maintain software • Pride of ownership	• May be significantly higher initial cost compared to COTS software or ASP • Necessity of hiring or working with a development team • Ongoing maintenance
Purchasing COTS Packages	• Refined in the commercial world • Increased reliability • Increased functionality • Often lower initial cost • Already in use by other firms • Help and training comes with software	• Programming focused; not business focused • Must live with the existing features • Limited customization • Uncertain financial future of vendor • Less ownership and commitment
Using SaaS	• Organizations that do not specialize in information systems can focus on what they do best (their strategic mission) • There is no need to hire, train, or retain a large IT staff • There is no expenditure of employee time on nonessential IT tasks	• Loss of control of data, systems, IT employees, and schedules • Concern over the financial viability and long-run stability of the SaaS provider • Security, confidentiality, and privacy concerns • Loss of potential strategic corporate advantage regarding innovativeness of applications

FIGURE 3.8

Comparing the advantages and disadvantages of creating custom software, purchasing COTS packages, and outsourcing to a SaaS provider.

CONSULTING OPPORTUNITY 3.2

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

"It'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 widget to track ad campaign roll outs. 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."

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 that 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 you can make a selection? Set up a table to evaluate each vendor. Answer each question in a separate paragraph.

Several situations call for the creation of original, custom 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 be unaffordable or not easily purchased or licensed.

Original software should be created when an 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 have existed. An organization also may be 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 also may benefit from creating original software.

The advantages of creating custom 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 pride of owning something you have created.

The drawbacks of developing custom software include the potential for a significantly higher initial cost compared to purchasing COTS software or contracting with a SaaS provider, the necessity of hiring or working with a development team, and the fact that you are responsible for the ongoing maintenance because you created the software.

Purchasing COTS Software

COTS 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 organization-level systems rather than office or personal use. A website such as softwareadvice.com lists popular (but costly) enterprise resource planning (ERP) packages such as Oracle and SAP in their reviews of COTS software. These packages differ radically in the amount of customization, support, and maintenance required compared to Microsoft Office. COTS software also can refer to software components or objects (also called building blocks) that can be purchased to provide a particular needed functionality in a system.

You should consider using COTS software when you can easily integrate the applications or packages into existing or planned systems and when you have identified no need to immediately or continuously change or customize systems 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 and additional functionalities often are 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 companion products, add-on features, and upgrades that enhance its attractiveness. Also, 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 a SaaS provider.

Another advantage of purchasing COTS packages is that many other companies use them, so analysts are not experimenting on their clients with one-of-a-kind software applications. Finally, 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 the company wanted to create ecommerce applications, it was 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; instead, they waited for COTS packages, such as PC-based box office software, or SaaS, such as online ticketing agencies with automation already in place, to make these services available to patrons. In-house, custom software development is out of the question for most of these groups, which 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 on which users relied. COTS software also may 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. 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 all projects are built from the ground up (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. Computer programmers may be in-house or outsourced.

Fewer 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.

Using the Services of a SaaS Provider

Organizations may realize some benefits from taking an entirely different approach to procuring software: Outsourcing some of the organization's software needs to a SaaS provider that specializes in IT applications.

There are specific benefits to outsourcing applications to a SaaS provider. For example, organizations that want to retain their strategic focus and do what they're best at may want to outsource the production of information systems applications. In addition, outsourcing 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 SaaS, there is little or no expenditure of valuable employee time on nonessential IT tasks; these are handled professionally by SaaS.

Hiring a SaaS provider should not be considered a magic formula for addressing software requirements. Some drawbacks to the use of SaaS 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 SaaS 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 a SaaS provider, there is a potential loss of strategic corporate advantage that might have been gained through the company's deployment of its own innovative applications created by its employees.

Evaluation of Vendor Support for Software and SaaS

Whether you purchase a COTS package or contract for SaaS from a provider, you will be working 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 3.9: performance effectiveness, performance efficiency, ease of use, flexibility, quality of documentation, and manufacturer support.

Evaluate packaged software based on a demonstration using test data from your client's business and examine accompanying documentation. Vendors' descriptions alone will not suffice. Vendors typically certify that software is working, but they do not guarantee that it will be error-free in every instance, that it will not crash when users take incorrect actions, or that it will be compatible with all other software the organization is currently running. Obviously, they will not guarantee their packaged software if it is used in conjunction with faulty hardware.

FIGURE 3.9

Guidelines for evaluating software.

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

Identifying, Forecasting, and Comparing Costs and Benefits

Costs and benefits of a proposed computer system must always be considered together because they are interrelated and often interdependent. Although a systems analyst tries 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, which becomes apparent in the next section.

Forecasting

Systems analysts are required to predict certain key variables before submitting a proposal 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.

A systems analyst has many forecasting models available. The main condition for choosing a model is the availability of historical data. If historical data 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), creation of scenarios, or 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 past three months. For example, the average sales for January, February, and March are 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 it also has many disadvantages. Moving averages are more strongly affected by extreme values than by using graphical judgment or estimating by using other methods, such as least squares. An analyst should learn forecasting well, as it often provides information that is valuable in justifying an entire project.

Identifying Benefits and Costs

Benefits and costs can be 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 that are 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 superior calculating power, and a decrease in the amount of employee time needed to complete specific tasks. And there are other tangible benefits. Although measurement is not always easy, tangible benefits can be measured in terms of actual dollars, resources, or time saved.

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 their bookkeeping functions.

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

Glinda replies, "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 were 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 homegrown."

"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 (COTS) 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.intuit.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. Another possibility is to subscribe to a QuickBooks Online plan."

"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 products 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. I can even deliver it through the cloud. 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 four distinct options: create a custom package on their own, buy a standalone COTS software product such as QuickBooks Pro, subscribe to an online plan such as QuickBooks Online, 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.

INTANGIBLE BENEFITS Some benefits that accrue to an organization from the use of an 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 see from this list, intangible benefits are extremely important and can have far-reaching implications for a 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 enable 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 costs that a systems analyst and the business's accounting personnel can accurately project.

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

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 nearly impossible to accurately project a dollar amount for intangible costs. To aid decision makers who want to weigh a 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 a proposed system. Two are break-even analysis and payback.

BREAK-EVEN ANALYSIS By comparing costs alone, a systems analyst can use break-even analysis to determine the break-even capacity of a 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 a system plus the developmental costs that occur only once (one-time costs of installing a new system)—that is, the tangible costs that were discussed previously. Figure 3.10 illustrates 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 incremental 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.

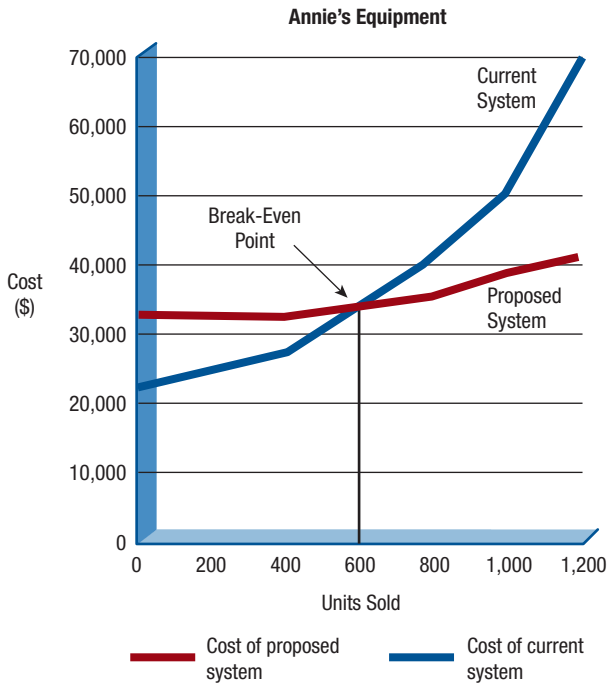
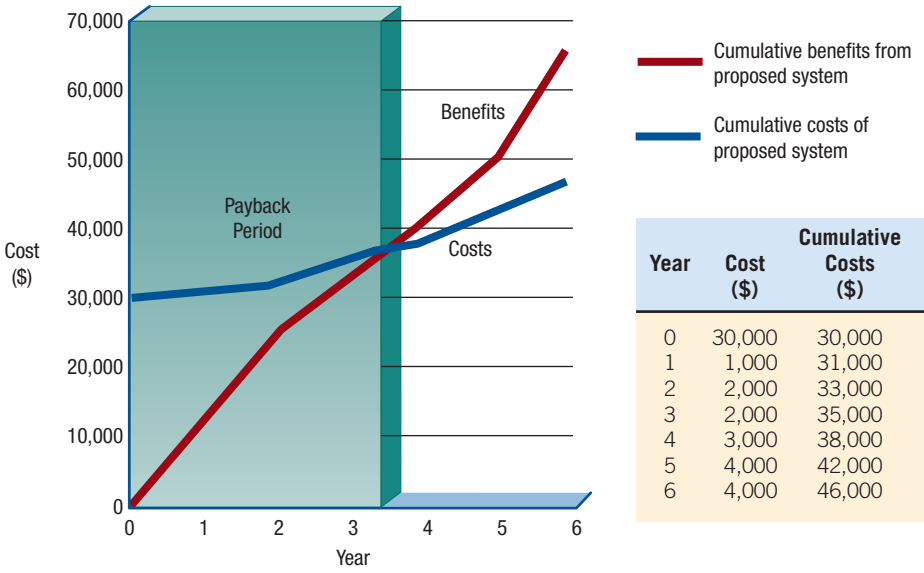


FIGURE 3.10

Break-even analysis for a proposed inventory system.



Year	Cost ($)	Cumulative Costs ($)	Benefits ($)	Cumulative Benefits ($)
0	30,000	30,000	0	0
1	1,000	31,000	12,000	12,000
2	2,000	33,000	12,000	24,000
3	2,000	35,000	8,000	32,000
4	3,000	38,000	8,000	40,000
5	4,000	42,000	10,000	50,000
6	4,000	46,000	15,000	65,000

FIGURE 3.11

Payback analysis showing a payback period of three and a half years.

Payback 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 this is clearly not the case.

Payback analysis can determine how long it will take for the benefits of the system to pay back the costs of developing it. Figure 3.11 illustrates a system with a payback period of three and a half years.

Managing Time and Activities

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, systems analysts usually use some of the techniques of project management to help get organized.

The Work Breakdown Structure

Systems analysts are responsible for completing projects on time and within budget and for including the features promised. To accomplish all three of these goals, a project needs to be broken down into smaller tasks or activities. These tasks together make up a work breakdown structure (WBS).

When defined properly, the tasks that comprise a WBS have special properties:

1. Each task or activity contains one deliverable, or tangible outcome, from the activity.
2. Each task can be assigned to a single individual or a single group.
3. Each task has a responsible person monitoring and controlling performance.

Activities in a work breakdown structure do not need to take the same amount of time or involve the same number of team members. The activities defined must add up to 100 percent of the work, however.

The main method for developing a WBS is decomposition, or starting with large ideas and then breaking them down into manageable activities. This subdivision of ideas into smaller ideas and eventually into tasks stops when each task has only one deliverable.

There are different types of work breakdown structures. A WBS can be product oriented. In other words, building a website can be broken down into many parts, with each set of pages having a specific purpose. You could divide a website into its home page, product description pages, a FAQ page, a contact page, and an ecommerce page. Each of these pages could contain activities that you could use in your work breakdown structure.

1.0	**Project Initiation**
1.1	Assemble and welcome project team
1.2	Conduct historical research about the business
1.3	Discuss objectives with client
2.0	**Early Planning Phase**
2.1	Investigate feasibility
2.2	Consider a make vs. buy decision
2.3	Develop a work breakdown structure
2.4	Provide time estimates
2.5	Develop a project schedule
2.6	Calculate cost estimates
2.7	Prepare project proposal to client
2.8	Present proposal to client
3.0	**Develop supporting plans**
3.1	Develop a quality management plan
3.2	Identify risks and build a risk management plan
3.3	Describe a communications plan
3.4	Develop a procurement plan
4.0	**Analysis**
4.1	Conduct interviews of key personnel
4.2	Administer questionnaires
4.3	Read company reports
4.4	Analyze data flow
5.0	**Design**
5.1	Build prototype website
5.2	Obtain reactions from client
5.3	Modify prototype website
5.4	Seek final recommendations from client
5.5	Complete website
6.0	**Launch**
6.1	Create training manual
6.2	Document website features and logic
6.3	Present final website to client

FIGURE 3.12

A sample work breakdown structure (WBS).

Another way is to create a process-oriented work breakdown structure. An example of this is shown in Figure 3.12. This type of WBS is typical in systems analysis and design. In this example, we show the development of a website, but rather than show the development of each page, this example emphasizes the importance of each phase in the systems development life cycle.

Time Estimation Techniques

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, you can employ some of the techniques of project management to help get organized. In this section, we discuss keeping a project on schedule by using time management techniques and keeping a project on budget by using cost management and control techniques.

One of the difficult tasks is estimating the time it takes to complete each of the tasks. There are numerous approaches:

1. Relying on experience
2. Using analogies
3. Using three-point estimation
4. Identifying function points
5. Using time estimation software

RELYING ON EXPERIENCE Experience pays off when it comes to estimating how long an activity will take. If you have previous experience developing software, you will not only know how much time some tasks will likely take, you will also know how much time it will take if something goes wrong. Your experience gives you a most likely estimate as well as a pessimistic estimate.

USING ANALOGIES If you don't have experience developing a particular piece of software but have worked on other types of projects of any kind, you still may be able to arrive at meaningful estimates. This approach involves identifying a project that is in some ways similar to the one you are about to begin and then describing the analogy. This means you will need to build two models, including two Program Evaluation and Review Technique (PERT) or network diagrams, and compare their similarities. Then you can have confidence when you provide time estimates for the new project.

USING THREE-POINT ESTIMATION Three-point estimation has been used for many years and is still a valid technique for time estimating. You start by developing three time estimates for completing each task and then apply a simple formula to calculate a weighted average. The formula is:

$$E = (a + 4 * m + b)/6$$

where a is the best-case estimate, b is the pessimistic or worst-case time estimate, and m is the most likely time estimate.

Typically the best-case scenario would improve on the time elapsed a little, but the pessimistic or worst-case estimate would imply that something disastrous happens, such as a weather or personnel delay. For example, writing a software module may take 10 days in most cases, but if the project is easier than expected, it might take only 8 days. If, however, the coder accepts a job elsewhere, it may take 30 days. If you apply the formula, you get this estimate:

$$\begin{aligned} E &= (8 + 4 * 10 + 30)/6 \\ &= 13 \text{ days} \end{aligned}$$

In this case, you will estimate that it will take 13 days to finish the task.

USING FUNCTION POINT ANALYSIS Another way of estimating the amount of work that needs to be done and how large a staff you need 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 rates them in terms of complexity.

You can use function point analysis to 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 website at www.ifpug.org.

USING TIME ESTIMATION SOFTWARE Estimating models, such as the Constructive Cost Model (COCOMO II), Constructive Systems Engineering Cost Model (COSYSMO), or software based on one or both of these models, such as SystemStar, work as follows. A 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.

Also considered are other variables, such as 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, you can make calculations and get a rough projection of the completion date. As the project gets under way, more specific estimates are possible.

CONSULTING OPPORTUNITY 3.4

Food for Thought

"We 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? Answer yes or no, and then discuss your recommendation and the reasoning behind it in a paragraph.

Project Scheduling

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.

This section contains an example in which a systems analyst, acting as a project manager, begins with the basic activities of analysis, design, and implementation. Then the analyst uses decomposition to break apart the main activities into smaller subtasks, as shown in Figure 3.13. Then the analysis phase is further broken down into data gathering, data flow and decision

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

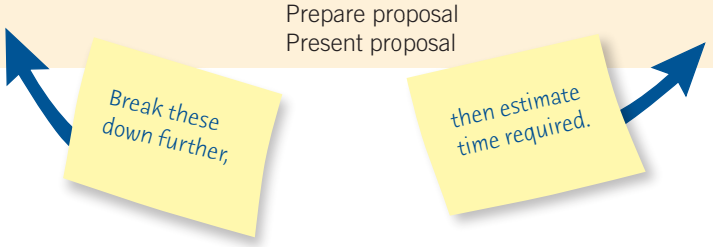
FIGURE 3.13

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

FIGURE 3.14

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



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, a systems analyst needs to consider each of these tasks and break them down further so that planning and scheduling can take place. Figure 3.14 shows how the analysis 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 people 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 a 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 a tool that enables you to easily schedule tasks. It is a chart on which bars represent tasks or activities. The length of each bar represents the relative length of the task.

Figure 3.15 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

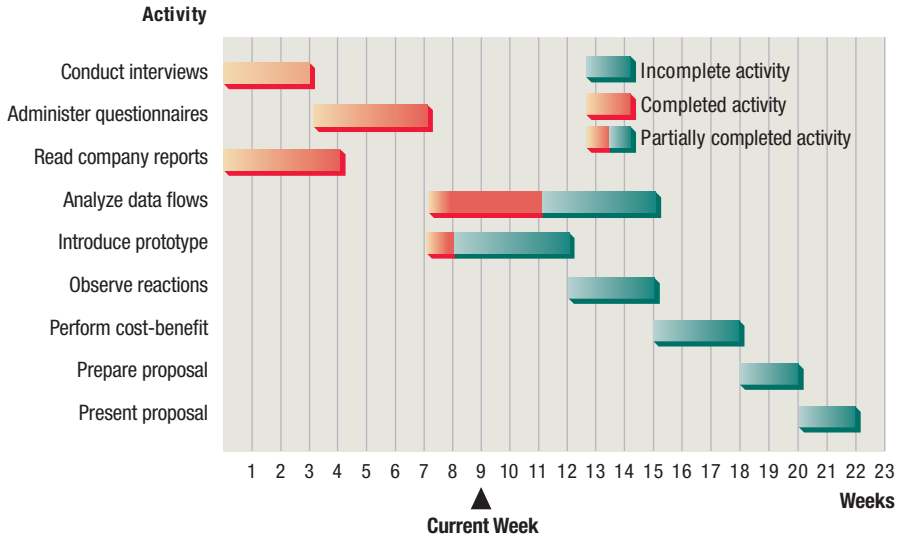


FIGURE 3.15

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

chart the special symbol ▲ signifies that right now, 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 a Gantt chart is its simplicity. Not only is this technique easy to use, but it also 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 bars indicates the relative length of time it will take to complete each task. You can use Microsoft Project to develop a Gantt chart.

Using PERT Diagrams

PERT is an acronym for Program Evaluation and Review Technique. A program (a synonym for a project) is represented by a network of nodes and arrows that are 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 of development time. PERT charts are called network diagrams in Microsoft Project.

PERT is useful when activities can be done in parallel rather than in sequence. A systems analyst can benefit from using 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 other team members are working on other tasks.

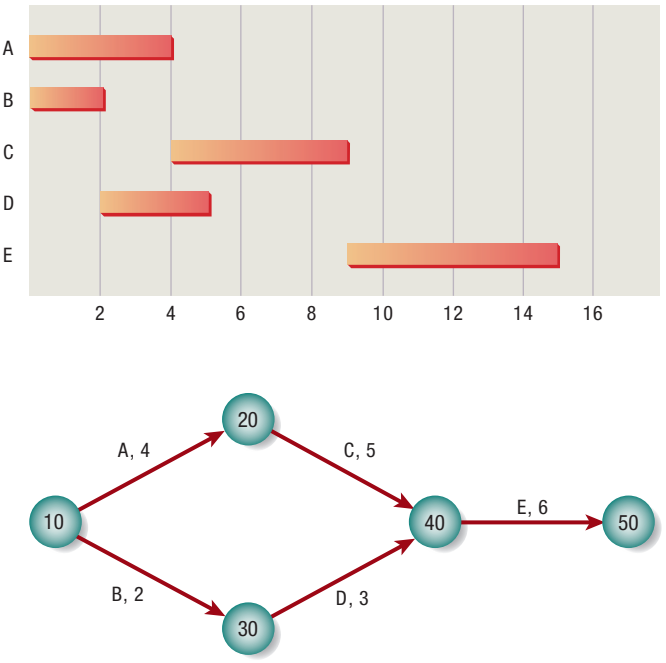
Figure 3.16 compares a simple Gantt chart with a PERT diagram. Arrows in the PERT diagram represent the activities expressed as bars in the Gantt chart. The length of the arrows has no direct relationship with the activity durations. Circles on the PERT diagram are called events and can be identified 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 new activities may be undertaken (which is called *precedence*).

In the PERT example shown here, 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; in this example, 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.

FIGURE 3.16

A Gantt chart compared with a PERT diagram (network diagram) for scheduling activities.

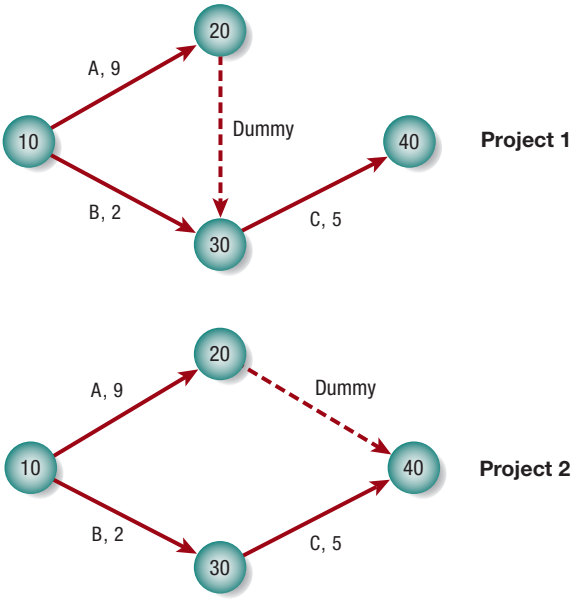


The longest path is referred to as the *critical path*. Although the critical path is determined by calculating the longest path, it is defined as the path that will cause the whole project to fall behind if even one day's delay is encountered on that path. Note that if you are delayed one day on path 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 to clarify the diagram. Figure 3.17 shows two PERT diagrams with dummies. Project 1 and Project 2 are quite different, and the way the dummy is drawn makes the difference clear. In Project 1, activity C can be started only 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.

FIGURE 3.17

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



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 3.18

Listing activities for use in drawing a PERT diagram.

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, eleminating event 20 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 3.18, 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 for this example, the analyst looks first at the activities that require no predecessor activities—in this case A (conduct interviews) and C (read company reports). In the example in Figure 3.19, the analyst chose to number the nodes 10, 20, 30, and so on and drew two arrows out of the beginning node 10. These arrows represent 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 that requires 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.

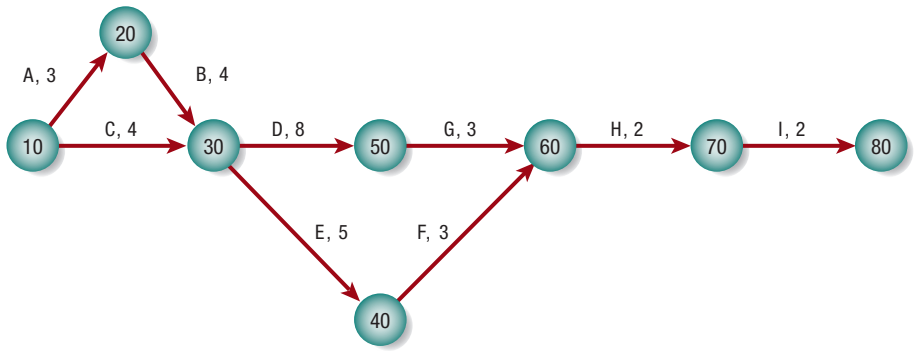


FIGURE 3.19

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

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 monitor the activities on the critical path to keep the entire project on time or even shorten the project length, if warranted.

Controlling a Project

No matter how well a systems analyst plans a project, things can go wrong. In this section, we discuss how to estimate cost and prepare a budget, how to predict and prepare for risk, how to make up time using expediting, and how to control costs when the budget needs revising, the team falls behind, or experiences cost overruns.

Estimating Costs and Preparing the Budget

Keeping a project on time is important, but it is also essential that the cost of a project be managed properly. Once a work breakdown structure is created and a schedule is planned, the analyst needs to:

1. Estimate costs for each activity in the work breakdown structure
2. Prepare a budget for the project and have it approved by the organization or client
3. Manage and control the costs throughout the project

Earlier we discussed cost estimates for equipment and off-the-shelf software, resources we need to complete the project. Now we are concerned with other types of resources needed to complete each task in the work breakdown structure. The main resources for this part of the project are the time of the team members and the type of special equipment and tools needed to finish each of the activities.

Many approaches to cost estimation are available to a systems analyst. They are similar to the estimates used for time estimates and include the following:

1. Basing estimates on similar projects, also called the top-down approach
2. Building bottom-up estimates
3. Using parametric modeling

THE TOP-DOWN APPROACH TO COST ESTIMATION Previous experience with estimating costs means a great deal, especially if the project you are attempting to estimate resembles a project you have previously worked on. If you've developed a website with similar features, then you can reliably estimate the costs of developing a new website.

Customization is possible. The new website may feature a different number of products for sale, but it is possible to adjust the costs according.

THE BOTTOM-UP APPROACH TO COST ESTIMATION Often, an analyst is faced with a project that requires something unique, such as development in a different programming language. In this case, the analyst needs to use a bottom-up approach.

A systems analyst can take the work breakdown structure and ask each responsible project team member to estimate the cost involved for completing the activity that is his or her responsibility. This method, however, yields estimates that may be good or bad, depending on the abilities of each team member. The analyst, acting as a project manager, must review each of these estimates and arrive at a cost estimation that satisfies the team and the client. The obvious problem with the bottom-up method is the time it takes to make each estimate along the way.

PARAMETRIC MODELING This method involves making estimates for each of the many factors, or parameters, that make up a project. For example, you can estimate that it will cost $75 per line of code and $80 per hour for the computer programmers needed; you can then estimate the lines of

MAC APPEAL

Color-coding helps a project manager sort out similar phases, tasks, and resources. OmniPlan, available for Macs, takes advantage of color-coding to set up a project, identify tasks, identify the critical path, and flag impossible situations.

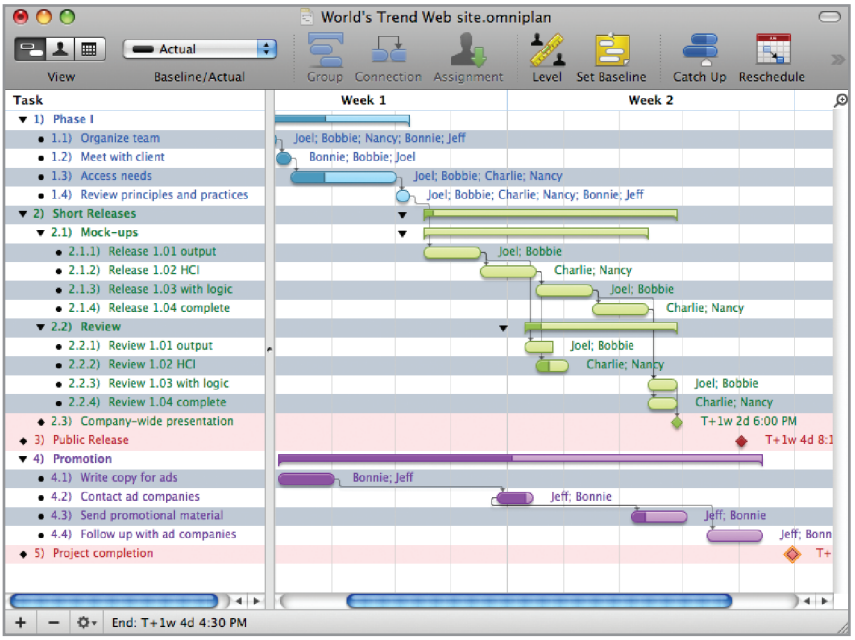


FIGURE 3.MAC

OmniPlan project management software from The Omni Group. (Used by permission of the Omni Group.)

code and hours it will take to complete the project. Special parametric modeling software such as COCOMO II, mentioned previously, is often useful when modeling the project.

WHY COST ESTIMATES FAIL In practice, most systems analysts use a combination of all three of the cost-estimating methods just described. There are two main reasons cost estimates fail. First, an analyst is likely to be overly optimistic. An analyst believes in his or her team members, and an optimistic estimate will show the team completing the project quickly and without errors all the time. An analyst is likely to be optimistic and underestimate the lines of code and effort in general.

Second, an analyst may want to move past the cost estimation process and get on with preparing and presenting the budget and beginning the actual work on the project. The analyst may therefore spend less time than is needed to properly prepare the estimates. The analyst should be as accurate as possible, even though the estimates will be revised as the project continues.

PREPARING THE BUDGET In the end, a systems analyst needs to prepare a budget even if the estimates are not perfect. The budget is a critical deliverable, and every client wants to see a detailed budget early in the process.

When working for a client, a systems analyst needs to conform to the standard process the client uses to develop a budget. Most of the time, the client will have standard forms it uses for this purpose. A sample budget is shown in Figure 3.20.

FIGURE 3.20

Part of a sample budget for a software development project, showing hardware, software, and personnel costs.

Items	Hours or Units	Cost per Hour or Unit	Subtotals
1. Project Team			
Project manager (systems analyst)	600	$120	$72,000
Project team members	2,400	80	192,000
Outside contractors (testers)	200	20	4,000
2. Hardware resources			
Workstations	5	4,000	20,000
iPads	5	900	4,500
3. Software			
Off-the-shelf software	5	400	2,000
Software developed in-house		75,000	75,000
4. Training			
Seminars for team members	5	3,500	17,500
Seminars for trainees	5	1,200	6,000
Trainee hourly costs	1,300	20	26,000
Total Project Cost Estimate			$419,000

The budget contains estimates for the hours worked and the rates of pay for each of the internal or outsourced workers. It also contains hardware and software costs and spells out how much of each type of equipment is needed. It also explains the costs involved with training.

Managing Risk

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. 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 3.21, you will see why it is called a *fishbone diagram*; it resembles the skeleton of a fish.

When using a fishbone diagram, you systematically list all the problems that can possibly occur. In the case of the agile approach, it is useful to organize a 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 learn from the wisdom gained by people involved in earlier project failures. When asked to reflect on why projects had failed, professional programmers cited management setting impossible or unrealistic dates for completion, 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 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 it. The team members should consider that their reputation and standing in the organization are inseparable from the projects they accept.

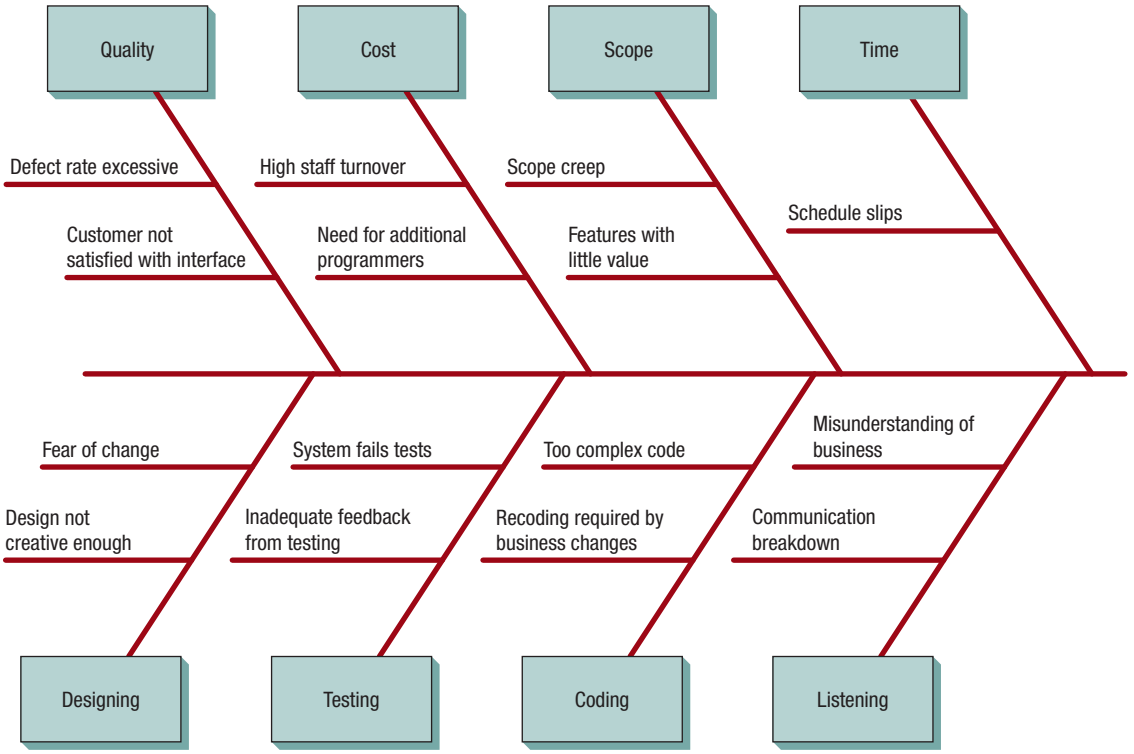


FIGURE 3.21

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

Managing Time Using Expediting

Speeding up a process is called *expediting*, and sometimes you may benefit from completing a project much faster, such as receiving a bonus if you finish sooner. A second example is realizing that valuable project team resources and team members can be used for some other project if you finish the current project before the due date.

Figure 3.22 lists each activity in the project and the original estimated time required to complete each of these activities. The third column, labeled "crash time," refers to the absolute minimum time in which an activity can be completed if additional money is funneled to that activity. The final column contains the cost of reducing the activity duration by one week.

Expediting can help reduce the time it takes to complete an entire project, but the expedited activities have to be on the critical path for expediting to make a time difference. Which activity is expedited on the critical path depends on the cost, assuming that the activity is not already at its crash time.

Activity	Estimated Duration	Crash Time	Cost/Week
A	3	1	$ 800
B	4	2	500
C	4	2	400
D	8	6	1,000
E	5	5	1,000
F	3	3	800
G	3	3	800
H	2	2	400
I	2	1	600

FIGURE 3.22

Estimated duration, crash time, and the cost of expediting project activities.

FIGURE 3.23

Using expediting to minimize project time.

Eligible Activities	Activity Chosen	Time for Each Path (22) 19 19 16	Cost	Cumulative Cost
A, B, D, or I	B	(21) 18 19 16	$ 500	$ 500
A, B, D, or I	B	(20) 17 19 15	500	1,000
A, D, or I	I	(19) 17 18 15	600	1,600
A or D	A	(18) 16 (18) 15	800	2,400
A and C, or D	D	(17) 16 (17) 15	1,000	3,400
A and C, or D	D	(16) (16) (16) 15	1,000	4,400
A and C	A and C	(15) (15) (15) 14	1,200	5,600

The maximum number of weeks each activity can be reduced is the difference between the expected time and its crash time. For example, activity B, administering questionnaires, could be reduced from four weeks to two weeks at a cost of $500 per week, but it cannot be reduced to less than two weeks; activity H, preparing the proposal, cannot be reduced because it is already at its crash time.

The expediting analysis for this example is provided in Figure 3.23. The expediting process takes place one step at a time, until it is impossible to expedite any further. The columns in the table include eligible activities (tasks that are on the critical path and can be reduced by expediting), the activity chosen (because it is the cheapest alternative), the time it currently takes to complete each of the paths, the cost of expediting the chosen activity, and finally the cumulative cost.

In the first step, the critical path is 10–20–30–50–60–70–80, so the eligible activities are A, B, D, and I. Activities G and H are also on the critical path, but they are already at their crash times and are consequently ineligible for expediting. The cheapest alternative is to expedite activity B by one day, which reduces the first path from 22 to 21 weeks and the second from 19 to 18 weeks; the third and fourth paths are not affected by the reduction because activity B is not on either of those paths.

The critical path, and therefore the entire project, is reduced from 22 to 21 weeks (circled on the table). We can repeat this reduction and reduce the project time by another week.

When activity B reaches its crash time, another activity must be chosen. Row 3 in the table shows that activities A, D, and I are eligible, and activity I is the cheapest alternative. Reducing activity I reduces not only the critical path but all paths because it is common to all of them.

In the fourth step, activity A is chosen, reducing paths 1 and 2, but as a result, there are now two critical paths. This implies that any reduction of the project time will take place only if both of the critical paths are reduced at the same time.

We can shorten both paths in the fifth and sixth steps by choosing either a combination of activities A and C (one activity from each of the critical paths) or activity D (an activity common to both critical paths). Reducing activity D by 2 days shortens the paths to 16, 16, 16, and 15 days, respectively, and now there are three critical paths.

Finally, when activity D reaches its crash time, the only available choice is a combination of activities A and C. The minimum project time is therefore 15 weeks, obtainable by reducing activity A by 2 days, activity B by 2 days, activity C by 1 day, activity D by 2 days, and activity I by one day, at a total cost of $5,600.

This example describes all-out expediting to obtain the minimum project time at any cost. But a systems analyst may be faced with a budget. In our example, a budget of $4,000 would result in expediting up to and including step 5. The project would be shortened from 22 to 17 weeks, at a cost of $3,400.

Another possible criterion would be the net amount that could be saved if the project were shortened. Suppose that in the above example the analyst would save $750 per week, mostly consisting of opportunities available for the project team to begin new projects sooner. In this case, expediting would not take place until Step 3 because the incremental cost of Step 4 ($800 for expending activity A) would exceed the $750 saved.

Expediting can make or break a successful project. The systems analyst has to remain on top of the situation by managing the project throughout the entire development process. The analyst needs to make sure project costs are managed properly.

Controlling Costs Using Earned Value Management

Once a systems analyst has an approved budget, it is imperative that the analyst keeps it updated so the project doesn't exceed the budget as it progresses. The baseline needs to be continually revised, and all the stakeholders need to be informed.

Changes often occur in the middle of a project. The client may request new features, or new technologies may be introduced that will change the way the system is developed. No matter what these changes are, the budget needs to be revised.

One tool available to systems analysts is earned value management (EVM). It is a technique used to help determine progress (or setbacks) on a project and involves project cost, the project schedule, and the performance of the project team. Here are the four key measures in EVM:

- *Budget at completion (BAC)* is the total budget for the project, from the beginning until completion. If you are calculating the performance measures for a task, then it is the total budget for the task.
- *Planned value (PV)* is the value of the work that is to be completed on the project (or, alternatively, the work completed on any task). Because the value of the work completed is how much effort and money will be put into it, you can think of PV as the budgeted cost of work scheduled.
- *Actual Cost (AC)* is the total cost (direct and indirect) incurred in completing the work on the project (or, alternatively, a task) up to that particular point in time. Another way of referring to this is actual cost of work performed to date.
- *Earned value (EV)* is an estimate of the value of the work performed thus far. EV refers only to the work that has been completed to date. Earned value is calculated as follows:

$$EV = PV * p$$

where p is the percentage of the work completed thus far.

Figure 3.24 shows the cost of developing a website over a five-month period. In this example, the development of our website is well under way. The budget at completion is the planned budget of $18,000, the total estimated cost of developing the website at the end of five months. It is calculated by summing the cost figures in the estimated cost column.

At the end of the first, second, and third months, the actual cost of the project equals the cumulative estimated cost, but in the fourth month, the actual cost is $17,000 versus the $15,000 from the cumulative estimate column. It is obvious that we are going over our budget.

It appears to be worse. We've only completed 50 percent of Stage 4 at the end of the fourth month. That means we're falling behind in our schedule as the costs are rising.

Let's see what the damage is. We already know that the budget at completion for the project is $18,000 and that the actual cost at the end of the fourth month is $17,000. Let's determine the planned value and the earned value at this time.

The planned value is simply the cumulative estimate at the end of month 4, or $15,000. To calculate the planned value we need to multiply the earned value by the percentage of the project

At the End of	Stage	Estimated Cost	Cumulative Estimate	Estimated Duration	Stage Completed	Actual Cost of Stage to Date	Actual Cost of Project to Date
Month 1	Stage 1	$6,000	$6,000	1 month	100%	$6,000	$6,000
Month 2	Stage 2	3,000	9,000	1 month	100%	3,000	9,000
Month 3	Stage 3	3,000	12,000	1 month	100%	3,000	12,000
Month 4	Stage 4	3,000	15,000	1 month	50%	5,000	17,000
Month 5	Stage 5	3,000	18,000	1 month	0%	Not yet begun	Not yet begun

FIGURE 3.24

The anticipated cost of a website development project over a five-month period.

that is complete. We see in the table that the first three stages are complete, but the fourth stage is only half finished. To date, this means that:

$$p = (100 + 100 + 100 + 50)/(100 + 100 + 100 + 100)$$
$$= .875$$

So the earned value is:

$$\text{EV} = \text{PV} * p$$
$$= \$15{,}000 * .875$$
$$= \$13{,}125$$

The four variables—budget at completion, planned value, actual cost, and earned value—are the core of earned value management. They can be used to calculate a number of performance measures, including cost variance, schedule variance, the cost performance index, and the schedule performance index:

- *Cost variance (CV)* tells us whether the project or task is costing more than we have planned. If cost variance is negative, our costs are greater than planned. If it is positive, it is costing less than planned. Cost variance is simply:

$$\text{CV} = \text{EV} - \text{AC}$$

- *Schedule variance (SV)* tells us whether the project is taking more time than planned. If so, it will have a negative impact on our costs. Once again, if schedule variance is negative, then it is taking longer than planned to perform the work, and the amount is the cost overage. If schedule variance is positive, then it is taking less time than planned, and the amount indicates how much we are under budget. Schedule variance is obtained by subtracting the planned value from the earned value, as follows:

$$\text{SV} = \text{EV} - \text{PV}$$

- *Cost performance index (CPI)* is a ratio that signifies whether a project is over budget. If the index is less than 1.0, the project or task is over budget. If the ratio is greater than 1.0, the project or task is under budget. Cost performance index can be calculated as follows:

$$\text{CPI} = \text{EV} / \text{AC}$$

- *Schedule performance index (SPI)* is a ratio that tells us whether a project is falling behind schedule. If the schedule performance index is less than 1.0, it implies that the project or task is behind schedule. If the schedule performance index ratio is greater than 1.0, the project is ahead of schedule. Schedule performance index can be calculated as follows:

$$\text{SPI} = \text{EV} / \text{PV}$$

In our continuing example of website development, we can now calculate these four performance measures:

Cost variance at the end of the fourth month is:

$$\text{CV} = \text{EV} - \text{AC}$$
$$= \$13{,}125 - \$17{,}000$$
$$= (-\$3{,}875)$$

meaning that we are $3,875 over budget.

Schedule variance is:

$$\text{SV} = \text{EV} - \text{PV}$$
$$= \$13{,}125 - \$15{,}000$$
$$= (-\$1{,}875)$$

implying that we are behind schedule and are over budget.

The cost performance index is:

$$\begin{aligned} CPI &= EV / AC \\ &= \$13{,}125 / \$17{,}000 \\ &= .772 \end{aligned}$$

or 77.2 percent. This means the team is performing at a rate far below the expected rate of performance. This figure will be used later.

The schedule performance index (SPI) is:

$$\begin{aligned} SPI &= EV / PV \\ &= \$13{,}125 / \$15{,}000 \\ &= .875 \end{aligned}$$

or 87.5 percent. Once again, a ratio lower than 1.0 means that the project is behind schedule.

Finally, a systems analyst may want to calculate two key variables: estimate to complete (ETC) and estimate at completion (EAC). They tell the analyst how much it will cost to finish the project or task from this point onward.

Estimate to complete considers how the team has done in the past and estimates how much additional money will be required to complete the project at its current rate of performance. It is calculated by subtracting the earned value from the budget at completion. That result is divided by the cost performance index calculated earlier, as follows:

$$ETC = (BAC - EV) / CPI$$

Estimate at completion represents the revised budget. It is the amount the entire project or task will cost when it is finished. It is calculated by adding the actual cost to the estimated amount of money it will take to complete the project. The equation is:

$$EAC = AC + ETC$$

In our ongoing example of the website development project, the estimate to complete the project is:

$$ETC = (\$18{,}000 - \$13{,}125) / .772 = \$6{,}315$$

This means that we will need to spend $6,315 more than we have up to this point to finish the website. The estimate at completion will be:

$$\begin{aligned} EAC &= \$17{,}000 + \$6{,}315 \\ &= \$23{,}315 \end{aligned}$$

which is significantly more than the $18,000 we originally budgeted for. Figure 3.25 shows how some of these performance measures relate to the original schedule and budget and the revised schedule and budget.

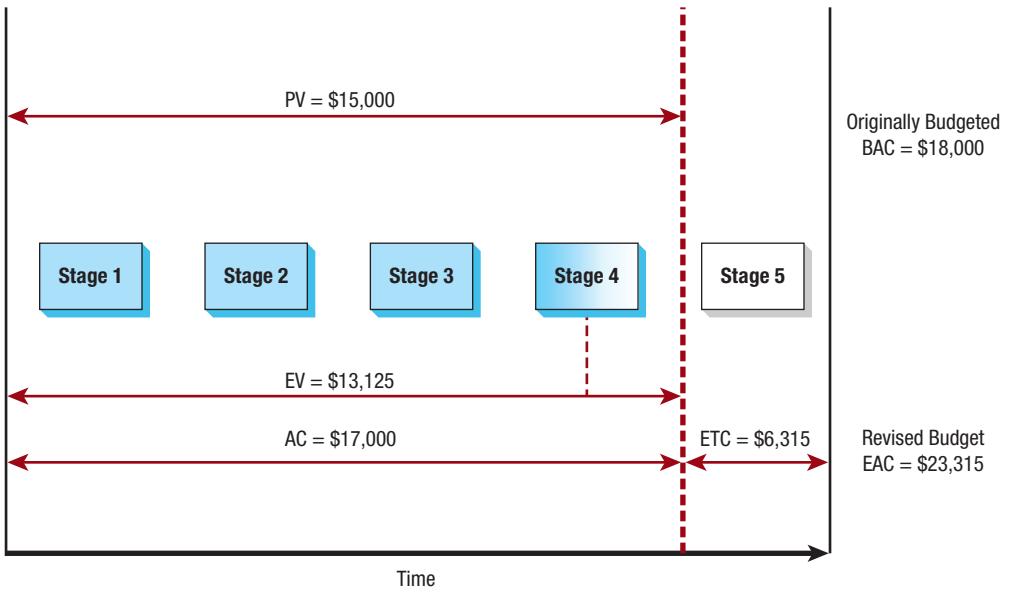


FIGURE 3.25

How the earned value management values relate to the planned and actual development of the website.

It is important for a systems analyst to keep an eye on cost and to address the budgetary implications when unexpected delays or cost overruns occur. An analyst must constantly balance cost, time, and scope (that is, which systems features will be included) when working on any project.

Managing the Project Team

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 competence 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 an opportunity to create a dream team of skilled people to develop a system, who should he or she choose? In general, project managers need to look for others who share their values of teamwork and are 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, competence, and 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 area of the system being developed. When developing an ecommerce site, for example, a team can enlist the help of someone in marketing, and those developing an inventory system can ask a person versed in production and operations to provide expertise.

A team ideally should include at least two systems analysts. They can help each other, check each other's work, and shift their workloads. There is certainly a need to have people with programming skills on board. Coding is important, but people who know how to conduct walkthroughs, reviews, testing, and documenting systems are important as well. Some people are good at seeing the big picture, and others perform well when tasks are broken down into smaller ones for them. Every team should have both types of individuals.

Beyond the basics just described, a project manager should look for people with both experience and enthusiasm. Experience is especially important when trying to estimate the time required for completing a project. Experience in computer 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 a 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. In addition, superior writers and articulate speakers can present proposals and work directly with customers, so hiring such individuals is a good idea.

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 as 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 relationships among team members.

In fact, teams 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

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 organization 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 red 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 page for MRE. Take a look at the corporate website 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 do 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. Mr. 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.

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

For a 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 (that is, the 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 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 puts extreme pressure on new members and does not take 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

As you work with your team members on a variety 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 on methods for estimating time required discussed earlier in this chapter 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 pairs 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.

A team needs to formulate and agree to goals, and these goals should be based on team members' expertise and former performance, as well as on 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, including 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 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 motivate team members by clarifying for them and others what must be done to get results. Goals define the level of achievement that is expected of team members. This use of goals simplifies the working atmosphere, and it electrifies it with the possibility that what is expected can indeed be done.

Managing Ecommerce Projects

Many of the approaches and techniques discussed so far 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 an organization. Therefore, you are not just managing data in a self-contained department or even in one solitary unit. Hence, organization politics may 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 from across the organization and with a variety of skills, including developers, consultants, database experts, and system integrators. Stable project groups that exist within a cohesive information systems (IS) group or systems development team are 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 number of people with the necessary expertise. The potential for organization 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 system 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 of the organization's systems."

A fourth difference between traditional project management and ecommerce project management centers on security concerns. The ecommerce system will be linking with the outside world via the Internet, so 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 a 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. The entire team as well as the client need to be on board. This chapter has elaborated on ways to estimate the delivery date for the completed system and also how to identify organization 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 (that is, 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 and 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 the analysis team, with the organization users requesting the new system.

The Systems Proposal

The project charter serves the purpose of identifying objectives, determining scope, and assigning responsibilities, but an 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 make up a systems proposal.

What to Include in a Systems Proposal

A written systems proposal has 10 main sections. Each section has a particular function, and eventually the proposal should be arranged in the following order:

1. Cover letter
2. Title page of project

CONSULTING OPPORTUNITY 3.5

Goal Tending

"Here'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 the project schedule for the Kitchener Redwings, an Ontario 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.

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 list the problems or suggest opportunities that call forth the alternatives presented in the next section.

In the systems alternatives section of the proposal, present 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. You 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 appendices are the last part of the systems proposal, and they can include any information that you feel 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.

You can propose a special meeting of key decision makers regarding the systems project for the purpose of delivering the results of the systems proposal. Develop a separate oral presentation (illustrated with PowerPoint slides or some other presentation software such as Keynote) that features highlights of your written report. Keep your presentation brief, 30 to 40 minutes maximum, with the majority of time devoted to questions. Never read your report aloud. It is preferable to prepare and deliver a dynamic slide presentation that takes advantage of the fact that you can interact with key decision makers face to face.

Using Figures for Effective Communication

The emphasis so far in this section has been on considering your audience when composing a systems proposal. Tables and graphs as well as words are important in capturing and communicating the basics of the proposed system. Never underestimate good design.

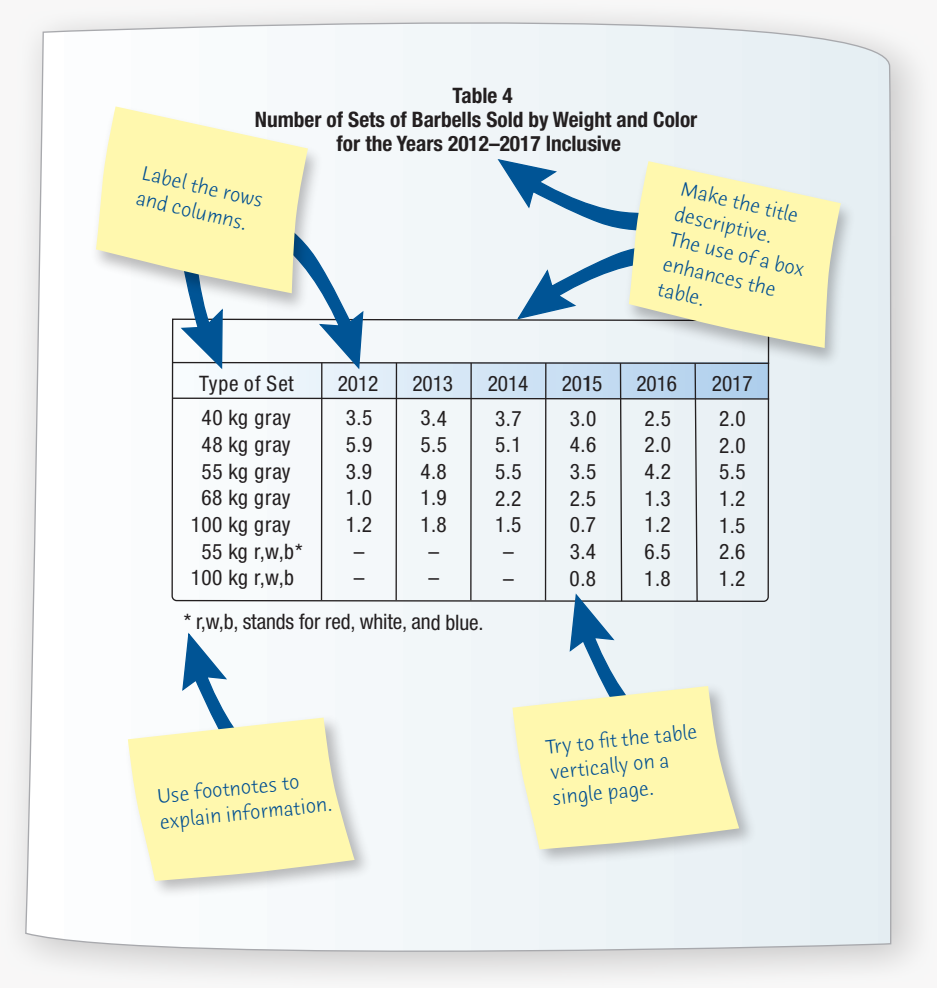
Integrating figures into your proposal helps demonstrate that you are responsive to the different ways people absorb information. Figures in the report supplement written information and must always be interpreted in words; they should never stand alone.

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

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

FIGURE 3.26

Guidelines for creating effective tables.



the proposal and should be meaningfully titled. Figure 3.26 shows the appropriate layout and labeling for a table.

The following are some guidelines for tables:

1. Integrate tables into the body of the proposal. Don't relegate them to the appendices.
2. Try to fit an entire table vertically on a single page, if possible.
3. Number and title a 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 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 such 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, including line graphs, column graphs, bar charts, pie charts, and area charts. Line graphs, column graphs, and bar charts compare variables, whereas pie charts and area charts illustrate the percentage composition of an entity.

The following guidelines will help you include effective graphs in a proposal (see Figure 3.27):

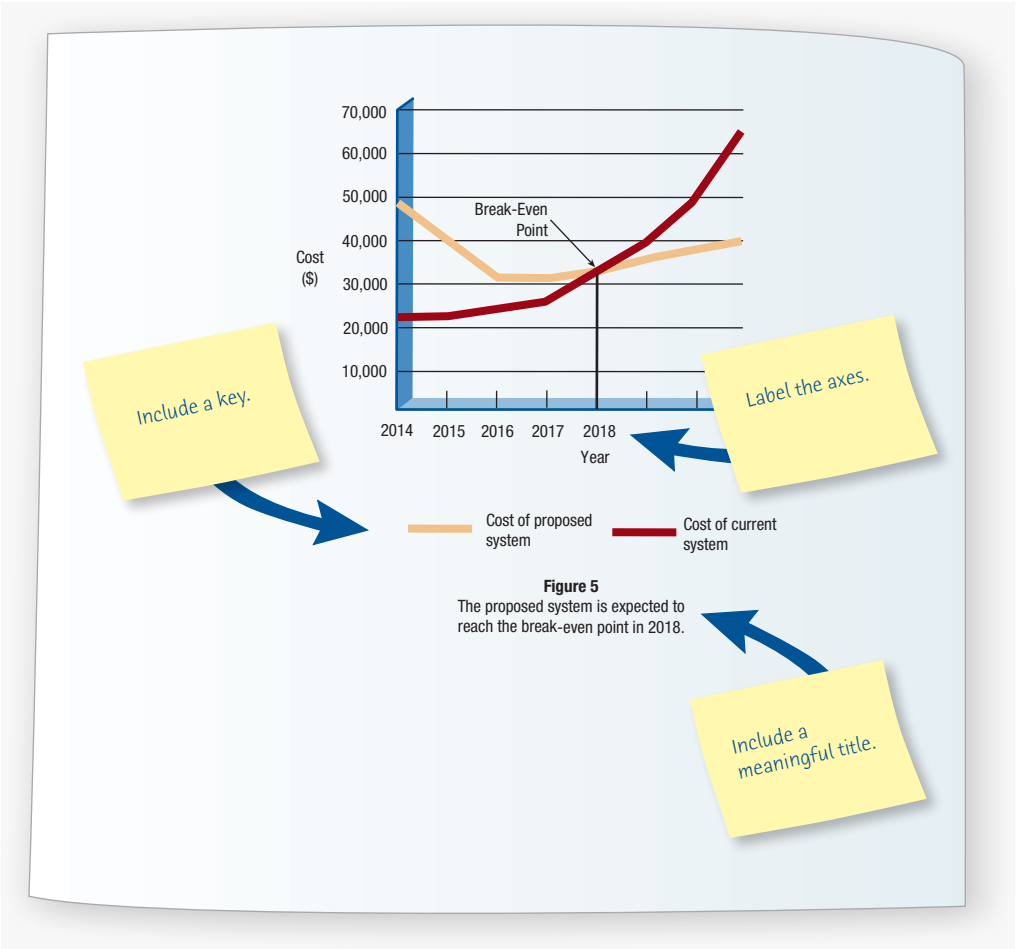


FIGURE 3.27

Guidelines for developing effective line graphs.

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 through interviews, questionnaires, sampling, discovery of other hard data, and observation. These topics are discussed in the next two chapters.

HYPERCASE EXPERIENCE 3.2

"Sometimes 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. Mr. Evans 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 Department, describing all the systems you find. *Hint:* Create an inventory form to simplify your task.
2. Using the software evaluation guidelines given in the chapter, do a brief evaluation of GEMS, a software package used by the Training and Management Systems Department employees. In a paragraph, briefly critique this custom software by comparing it with COTS 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 Mr. Evans is considering for the proposed project tracking and reporting system.
5. What organizational and political factors should Mr. Evans 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, click on the small red directory if you want to visit an MRE employee.

Summary

The five major project management fundamentals a systems analyst must handle are (1) project initiation—defining a 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, an 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, a systems analyst gathers data to enable management to decide whether to proceed with a full systems study. By inventorying equipment already on hand and on order, systems analysts can better determine whether new, modified, or current computer hardware is to be recommended.

There are advantages and disadvantages to purchasing computer hardware. Alternatively the analyst may help the organization weigh the advantages and disadvantages of renting time and space through use of a cloud service provider. Three main categories of cloud computing are Software as a Service (SaaS), Infrastructure as a Service (IaaS), and Platform as a Service (PaaS). As user sophistication grows, some companies are adopting bring your own device (BYOD) approaches to boost morale of employees and lower the initial cost to the organization of purchasing mobile devices. Security risks from untrained users are likely the biggest threat to organizations adopting a "bring your own device" policy.

Cloud services and other hardware 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 a SaaS provider.

Preparing a systems proposal means identifying all the costs and benefits of a number of alternatives. A 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 (quantifiable) or intangible (nonquantifiable and resistant to direct comparison). A systems analyst can use many methods for analyzing costs and benefits, including break-even analysis and the payback method.

Project planning includes the estimation of time required for each of the analyst's activities, scheduling the activities, and expediting them if necessary to ensure that a project is completed on time.

To complete projects on time, within budget, and with the features that are promised, a project needs to be broken down into smaller tasks or activities. These tasks together make up a work breakdown structure (WBS), usually through decomposition. There are different types of work breakdwon structures; they can be product oriented or process oriented. A process-oriented WBS is typical in systems analysis and design.

One technique available to a systems analyst for scheduling tasks is a Gantt chart, which displays activities as bars on a graph. Another technique, called Program Evaluation and Review Technique (PERT), displays activities as arrows on a network. PERT charts are also called network diagrams. PERT helps an analyst determine the critical path and slack time, which is the information required for effective project control. Both Gantt charts and PERT charts can be developed with Microsoft Project.

Earned value management (EVM) is a technique used to help the analyst determine progress (or setbacks) on a project and involves project cost, the project schedule, and the performance of the project team. The four key measures in EVM are budget at completion (BAC), planned value (PV), actual cost (AC), and earned value (EV). These four measures or variables are the core of EVM. They can be used to calculate a number of performance measures, including cost variance (CV), schedule variance (SV), the cost performance index (CPI), and the schedule performance index (SPI).

Creating a project charter that contains user expectations and analyst deliverables is recommended. Reasons computer programmers cited for projects that had failed included 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. Project failures can usually be avoided by examining the motivations for requested projects and understanding a team's motives for recommending or avoiding a particular project.

A systems analyst must follow these steps when putting together an effective systems proposal: Effectively organize the proposal content and write and deliver the proposal in an appropriate business style. To be effective, a 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. Face-to-face meetings with key decision makers provide an opportunity to orally present the systems proposal in a brief and compelling way.

Keywords and Phrases

actual cost (AC)
benchmarking
break-even analysis
bring your own device (BYOD)
bring your own technology (BYOT)
budget
budget at completion (BAC)
cloud computing
cost performance index (CPI)
cost variance (CV)
critical path
earned value (EV)
earned value management (EVM)
ecommerce project management
economic feasibility
estimate at completion (EAC)
estimate to complete (ETC)
expediting
forecasting
function point analysis
Gantt chart
Infrastructure as a Service (IaaS)
Hardware as a Service (HaaS)
intangible benefits
intangible costs
moving average
operational feasibility
payback
planned value (PV)
Program Evaluation and Review Technique (PERT)
problem definition
productivity goals
project charter
Platform as a Service (PaaS)
schedule performance index (SPI)
schedule variance (SV)
socioemotional leader
Software as a Service (SaaS)
systems proposal
tangible benefits
tangible costs
task leader
team motivation
team norms
team process
technical feasibility
vendor support
work breakdown structure (WBS)

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 two main options do organizations have for acquiring or using computer hardware?
9. What does COTS stand for?
10. Compare the advantages and disadvantages of purchasing computer resources versus using cloud services.
11. List the criteria used by organizations as guidelines for vendor selection.
12. What does bring your own device (BYOD) mean for systems analysts?
13. What are the benefits of BYOD to an organization?
14. What are the benefits of BYOD to an employee?
15. What is the biggest drawback of BYOD for an organization?
16. How can cloud computing decisions be addressed at a strategic level?
17. Define *tangible costs* and *tangible benefits*. Give an example of each one.
18. Define *intangible costs* and *intangible benefits*. Give an example of each one.
19. List the different forecasting models available to a systems analyst and the conditions for choosing them.
20. When is calculating the payback period useful?
21. What are the three drawbacks of using the payback method?
22. What is work breakdown structure (WBS), and when should it be used?
23. What is a Gantt chart?
24. When is a PERT diagram useful for systems projects?
25. List three advantages of using a PERT diagram over a Gantt chart for scheduling systems projects.
26. Define the term *critical path*.
27. Which form of analysis would you use to "sell" a systems project to a manager who is only interested in how many widgets need to be sold before the project becomes profitable? Why?
28. What costs need to be estimated to prepare a budget?
29. Why is preparing a budget so important for a systems analyst who is managing a project?
30. List the approaches to estimating the time required for the completion of a task.

31. What does crash time mean when expediting a project?
32. What is earned value management (EVM)?
33. What are the four key measures in earned value management?
34. How is earned value management used to compare actual and planned project development?
35. List the two types of team leaders.
36. What is meant by a dysfunctional team norm?
37. What is meant by team process?
38. What are three reasons that goal setting seems to motivate systems analysis team members?
39. What are four ways in which ecommerce project management differs from traditional project management?
40. What elements are contained in a project charter?
41. For what purpose is a fishbone diagram used?
42. What are the three steps a systems analyst must follow to put together an effective systems proposal?
43. List the 10 main sections of a 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, and any emailed order forms received through the website are answered via email by clerical personnel, with orders being forwarded to the appropriate department.

   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 arrive 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 for 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 online but only has a basic website with information about the company and an order form that can be downloaded, printed, filled out by the customer, and returned via email. 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, Internet-based network 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, and 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 have been working for two weeks with Williwonk's on some minor modifications for its inventory information system when you overhear 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 Williwonk's management people better, you have approached them 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, or a cloud service provider. The criteria are listed here, but not 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 to purchase from.
      c. Using its initial input, help Delicato, Inc. draw up a more suitable list of criteria for selecting cloud vendors who could provide HaaS and SaaS.
      d. In a paragraph, state how the list of attributes for selecting a computer hardware vendor to purchase from should differ from the list of attributes for selecting a cloud provider for HaaS.
      e. In a paragraph, state how the list of attributes for selecting a computer software vendor to purchase applications from should differ from the list of attributes for selecting a cloud provider for SaaS.
7. Pinacle, a mobile application development firm, is planning to develop a mobile application to search for cricket coaches. The application will help parents and students identify coaches available in the vicinity, check their profiles, coaching experience, fees, and timings. They can then book an appointment with the shortlisted coaches and choose the one who suits them best. The application is being designed for a single city but will be expanded to state-wide coverage.
   a. Identify the company's likely hardware and software requirements for developing the mobile application.
   b. Which hardware and software approach would you recommend from the alternatives listed in the text and why?
8. The following is 12 years' data for the annual debt of a firm.

Year	Debt
2001	846,000
2002	1,720,000
2003	2,285,000
2004	96,000
2005	93,000
2006	2,247,203
2007	1,268,386
2008	1,631,809
2009	995,204
2010	646,000
2011	1,873,678
2012	1,470,000

   a. Graph the debt data for the firm.
   b. Determine the linear trend for the firm using a three-year moving average.
9. Which trend is the best fit for the firm's debt data in Problem 8? Explain.
10. Interglobal Health Consultants has asked for your help in comparing its present computer system with a new one its board of directors would like to see implemented. The proposed system costs and present system costs are as follows:

Item	Proposed System Costs	Present System Costs
Year 1		
Equipment lease	$20,000	$11,500
Salaries	30,000	50,000
Overhead	4,000	3,000
Development	30,000	—
Year 2		
Equipment lease	$20,000	$10,500
Salaries	33,000	55,000
Overhead	4,400	3,300
Development	12,000	—
Year 3		
Equipment lease	$20,000	$10,500
Salaries	36,000	60,000
Overhead	4,900	3,600
Development	—	—
Year 4		
Equipment lease	$20,000	$10,500
Salaries	39,000	66,000
Overhead	5,500	4,000
Development	—	—

Graph the costs of the proposed and present systems and show the break-even point.

11. The following are system benefits for Interglobal Health Consultants (from Problem 10):

Year	Benefits
1	$55,000
2	75,000
3	80,000
4	85,000

Use the costs of Interglobal Global Health Consultants proposed system from Problem 10 to determine the payback period. (Use the payback method.)

12. Brian F. O'Byrne ("F," he says, stands for "frozen") owns a frozen foods 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 of using a Gantt chart? Explain in a paragraph.

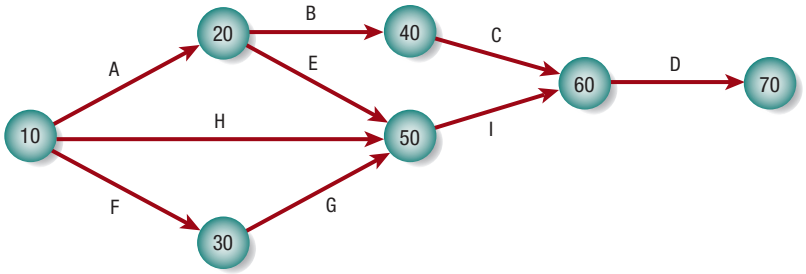
Description	Task	Must Follow	Time (Weeks)
Draw data flow	A	None	5
Draw decision tree	B	A	4
Revise tree	C	B	10
Write up project	D	C, I	4
Organize data dictionary	E	A	7
Do output prototype	F	None	2
Revise output design	G	F	9
Write use cases	H	None	10
Design database	I	H, E, and G	8

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 for Brian's frozen foods company.



13. In addition to using a Gantt chart, you've drawn a PERT diagram for Brian so that you can communicate the necessity of keeping 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.
14. 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?
15. Using the PERT diagram in Figure 3.EX2 to determine answers:
    a. What activities can you expedite to complete the project a week ahead of schedule?
    b. Suppose activity E is the least costly activity to expedite. What happens if you try to expedite the project by more than one week? Explain.
16. You can help Cherry finish her project faster by expediting. Here are the costs.

Activity	Estimated Duration	Crash Time	Cost per Week
A	6	3	600
B	3	2	100
C	2	2	400
D	3	2	400
E	4	2	200
F	2	2	200
G	5	3	300
H	3	2	400
I	2	2	300

If Cherry can keep her expediting expenses to $325 per week, she would benefit from expediting because she can start a new project earlier than planned. If she goes over the $325 per week limit, it would not be worthwhile.

a. Which three activities cannot be expedited at all because they are at their crash times already?
b. Which two activities cannot be expedited because their expediting cost exceeds the daily limit?
c. Which two activities are unlikely candidates for expediting because they are not on the critical path?
d. Set up a table and show step by step which activities should be expedited to shorten the project time. What is the minimum time the project will take if Cherry expedites the project as much as she can and stays within her limits?
e. Why is Cherry's limit exceeded if you try to shorten the project by one week more?

FIGURE 3.EX3

Tasks to be performed during systems development of an order fulfillment system.

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

17. Robyn Cucurullo is developing a social networking app for tablet computers. She has:

Week or Stage	Estimated Cost of Stage	Stage Completed	Actual Cost of Stage to Date
Week 1	$500	100%	500
Week 2	400	100%	500
Week 3	600	100%	700
Week 4	500	50%	50
Week 5	400	0	Not yet begun

   a. Create a table similar to the one in Figure 3.24.
   b. Calculate the budget at completion (BAC), planned value (PV), actual cost (AC), and earned value (EV) at Week 3.
   c. For Week 3, calculate the performance measures of cost variance (CV), schedule variance (SV), the cost performance index (CPI), and the schedule performance index (SPI).
   d. What can you tell about the *budget* in Week 3 by using these performance measures?
   e. What can you tell about the *schedule* in Week 3 by using these performance measures?
   f. For Week 3, calculate the estimated time to complete (ETC) and estimate at completion (EAC).
18. Using the data in the table from the previous problem:
   a. Create a table similar to the one in Figure 3.24 if you haven't done so already.
   b. Calculate the budget at completion (BAC), planned value (PV), actual cost (AC), and earned value (EV) at Week 4.
   c. For Week 4, calculate the performance measures of cost variance (CV), schedule variance (SV), the cost performance index (CPI), and the schedule performance index (SPI).
   d. What can you say about the *budget* in Week 4 by using these performance measures?
   e. What can you say about the *schedule* in Week 4 by using these performance measures?
   f. For Week 4, calculate the estimated time to complete (ETC) and estimate at completion (EAC).
19. Angus McIndoe wants to modernize his popular restaurant by adapting it more closely to the preferences of his repeat customers. This would involve 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 Angus because he believes this information will help him 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 has to say about his customers. He can certainly keep track of additional preferences. Develop a problem definition for Angus similar to the one developed for Catherine's Catering in this chapter.
20. Recently, two analysts just out of college have joined your systems analysis 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.

   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 upon?
21. "I think it's only fair to write up *all* the alternatives you've considered," says Lou Cite, a personnel supervisor for DayGlow 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, cloud-based backups: SOS Online Backup, Spare Backup, MozyPro, and KineticD. With your group, research the cost of these or other services, and 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 service or find some other way? Write two paragraphs defending your group's analysis and recommendations.
2. Explore four or five Voice over IP (VoIP) providers with your group.
   a. 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.
   b. Make a list of attributes, such as free in-network calls, international calling, virtual telephone numbers, teleconferencing, support for caller ID, and so on.
   c. Write a paragraph with your group to explain how a person would use all the quantitative and qualitative information to make an informed decision about which VoIP provider to select. Are any other variables important? What type of software could be used to help compare these services?
3. With your group, choose one VoIP provider you would recommend to a client based on the analysis in Group Project 2, Parts a and b.
4. With your group members, explore project management software such as Microsoft Project.
   a. What features are available? Work with your group to list them.
   b. 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 the team, specifically: evaluate its capacity to coordinate activities, time, and resources. Also state which particular features support these aspects of any systems project. Also note whether the software falls short of these criteria in any regard.
5. A hospital is facing a number of issues in supply chain management (SCM), including overstocking, demand–supply gap, and transparency problems. In a group, brainstorm other possible issues that the hospital might be facing in SCM.
   a. Prepare a list of the problems identified and categorize them appropriately.
   b. Using your assumptions, draw a fishbone diagram to depict the identified problems.

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4

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 using interactive methods for information gathering.
2. Construct interview questions to elicit human information requirements and structure them in a way that is meaningful to users.
3. Understand the purpose of listening to user stories and why they are useful in systems analysis.
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.

You can use three key interactive methods to elicit human information requirements from organization members. These three methods are interviewing and eliciting stories, joint application design (JAD), and surveying people through questionnaires. Although different in their implementation, these methods also have a great deal in common. The basis of their shared properties is talking with and listening to people who can tell stories about their interactions with technology.

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 such as sampling, investigation, and observing a decision maker's behavior and physical environment do not require the same degree of interactivity between analysts and users. These methods are 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, 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.

Thoroughly think through an interview 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 opportunity to explore key human–computer interaction (HCI) concerns, including the ergonomic aspects, 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. Later in the chapter, we discuss joint application design (JAD) (pronounced "jad," 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.

READING BACKGROUND MATERIAL It's important to read and understand as much background information about the interviewees and their organization as possible. This material often can be obtained on the corporate website, 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 information from Standard & Poor's.

FIGURE 4.1

Steps a systems analyst follows in planning an interview.

Steps in Planning the Interview
1. Read background material.
2. Establish interviewing objectives.
3. Decide whom to interview.
4. Prepare the interviewee.
5. Decide on question types and structure.

As you read through this material, be particularly sensitive to the language organization 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 optimize the time you spend in interviews; without such preparation, you may waste time asking general background questions.

ESTABLISHING 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 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.

DECIDING 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 a balance that addresses as many users' needs as possible. Your organization contact will also have some ideas about who should be interviewed.

PREPARING 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 the 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) interviews should typically be conducted in person and not via email. Interviews should be kept to 45 minutes or an hour at 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.

DECIDING 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

You will use three main question types when you construct your interview: open-ended questions, closed questions, and probes. Each question type is useful in different situations and at specific times during the interview. In addition, each type of question elicits different information from the person you are interviewing.

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." and "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

FIGURE 4.2

Open-ended interview questions allow the respondent open options for responding. These examples were selected from different interviews and are not shown in any particular order.

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 website, 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?

3. Providing richness of detail
4. Revealing avenues of further questioning that otherwise may go untapped
5. Making the interview more interesting for the interviewee
6. Allowing more spontaneity
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 responses 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 get credit for correctly answering the question.

A special kind of closed question is the bipolar question. This type of question limits the interviewee even further by allowing only a choice on either pole, such as yes or no, true or false, or 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

FIGURE 4.3

Closed interview questions limit the respondent's options. These examples were selected from different interviews and are not shown in any particular order.

Closed Interview Questions

- How many times a week is the project repository updated?
- On average, how many calls does the call center receive monthly?
- Which of the following sources of information is most valuable to you?
  - Completed customer complaint forms
  - Email complaints from consumers who visit the website
  - Face-to-face interaction with customers
  - Returned merchandise
- List your top two priorities for improving the technology infrastructure.
- Who receives this input?

Bipolar Interview Questions

- Do you use the Web to provide information to vendors?
- Do you agree or disagree that ecommerce on the Web lacks security?
- Do you want to receive a printout of your account status every month?
- Does your website maintain a FAQ page for employees with payroll questions?
- Is this form complete?

FIGURE 4.4

Bipolar interview questions are a special kind of closed question. These examples were selected from different interviews and are not shown in any particular order.

3. Getting to the point
4. Keeping control over the interview
5. Covering lots of ground quickly
6. Getting to relevant data

The drawbacks of using closed questions are substantial, however. They include the following:

1. Boring for the interviewee
2. Failing to obtain rich detail (because the interviewer supplies the frame of reference for the interviewee)
3. Failing to address the main ideas for the preceding reason
4. Failing to build rapport between interviewer and interviewee

Thus, as an 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 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 "Please provide an example of a time you did not find the system trustworthy." and "Please elaborate on that for me." Some examples of probing questions can be found in Figure 4.6. The purpose of a 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.

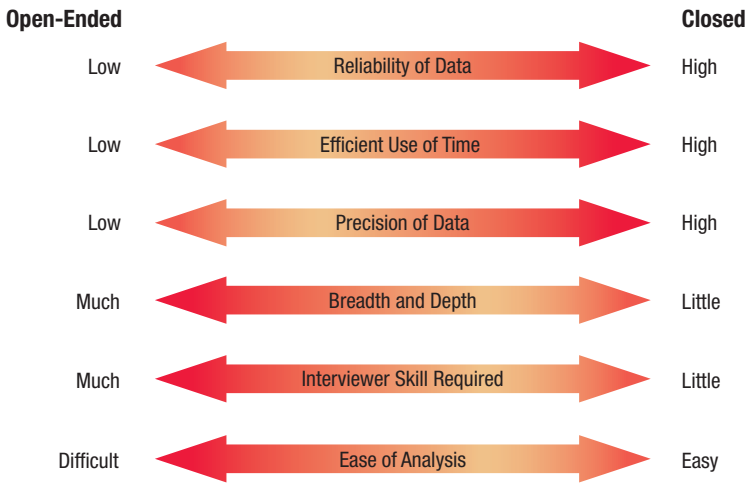


FIGURE 4.5

Attributes of open-ended and closed questions.

CONSULTING OPPORTUNITY 4.1

Strengthening Your Question Types

Strongbodies, 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 by developing a dashboard. 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 problems 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.

You should use a pyramid structure 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 determination about the topic. Such is the case in the final question in Figure 4.7, "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 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 pyramid and funnel 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.

FIGURE 4.6

Probes allow a systems analyst to follow up on questions to get more detailed responses. These examples were selected from different interviews and are not shown in any particular order.

Probes
• Why? • Give an example of how ecommerce has been integrated into your business processes. • Please give an illustration of the security problems you are experiencing with your online bill payment system. • You mentioned both an intranet and an extranet solution. Please give an example of how you think each differs. • What makes you feel that way? • Tell me step by step what happens after a customer clicks the "Submit" button on the Web registration form.

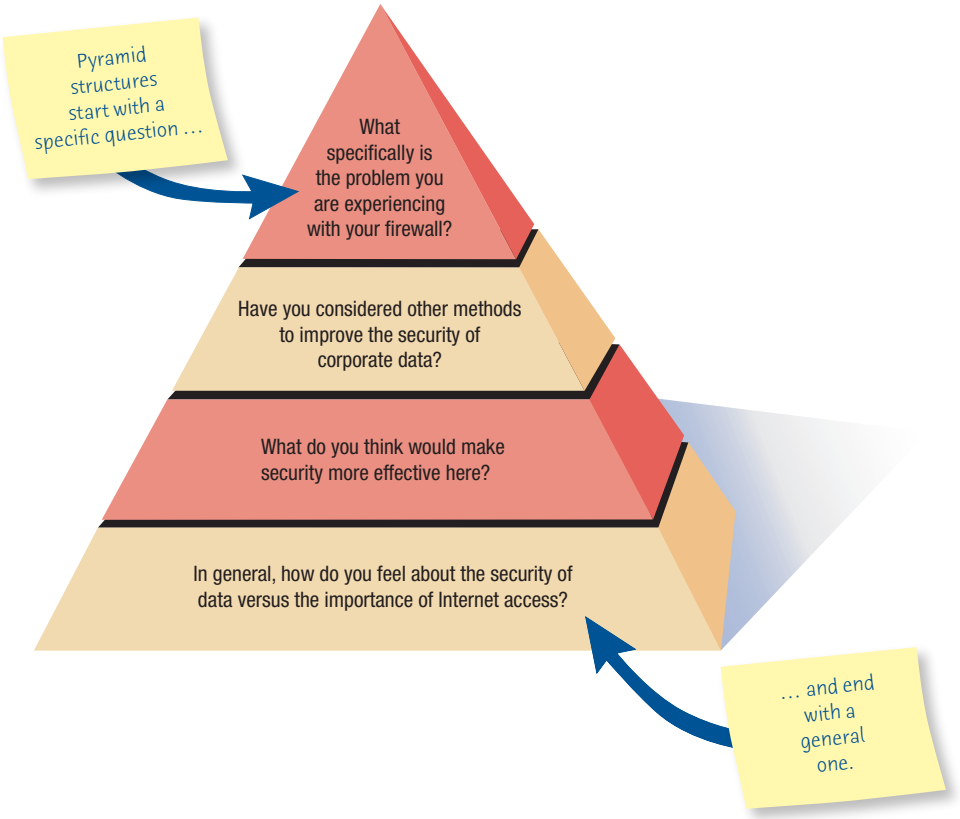


FIGURE 4.7

The pyramid structure for interviewing goes from specific to general questions.

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

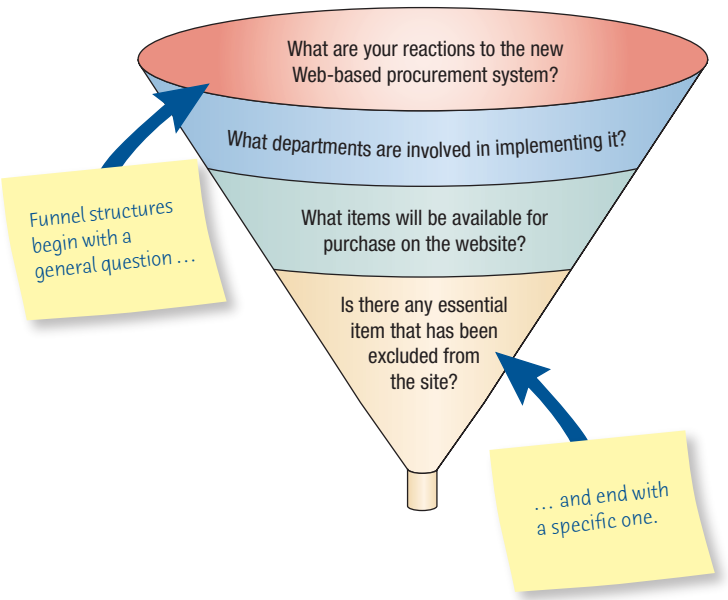
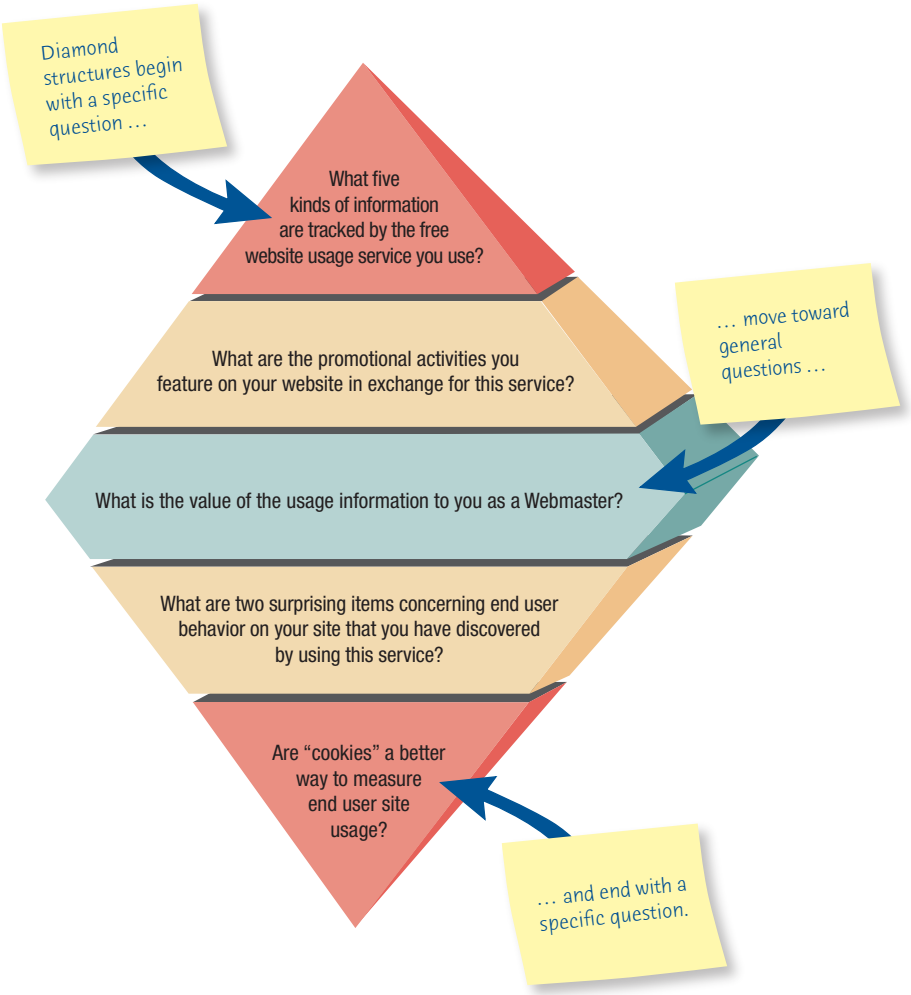


FIGURE 4.8

The funnel structure for interviewing begins with broad questions and then funnels to specific questions.

FIGURE 4.9

The diamond-shaped structure for interviewing combines the pyramid and funnel structures.



in the other times, when this question opens the proverbial floodgates and much new data are presented.

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.

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.

Listening to Stories

Stories originate in the workplace, and many are shared with, and repeated by, coworkers. Organizational stories, like myths and fables, are used to relay some kind of information. This shared information is usually considered important enough to build an entire story around it, and when a

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 sales managers at SureCheck are all interested in processing their own data and producing their own reports on quantities and kinds of dairy products sold so that they 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 via the Web to corporate headquarters, 600 miles away, and even the production of online reports 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.

story is told and retold, even handed down over time, the story takes on a mythic quality. Isolated stories are welcome when you are looking for facts, and enduring stories capture all aspects of the organization. Enduring stories are the ones a systems analyst should be seeking.

Although structured interviews have many advantages, including the ability to ask many people the same set of questions, they may not produce the rich detail you need to design your system.

Suppose the developer is faced with the task of analyzing and redesigning a system. The developer can learn from experiences the organization encountered in their previous design project. It would be helpful to identify people who had lived through that experience. They may have valuable insights that will help the developer with the new project.

It is difficult for the developer to generate a list of interview questions because the problems encountered, the obstacles cleared, and the learning that took place are unknown to the developer. By encouraging stories, however, these experiences may be brought out, maybe not at first, but as the story is being told. Patience is a key value of the listener.

The developer may be able to understand the behavior and the values of organization members by listening. By listening carefully to organization members, the developer can get a much better understanding of the strategic objectives, potential obstacles, decisions, and lessons learned.

It might be apparent that listening to stories is not efficient. It takes considerably more time than asking interview questions. However, listening to stories may be more rewarding. Stories are more easily remembered than interview responses, so in some ways that makes up for the fact that it takes time to listen.

Stories Are Made Up of Elements

Storytellers often make themselves the hero of the story. This is not unusual and it is not a drawback. When storytellers put themselves into the center of the story, the struggles they encounter are their own battles. They become real to the listener who can empathize with the storytellers.

An example of a story is shown in Figure 4.10. All stories have these elements:

1. The call to adventure
2. The quest
3. The struggle
4. The transformation
5. The resolution
6. The moral
7. The epilogue

FIGURE 4.10

Story elements and corresponding examples. Quotation from "Open source software opens door to Web design career" by Mark Thomas (2016).

Story element	Example from "Open source software opens door to Web design career" by Mark Thomas (2016)
The call to adventure	"I was fascinated and envious—I wanted to be able to create those exciting images with their grungy textures, characters lifted from games, dramatic lighting, and emphatic quotes. Other people didn't seem to find it difficult to finish them, but I had no idea where to even start."
The quest	"I was going to have to learn this discipline properly. Such things are not achieved overnight, of course, and so began a long quest to find, practice, and learn from every design resource I could find."
The struggle	"Researching the topic, I realized that I had used the wrong tool for the job. Exasperated and in no small way desperate, I began looking for a package I could turn to rescue the situation. Time was pressing and, even if I could find an answer in time, as the now self-proclaimed designer in the team I would have to learn it double-quick."
The transformation	"Taking stock for a moment, I began to wonder if it was possible to begin a business operation based on the open source software I was now developing in confidence and ability with. It became an ambition."
The resolution	"In 2009, I designed and built a website for the bakery that went on to supply our wedding cake, saving us money and introducing new customers to their business, too. In 2010, I created all the artwork for our wedding stationery. Later the same year, I registered my UK company and began providing Web design services to local companies who needed designs for their websites, which I then started to code."
The moral	"To me, open source software means opportunity. It means education, freedom, commitment, collaboration and challenges. I went from knowing nothing whatsoever about design and coding to starting my own Web design business and capturing local clients who were happy with the things I've made for them and unconcerned by the tools I'd used to do it."
The epilogue	"And even though my day job prevents me from publishing anywhere near the number of blog articles I want to (for which I apologize to my readers—you are not forgotten), it still manages nearly 3,000 visitors a month, and I regularly receive requests for tutorials from around the world, which I will get around to at some point."

A typical story starts with a reason an opportunity was noticed or a problem needed addressing. This is the call to adventure, and there is never a simple solution. No one tells a story such as "It was drafty last night, so I got up and shut the window." That is a statement not a story. Stories have twist and turns, advances and setbacks, learning and decision making.

The quest in a story implies that there is something worth finding or achieving. In explaining the quest, the storyteller enumerates the organization's objectives. It is worthwhile to undergo hardship if there is a worthwhile goal.

Next comes the struggle. Listen to hear who the storyteller names as villains. Is it government regulation, external competition, or other members of the organization? It helps to understand what obstacles may exist now.

If a solution existed, the problem would be solved and the story would end here, but simply pushing a metaphorical boulder out of the way does not typically solve problems. Usually, something within the organization, or even the hero, has to change. Problems are solved by process or behavior changes rather than by product changes, and this is revealed in this part of the story. Storytellers also reveal their own weaknesses. In this revelatory approach, the storyteller describes overcoming this weakness, even undergoing a phenomenal transformation. Once the hero undergoes the transformation, it becomes possible to solve the problem.

The resolution comes when the storyteller tells whether or not the quest succeeded. It is possible that the storyteller may be telling you how a technology adoption failed, but you are more likely to hear a positive story.

Usually a moral is important to the story. The reason for the moral is to tell others how to behave and, furthermore, what values they should possess. It is a statement of the lessons learned.

Finally, the story may end with an epilogue. A happy resolution when the problem was first solved may be changed with the passage of time. Competition, customer preferences, improved hardware, and social, environmental, or legal issues that have occurred since the successful implementation may be creating new obstacles for the organization. Perhaps that is why the developer has been called in to change the system again.

Reasons for Telling Stories

The rich information an analyst gets from listening carefully to the stories is in itself valuable, but the analyst shouldn't stop there. The information gleaned from the stories will make more sense and be more valuable if seen in context. Why did the storyteller tell this story? In childhood, we are told stories and fables so that we adopt good values. For example, the fables about "The Grasshopper and the Ant" or "The Hare and the Tortoise" are commonly told in English-speaking cultures. The former teaches us the importance of good work habits and the latter emphasizes what happens if we are overconfident. Do business stories have the same purpose?

Business stories are a little more complex. We can break down stories into four important main types:

1. Experiential stories
2. Explanatory stories
3. Validating stories
4. Prescriptive stories

Experiential stories describe what life is like in the organization. Explanatory stories go a little further, suggesting that there is an explanation for behavior or a reason for the decisions made within the organization. Validating stories are used to convince people that the organization made the correct decision, or they are used to express and maintain the existing values of the organization. Prescriptive stories are the organizational equivalent of childhood fables. These stories suggest how everyone in the organization *should* behave. It is helpful for the developer to know why a storyteller is telling his or her story.

Systems analysts can use storytelling as a complement to other information-gathering methods such as interviewing, JAD, and surveys. You need to engage organization participants by reacting to stories, matching one story to another by recounting it to other participants, and even collaborating with the participant to reframe and understand organization stories. It is a good way to deeply understand some of the problems associated with information systems use, systems development, systems adoption, and designing for your intended audience.

We have observed that many of the stories systems analysts have reported on in the past have been mere fragments of stories. The intent or purpose of the story is not understood, and therefore the analyst is not able to fully understand the importance of the story. The systems analyst needs to listen to the story as a whole to truly understand its content and purpose.

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. IBM developed an alternative approach to interviewing users one by one, called joint application design (JAD). The motivations for using JAD are to cut the time (and hence the cost) required for 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 systems development life cycle (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 be learned only 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 organization 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. Organization 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 contribute different 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 information systems (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, of any rank, can be chosen 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 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.

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 projectors to connect to two laptops, iPads, or PCs; a whiteboard; a flip chart; and easy access to a copier. Group decision support rooms 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 every participant receives an agenda before the meeting, and consider 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.

HYPERCASE EXPERIENCE 4.1

"Well, I did warn you that things aren'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 Mr. Evans interview. In particular, what did you learn by following up on the questions you asked Mr. Evans?

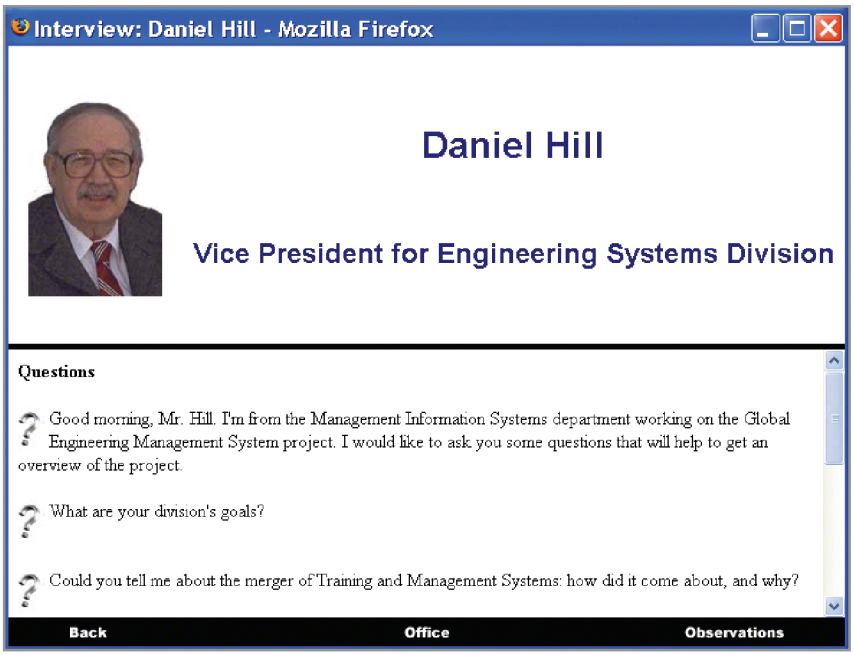


FIGURE 4.HC1

Pointing to a question in HyperCase will reveal an answer.

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 be asked and answered as well. Clearly, ad hoc interactive systems such as recommender 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, also should 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 JAD. The first potential benefit is timesavings over traditional one-on-one interviews. Some organizations have estimated that JAD sessions have provided a 15 percent timesavings over the traditional approach.

Hand in hand with timesavings 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. Analysts are always striving to involve users in meaningful ways and to encourage users to take early ownership of the systems being designed. 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 evolve through facilitated interactions rather than in relative isolation.

Potential Drawbacks of Using JAD

There are three drawbacks or pitfalls that you should 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 organization 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 organization 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 package. 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.

CONSULTING OPPORTUNITY 4.3

A Systems Analyst, I Presume?

"Know what I think of the work the last systems analyst team did? The proliferation of PDF reports created a jungle on my desktop. 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 drill-down capabilities that I have had to create for myself. I delete everything that's irrelevant. Sometimes I rip out the excess vegetation until I see the numbers I need on my screen," says Henry Stanley, accounting supervisor for Zenith Glass Company. As you interview him, he points unhappily to an untidy stack of old printouts sprouting beside his desk. "Those were output from the work of a systems team who worked here a dozen years ago. I still keep them because you never know when you'll need them as a guide. It's definitely survival of the fittest around here."

Identify the overriding metaphor Henry is using to describe the reports 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 by writing six interview questions based on his metaphor.

Planning for the Use of Questionnaires

At first glance, using 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, conducting 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 (as in 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 an 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.)

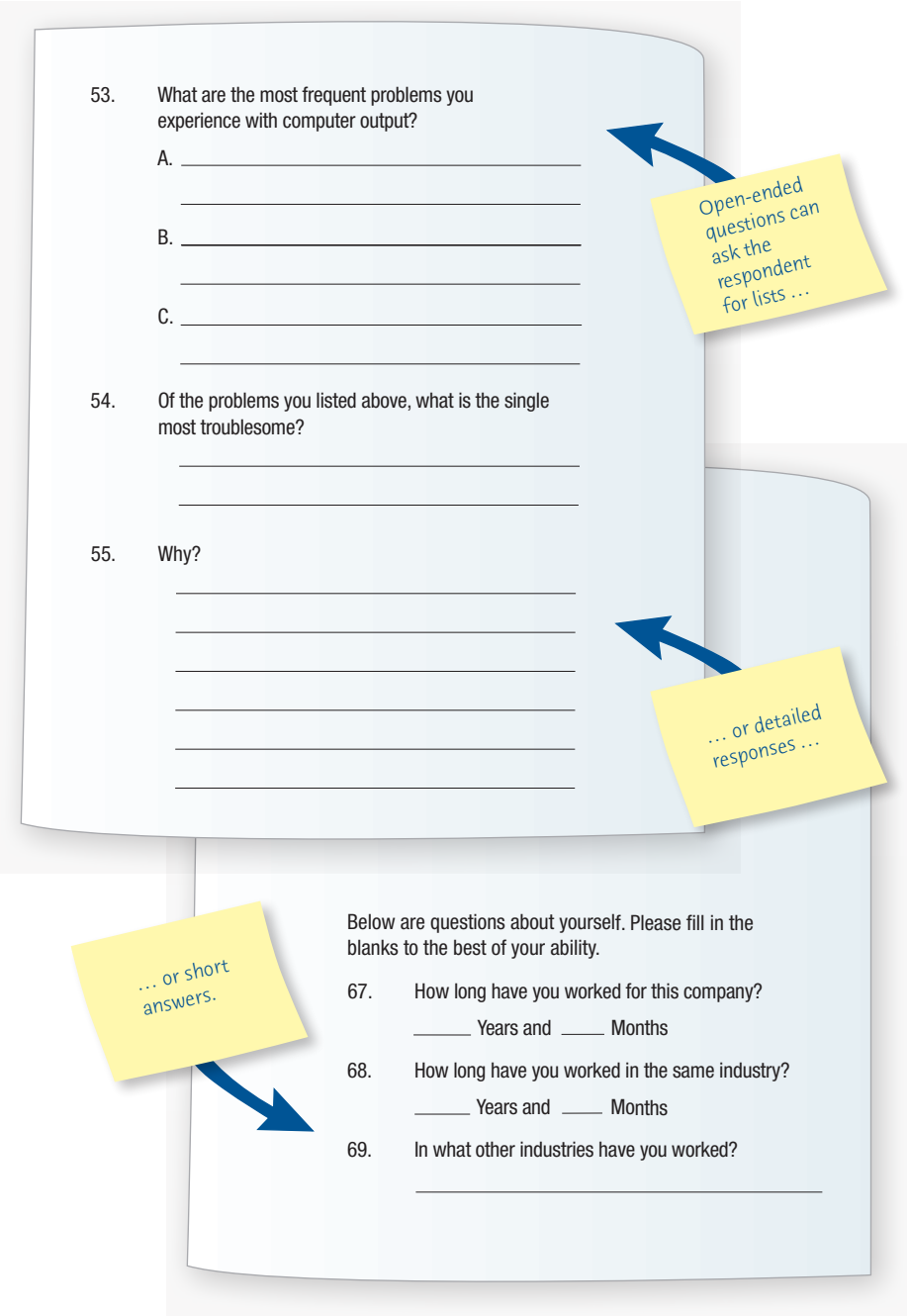
The basic question types used on the questionnaire are open-ended and closed, as discussed for interviewing. Due to the constraints placed on questionnaires, some additional discussion of question types is warranted.

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 4.11.)

FIGURE 4.11

Open-ended questions used for questionnaires.



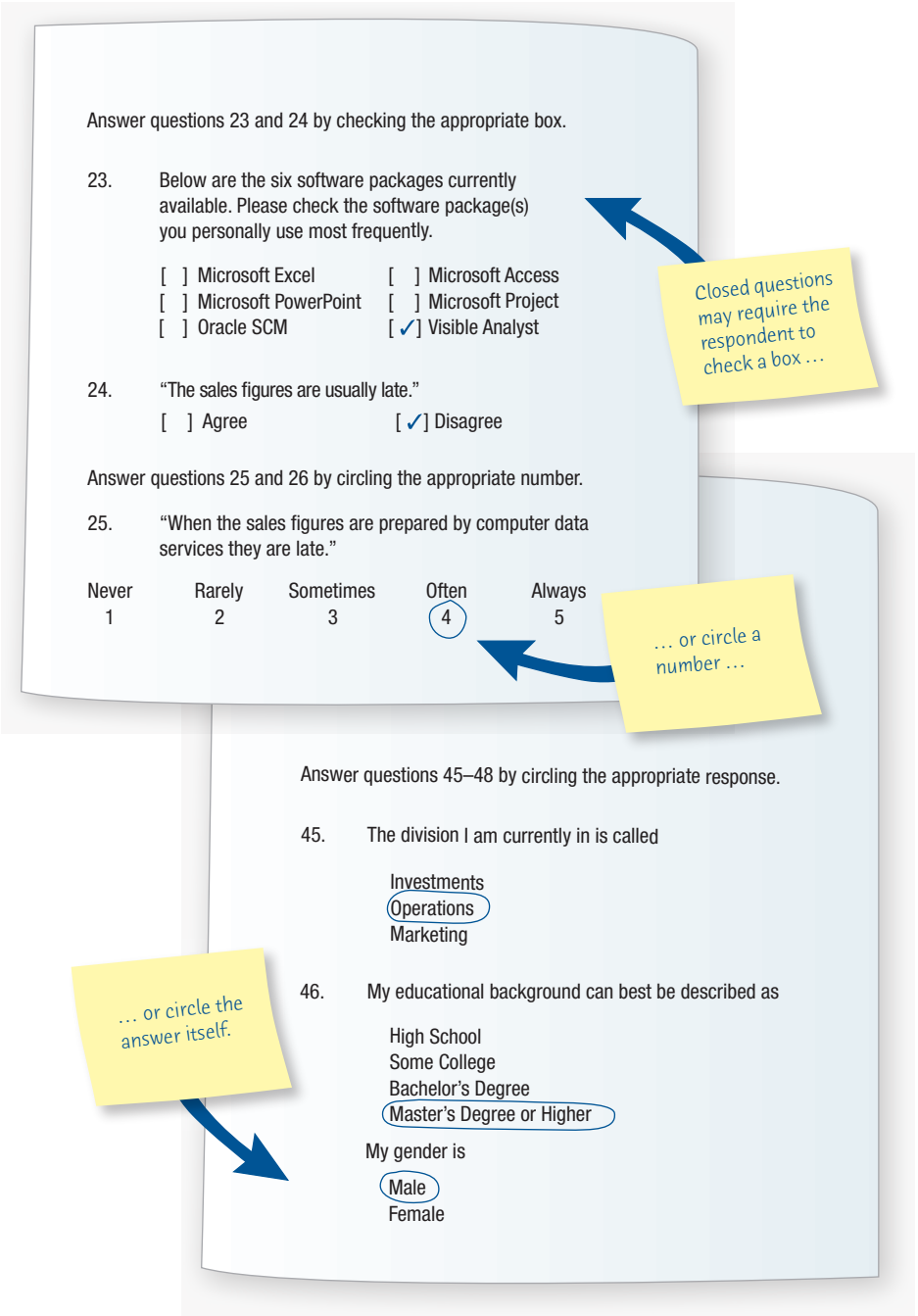


FIGURE 4.12

Closed questions on questionnaires help ensure responses.

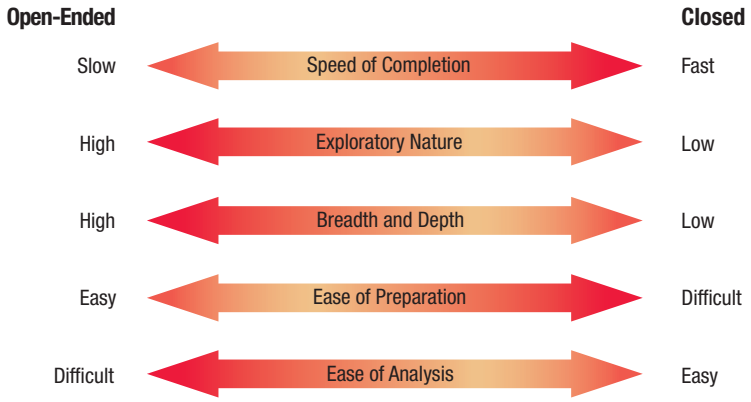
Open-ended questions are particularly well suited to situations in which you want to get at organization members' opinions about some aspect of the system, whether product or process. In such cases you will want to use open-ended questions when it is impossible to list effectively all the possible responses to the question.

CLOSED QUESTIONS Recall that closed questions (or statements) limit or close the response options available to the respondent. For example, in Figure 4.12 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.

A systems analyst should use closed questions when it is possible to effectively list 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.

FIGURE 4.13

Trade-offs between the use of open-ended and closed questions on questionnaires.



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 or some type of text analytics software.

There are trade-offs involved in choosing either open-ended or closed questions for use on questionnaires. Figure 4.13 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, analyzing responses to them is difficult and time consuming.

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 a systems analyst has a standard set of questions 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 into 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. Be specific rather than vague in your wording. Avoid overly specific questions as well.
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 includes 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 a 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).

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 & 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.

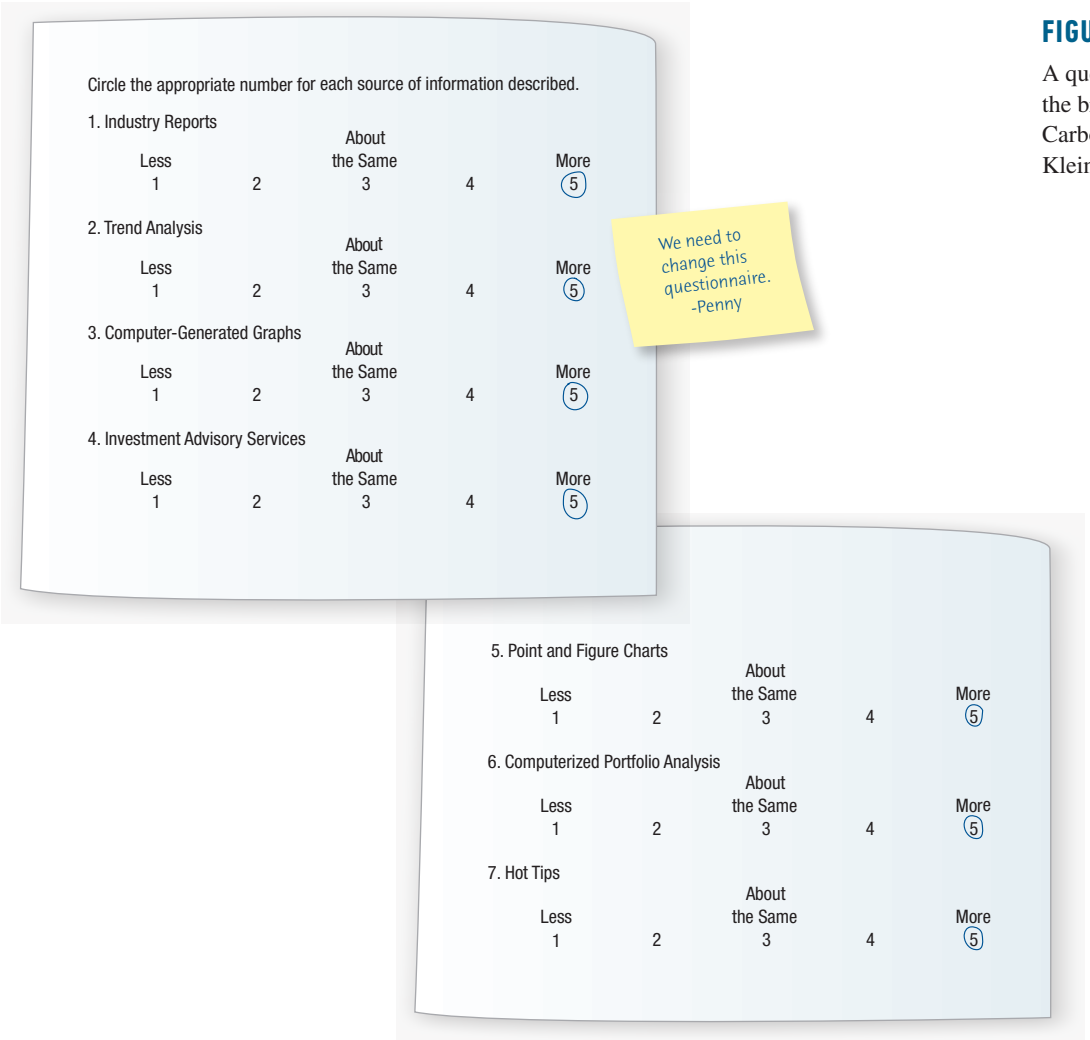
"We need a crystal ball to understand these," By and Sal call out together.

"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.

1. Industry Reports

Less		About the Same		More
1	2	3	4	(5)

2. Trend Analysis

Less		About the Same		More
1	2	3	4	(5)

3. Computer-Generated Graphs

Less		About the Same		More
1	2	3	4	(5)

4. Investment Advisory Services

Less		About the Same		More
1	2	3	4	(5)

We need to change this questionnaire. -Penny

5. Point and Figure Charts

Less		About the Same		More
1	2	3	4	(5)

6. Computerized Portfolio Analysis

Less		About the Same		More
1	2	3	4	(5)

7. Hot Tips

Less		About the Same		More
1	2	3	4	(5)

FIGURE 4.C1

A questionnaire developed for the brokerage firm Carbon, Carbon, & Rippy by Rich Kleintz.

MEASUREMENT Systems analysts commonly use two different forms of measurement scales:

1. Nominal scales
2. Interval scales

Nominal scales are used to classify things. A question such as the following uses a nominal scale:

What type of software do you use the most?

1 = A word processor
2 = A spreadsheet
3 = A database
4 = An email program

Obviously, nominal scales are the weakest forms of measurement. Generally, all an analyst can do with them is obtain totals for each classification.

In interval scales, the intervals between each pair of 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.

By anchoring the scale on either end, the analyst may want to assume that the respondent perceives the intervals to be equal when they respond to this question:

How useful is the support given by the Technical Support Group?

Not Useful at All				*Extremely Useful*
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. A systems analyst should be aware of these concerns.

Validity is the degree to which a question measures what the analyst intends for it 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 a 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 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 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 Questionnaires

Many of the same principles that are relevant to the design of forms for data input (as covered in Chapter 12) are important in designing questionnaires as well. Although the intent of a 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 organization members on the whole tend to receive too many surveys, many of which are ill conceived and trivial.

A well-designed, relevant questionnaire can help overcome some of the resistance to responding. 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 4.14. Following the four guidelines should help you gain a better response rate to the questionnaire.

QUESTION ORDER There is no best way to order questions on a 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 respondents' 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 as interested in the questions being asked as possible, without getting overwrought about a particular issue.

Administering Questionnaires

The topic of administering questionnaires centers around two main questions. These are "Who in the organization should receive the questionnaire?" and "How should the questionnaire be administered?" Both questions are worth considering carefully before a questionnaire is sent. Doing so will help you better visualize and anticipate the data you are trying to collect with the questionnaire, and it also will help you plan ahead so that appropriate timing is observed in administering the questionnaire.

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 a systems analyst determine what sort of representation is necessary and hence what kind of respondents should receive 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	Button	Most often used for an action (e.g., a respondent pushes a button marked "Submit" or "Clear")

FIGURE 4.14

When designing a Web survey, keep in mind that there are different ways to capture responses.

CONSULTING OPPORTUNITY 4.5

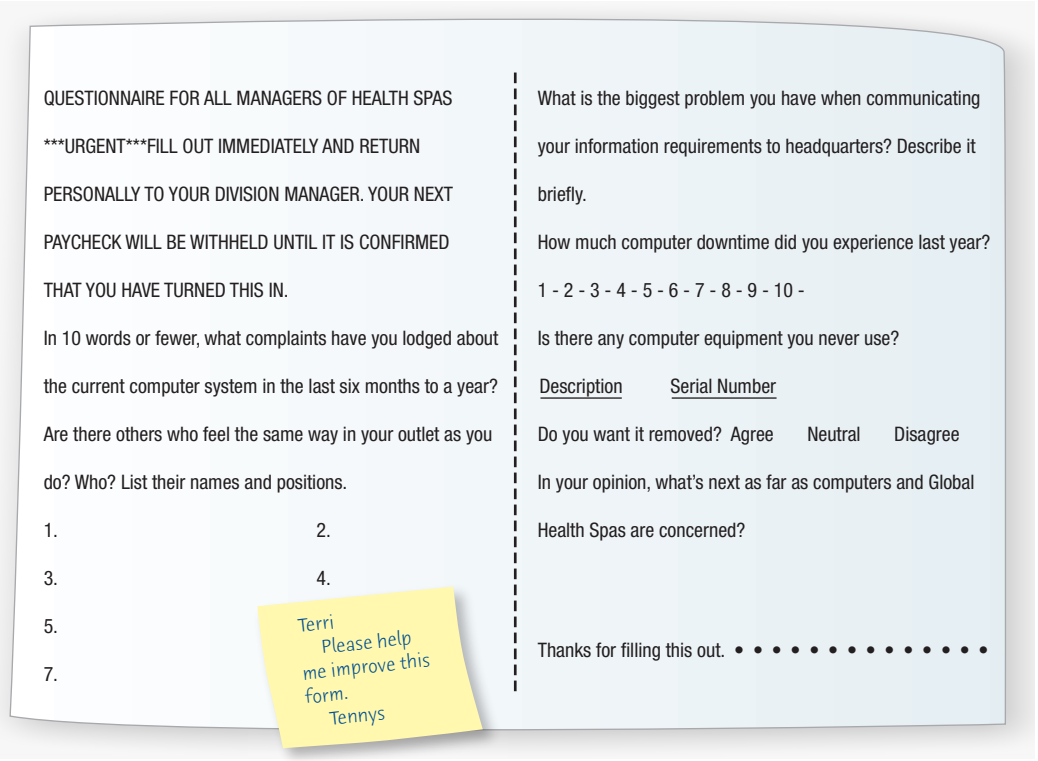
Order in the Courts

"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 cloud-based system to be used by all 80 outlets. "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

URGENTFILL 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.

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

A questionnaire developed for managers of Global Health Spas by Tennys Courts.

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 A QUESTIONNAIRE A systems analyst has several options for administering a 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 at one time.
2. Personally handing out blank questionnaires and taking back completed ones.

HYPERCASE EXPERIENCE 4.2

"You've probably noticed by now that not everyone enjoys filling out questionnaires at MRE. We seem to get more questionnaires than most other 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 Mr. Evans 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 Mr. Evans 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.

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 a 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 a 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 is a private company called SurveyMonkey (see www.surveymonkey.com). It is a cloud-based Software as a Service (SaaS) company that acquired an email marketing services company called MailChimp to add to its product offerings. MailChimp allows organizations to send email newsletters and design, send, and track email campaigns.

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: interviewing, joint application design, and construction of questionnaires. During the process of interviewing analysts, a systems analyst should listen for HCI concerns related to ergonomics, aesthetics, usability, and usefulness, as well as goals, feelings, opinions, and informal procedures in interviews with

organization decision makers. Interviews are planned question-and-answer dialogues between two people. An analyst can use an interview to develop a 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 an interview are to read background material, establish interviewing objectives, decide who 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 either way, 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 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 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 organization culture will help an 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, if many people are involved with the systems project, if exploratory work is necessary before recommending alternatives, and if 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. Software or SaaS is available to automatically create, distribute, and then tabulate email or Web responses.

Systems analysts can use storytelling as a complement to other information-gathering methods. You need to involve users by reacting to stories, matching one story to another by recounting it to other participants, and even collaborating with the participant to reframe and understand organization stories. It is a useful way to understand problems associated with the use of technology, systems development, systems adoption, and systems design. The systems analyst needs to listen to the story as a whole to truly understand its content and purpose.

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
stories
survey respondents
validity

Review Questions

1. Why is it important to seek opinions during interviews?
2. Describe a situation in which JAD would be ideal.
3. When should an interviewer compose a written interview report and why?
4. When are open-ended questions appropriate for use in interviewing?
5. Define what is meant by closed interview questions. List 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 this structure in interviews?
9. Define what is meant by *funnel structure*. When is it useful to employ this structure in interviews?
10. Define what is meant by *diamond-shaped structure*. When is it useful to employ this structure in interviews?
11. Compose an open-ended question for Dr. DiVito, a university professor who is eligible for retirement in three weeks.
12. Discuss the importance of user stories for systems analysts.
13. Define *joint application design (JAD).*
14. List the situations that warrant use of JAD in place of personal organization interviews.
15. Identify the various participants involved in a JAD session.
16. What does IBM recommend for the structured approach of JAD? Where would it be less useful?
17. What kinds of information is a systems analyst seeking through the use of questionnaires or surveys?
18. List four situations in which the use of questionnaires is appropriate.
19. In what sense does choosing either open-ended or closed-ended questions involve a trade off?
20. List two reasons a systems analyst would use a closed question on a questionnaire.
21. List two reasons a systems analyst would use an open-ended question on a questionnaire.
22. Explain how the language of questionnaires is an important aspect of their effectiveness.
23. Define what is meant by *scaling*.
24. What are two kinds of information or scales that systems analysts most commonly use?
25. What are nominal scales used for?
26. Give an example of an interval scale.
27. When should an analyst use an interval scale?
28. Define *reliability* as it refers to the construction of scales.
29. Define *validity* as it refers to the construction of scales.
30. List three problems that can occur because of careless construction of scales.
31. What four actions can be taken to ensure that a questionnaire's format is conducive to a good response rate?
32. What are the possible benefits of administering questionnaires electronically?
33. Why should questions on similar topics be clustered together?
34. What is an appropriate placement for controversial questions?
35. List five methods for administering a questionnaire.
36. 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 manufacturer 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 website)? 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.
   f. Describe how you would ask Leo to tell a relevant story. What seven elements should you listen for?
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.

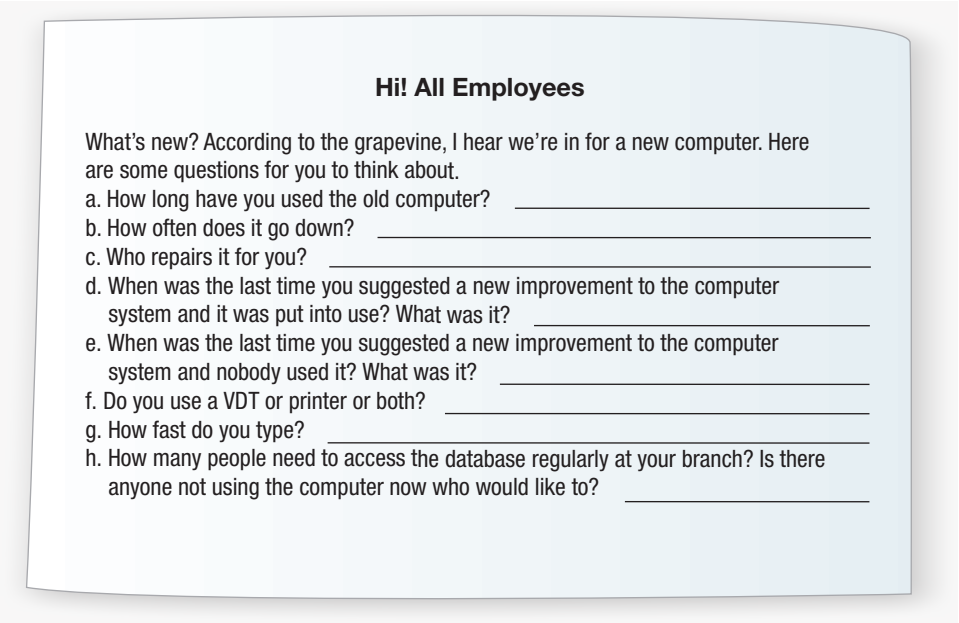
1. When was the last time you thought seriously about your decision-making process?
2. Who are the trouble makers in your store—I mean the ones who will show the most resistance to changes in the system that I have proposed?
3. Are there any decisions you need more information about before you can make 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 so it is 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 in 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 list of possible interview scenarios presented below:
   1. Reasons for absenteeism from work
   2. Why job candidates wish to work at a firm
   3. Customers' interview on the addition of a "features" section on a website
   4. Employee reactions to a change in management
   5. An interview by executives of a consultant who is presenting his findings
   6. Local vendors' opinions on foreign partnerships in organic foods marketing
   7. Suppliers' opinions on ways to reduce costs
   8. Home-owner attitudes toward changes in a loan process
   9. Ethical dilemmas employees face at work
      a. Explain which interview structure would be appropriate for each scenario.
      b. Prepare a list of interview questions for at least two of the scenarios depicted above. Is it possible to reorder the questions and change the interview structure? Justify your answer.
7. The following is a story narrated to a systems analyst involved in developing an information system for selecting and ordering a book for a library. "A library employed a branch librarian and five librarians. Each month, the librarians placed a check mark against a list of forthcoming books received for pre-order. The branch librarian would order books with at least three check marks after exercising his own judgment. However, the librarians believed that the head librarian wasn't using his judgment at all. Moreover, as there was only one librarian who handled children's books, they were rarely ordered. They proved their point by placing a check mark against a highly priced book that was not relevant to the library, yet the book was ordered and received."
   a. What is the type of user story narrated above?
   b. Discuss how a systems analyst can use this story for information system design and development.
   c. Should a systems analyst complement this story with other information gathering methods? Why?
8. Mike is a newly hired systems analyst with your group. He has always believed that JAD sessions are a huge waste of professional time as they need lots of preparation and commitment. You will be working on a systems project for Ken University that will enroll international students through its distance programs, and you want to use JAD sessions to elicit opinions from management and students about the current and proposed systems.
   a. Based on what you know about the requirements of the project, list three reasons why Mike should use JAD for this study.
   b. Given your arguments, Mike agrees to use JAD but strongly urges that it be made as structured as possible. In a paragraph, illustrate the approach you would follow to implement JAD. How would you structure it?
9. Experiencing increased employee turnover after implementing a new information system, Global Marketing Inc. decided to distribute a standard questionnaire to gauge reasons for employee satisfaction or dissatisfaction. However, employees said that many of the points covered by the questionnaire were either irrelevant or insufficient. Additionally, some employees were reluctant to share their opinions. Consider this situation as a systems analyst and answer the following:
   a. Do you think a custom questionnaire would be an improvement in this situation? How?
   b. How would soliciting user stories before designing the questionnaire make it more relevant?
   c. What would be the best way to administer the questionnaire? Would electronic administration offer greater benefits?

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 website to get an answer.

Sometimes	*Never*	*Always*	*Usually*
1	2	3	4

    a. What type of scale is this 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.
    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 that says 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 that says what changes were necessary to accommodate Web users.



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? _____

FIGURE 4.EX1

A questionnaire developed by Di Wooly.

Group Projects

1. 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 PCs connected to a mainframe because it wants to use tablets to improve worker mobility, and it is also interested in investigating a cloud-based 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.
2. 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. Remember to devote part of the interview to asking for and listening to stories from each interviewee.
3. 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.
4. Using the interview data you gained from the group exercise on Maverick Transport in Group 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 cloud-based 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.
5. Using the interview data you gained from the group exercise on Maverick Transport in Group 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 computer programmer survey, consider what you have learned about users in the other interviews as well as what vision the director of information technology has for the company.
6. Divide your group into three distinct teams considering the case of a large manufacturer and online seller of sports clothing and health accessories called Ganymede Fitness. They manufacture and sell clothing including shirts, shorts, pants, headbands, and some fitness technology products. They are privately held, global company headquartered in Seattle, Washington, in the U.S., which has a corporate slogan stating, "Helping the world get fit, happy, and healthy, one person at a time."
   a. Assign team members so that there are an equal number of team members in each of the following three groups:

      Team 1 Systems Analysts. This team should take the position of systems analysts who are have been asked to gather feelings of two groups—Team 2, the consumers of Ganymede Fitness products and their website content, and asking Team 3, the Ganymede Fitness ecommerce managers about the usefulness of recommendation systems and ratings systems for online shopping. Eventually, the analysts will be tasked with designing recommendation systems and rating systems for Ganymede Fitness.

      Team 2 Ganymede Fitness product users and website users. This team is made up of avid users of Ganymede Fitness products (which are only available on their website), many of who have been with them since their opening in 2010. They have eagerly adopted all of the products Ganymede Fitness offered, most recently their fitness technology products.

      Team 3 Ganymede Fitness Ecommerce managers. This team is composed of ecommerce managers who work for Ganymede Fitness and are charged with keeping the ecommerce portion of the website up to date. They would like to know more about their customers so that the website becomes more personalized with recommendations for purchases and ratings of their products. They would also like to find out from the systems analysts what the possibilities are for improving their website.

   b. Each team should meet virtually or face to face and reaffirm their purpose as a team. During their initial meeting, Team 1 should prepare a series of interview questions for both Teams 2 and 3. Team 1 of systems analysts should prepare a list of six open-ended questions for the users and a list of six open-ended questions for the ecommerce managers. Team 2 of product and website

users should discuss and create a common list of sports clothing and health accessories they have purchased or would consider purchasing online, and what their favorite features of each product are. Team 3 of ecommerce managers should write six interview questions for Team 1 about what kind of support for online purchases, including ratings and recommendations, they can provide. Team 3 should also prepare six questions for Team 2 about their website preferences.

c. Once each team has completed their assignment, they should meet face to face or in a monitored chat room (using whatever technology is available to the class) to role-play the tasks and perspectives outlined for each team in part a. Team 1 should take the lead and begin interviewing members of Team 2. Team 3 should join in asking any questions that have not yet been asked of Team 2, and also following up on the initial questions with probing questions. Team 1 should move to the next phase, and ask their prepared questions of Team 3 about how useful ratings and recommendations would be to the Ganymede Fitness website. Assigning a scribe or note taker for each team to write notes about answers will help move the process along for the last step.

d. Each of the three teams should meet separately (face to face or online) as a team to discuss what they learned in response to their questions. Each team should write a brief one-page report that includes: date, time of day, length of interview, and participants in the interview. The one-page report should include a summary of key information learned in the interview, and also include a list of any points that were raised but that still need to be clarified.

7. To extend exercise six above, teams working on the Ganymede Fitness case can share their written reports with the other two teams (via posting on the course website, or via email) to compare where they are in terms of understanding the usefulness of improving the ecommerce website for Ganymede Fitness with product ratings and recommendations. Teams can make a brief oral presentation of what they learned in the interview process including (1) any suggestions for new material for the website and (2) any follow up questions they would like to ask and which team members they would like to ask additional questions.

8. Each of the three teams working on the Ganymede Fitness case above should design an online survey based on their experience with conducting interviews. The online survey should be developed for a specific audience, either Team 2 of Ganymede Fitness product and website users or Team 3 of Ganymede Fitness ecommerce managers. The online survey should pose both open ended and closed questions about the desirability of adding product rankings and recommendations to the Ganymede Fitness website.

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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 of 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. Interpret managers' and customers' messages, interviews, and communications using text analytics.
5. Create an analyst's playscript to observe decision makers' activities.
6. Apply the STROBE technique to observe and interpret a decision maker's environment and interaction with technologies.

Just by being present in an organization, a systems analyst changes it. However, unobtrusive methods such as sampling, investigating, and observing a decision maker's behavior and interacting with his or her physical environment are less disruptive than other ways of eliciting human information requirements. Text analytics is software that can analyze qualitative data from any unstructured written source. Interviews, written reports, or customers' communication collected through wikis, blogs, chat rooms, and other social networking sites provide analysts and decision makers with insights about the organization. Unobtrusive methods are insufficient information-gathering methods when used alone. Rather, they should be used in conjunction with one or more interactive methods such as those studied in the previous chapter. This is called a *multiple methods approach*. Using both interactive and unobtrusive methods in approaching an organization is a wise practice that will result in a more complete picture of human information requirements.

Sampling

Sampling is the process of systematically selecting representative elements of a population. When these selected elements are examined closely, analysis of the sample will reveal useful information about the population as a whole.

A systems analyst has to make decisions on two key issues. First, people in the organization have generated many reports, forms, output documents, memos, and websites. Which of these should the systems analyst pay attention to, and which can the systems analyst safely pass over?

Second, a great many employees may 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 data gathering
3. Improving effectiveness
4. Reducing bias

Examining every scrap of paper, talking with everyone, and reading every web page from the organization is 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 more detailed questions. 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 A systems analyst needs a realistic plan about what will be done with the data 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 (for example, investigation, interviews, questionnaires, and 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, a systems analyst must determine the size of the population. In the case of hard data, the systems analyst needs to decide, for example, whether

FIGURE 5.1

Four main types of samples a systems analyst has available.

	Not Based on Probability	Based on Probability
Sample elements are selected directly without restrictions	Convenience	Simple random
Sample elements are selected according to specific criteria	Purposive	Complex random (systematic, stratified, and cluster)

The systems analyst should use a complex random sample if possible.

data from 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. Perhaps the analyst will need to go outside the system and include the reactions of customers, vendors, suppliers, or competitors as well. These decisions are explored in more detail in upcoming sections.

CHOOSING THE TYPE OF SAMPLE A systems analyst can use one of four main types of samples, as shown in Figure 5.1. They are convenience, purposive, simple random, and complex random. Convenience samples are unrestricted and 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 interested in working with the new sales performance reports to come to a meeting Tuesday morning. Obviously, this sample is the easiest to arrange, but it is also the least reliable. A purposive sample is based on judgment. The systems analyst chooses a group of individuals who appear knowledgeable and who are interested in the new information system. Although this sample is based on criteria—knowledge about and interest in the new system—purposive sampling is also a nonprobability sample and is only moderately reliable. If the analyst chooses a simple random sample, the sample must come from 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. Complex random samples that are most appropriate for a 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. The analyst 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 tool for a 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 the analyst seeks 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 compensates for this. Stratification also is called for when a systems analyst wants to use different methods to collect data from different subgroups. For example, the analyst may use a survey to gather data from middle managers but use personal interviews to gather similar data from executives.

Sometimes a systems analyst must select a group of people or documents to study. This process is referred to as *cluster sampling*. Suppose an organization has 20 help desks scattered

across the country. The analyst may select one or two of these help desks, under the assumption that they are typical of all the help desks.

DECIDING ON THE SAMPLE SIZE 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. Of course, this is not the case, so 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 from people in the organization. This subsection provides guidelines for determining the required sample size under ideal conditions—for example, to determine what percentage of input forms contain errors or what proportion of people to interview.

A systems analyst follows 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 σ_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 to sample. Once this is done, find out where these data are 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, to 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 ±0.10 means the analyst is 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, such as 95 percent. Once the confidence level is chosen, the confidence coefficient (also called a z value) can be looked up in a table similar to 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 the required sample size.

EXAMPLE

The foregoing steps can best be illustrated by an example. Suppose the A. Sembly 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:

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.

CONSULTING OPPORTUNITY 5.1

Trapping a Sample

"Real 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 networked computer 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. Although the computer might help, he believes other approaches should be considered as well.

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 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. In a paragraph, suggest a type of sample for each group and justify it. The constraints you are subject to include the need to act quickly to remain competitive, the need to retain a low profile so competing furriers are unaware of your fact gathering, and the need to keep costs of data gathering to a reasonable level.

4. Make a subjective decision that the acceptable interval estimate will be ±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 σ_p as follows:

$$\sigma_p = \frac{i}{z} = \frac{0.02}{1.96} = 0.0102$$

7. Determine the necessary sample size, n, as follows:

$$n = \frac{p(1-p)}{\sigma_p^2} + 1 = \frac{0.05(0.95)}{(0.0102)\,(0.0102)} + 1 = 458$$

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.

DETERMINING SAMPLE SIZE WHEN INTERVIEWING There are no magic formulas to help a systems analyst set the sample size for interviewing. The overriding variable that determines how many people a systems analyst should interview in depth is the time an interview takes. A true in-depth interview and a follow-up interview are very time consuming for both the interviewer and the participant.

First decide on the confidence level . . .

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

. . . then look up the *z* value.

FIGURE 5.2

A systems analyst can use a table of area under a normal curve to look up a value once he or she decides on the confidence level.

A good rule of thumb is to interview at least three people at 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 it is not necessary 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.

Analyzing Quantitative Documents

Investigation is the act of discovery and analysis of data. When investigating evidence in an organization, an analyst acts like Sherlock Holmes, the fabled detective from 221B Baker Street.

As a systems analyst works to understand users, their organization, and its information requirements, it becomes 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.

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 of these documents are targeted for specific purposes and audiences.

Systematically Examining Quantitative Documents

A systems analyst needs to obtain some of the documents used in running the business. These documents often are paper reports regarding the status of inventory, sales, production, and employee and customer satisfaction. Many of these reports are not complex, and they can provide 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, labor, and plant information. Service reports include the delivery of services and reports on employee performance and customer satisfaction. In addition to using these key reports, decision makers use many summary reports to provide background information, spot exceptions to normal occurrences, and afford strategic overviews of organization plans. The following reports, records, and forms deserve special attention.

PERFORMANCE REPORTS Most performance reports take 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 important to be able to determine whether 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 whether a performance measurement is available and adequate for key organization 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 a

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, waste 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, and 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 in 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

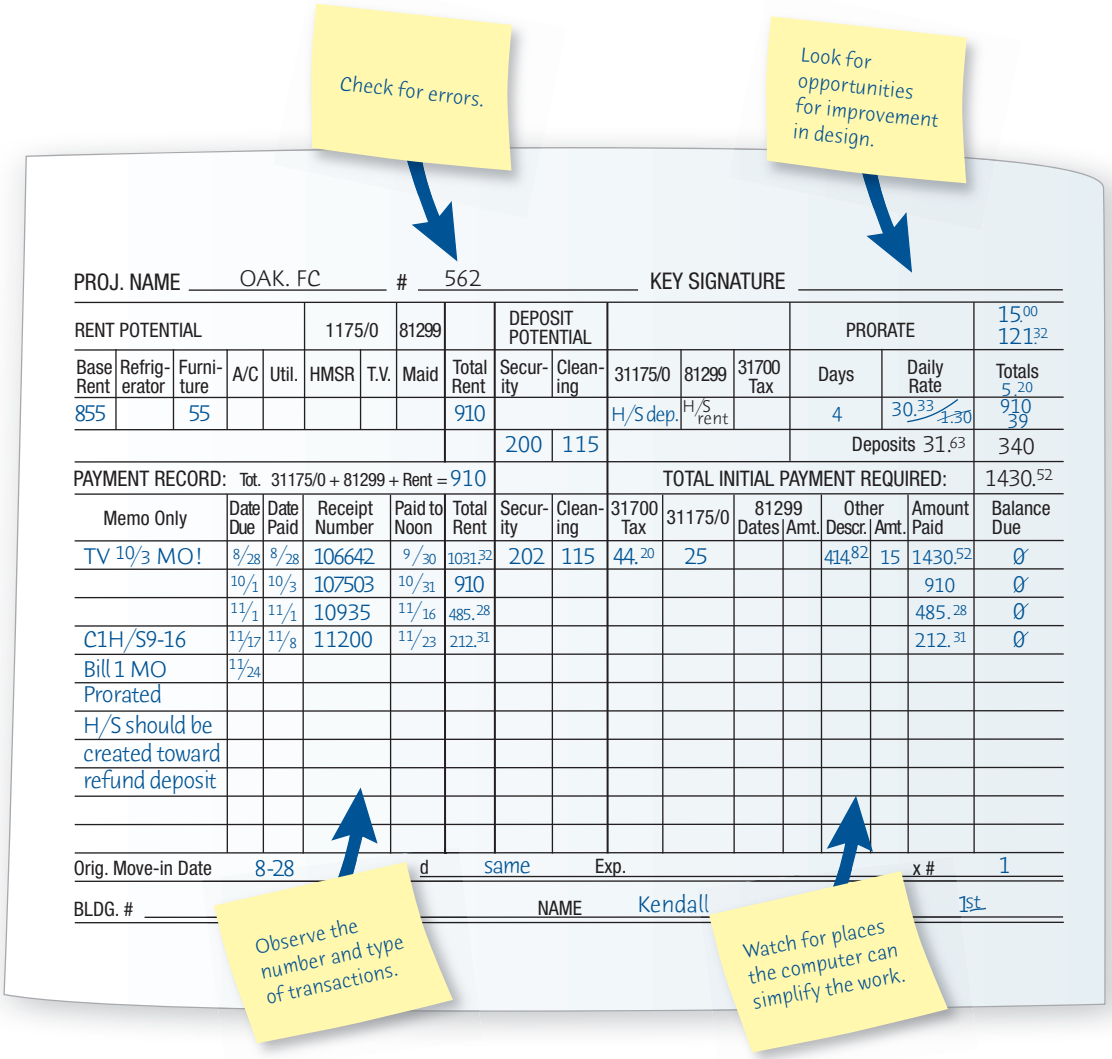
A performance report showing improvement.

Week	Number of Batches Produced	Number of Batches Rejected	Percentage Rejected	Amount Away from 5% Goal
2/2	245	19	7.8	2.8
2/9	229	19	8.3	3.3
2/16	219	14	6.3	1.3
2/23	252	13	5.2	0.2
3/2	245	13	5.3	0.3
3/9	260	13	5.0	* * *
3/16	275	14	5.1	0.1
3/23	260	13	5.0	* * *
3/30	260	13	5.0	* * *
4/6	244	12	4.9	* * *
4/13	242	11	4.5	* * *
4/20	249	11	4.4	* * *
4/27	249	11	4.4	* * *

* * * indicates met or exceeded the < 5% goal

Performance reports show goals . . .

. . . and trends.



PROJ. NAME OAK. FC # 562 KEY SIGNATURE

RENT POTENTIAL					1175/0		81299		DEPOSIT POTENTIAL					PRORATE		15.00 121.32
Base Rent	Refrig-erator	Furni-ture	A/C	Util.	HMSR	T.V.	Maid	Total Rent	Secur-ity	Clean-ing	31175/0	81299	31700 Tax	Days	Daily Rate	Totals 5.20
855		55						910			H/S dep.	H/S rent		4	30.33 ~~1.30~~	910 39
									200	115					Deposits 31.63	340

PAYMENT RECORD: Tot. 31175/0 + 81299 + Rent = 910 TOTAL INITIAL PAYMENT REQUIRED: 1430.52

Memo Only	Date Due	Date Paid	Receipt Number	Paid to Noon	Total Rent	Secur-ity	Clean-ing	31700 Tax	31175/0	81299 Dates	Amt.	Other Descr.	Amt.	Amount Paid	Balance Due
TV 10/3 MO!	8/28	8/28	106642	9/30	1031.32	202	115	44.20	25			414.82	15	1430.52	Ø
	10/1	10/3	107503	10/31	910									910	Ø
	11/1	11/1	10935	11/16	485.28									485.28	Ø
C1H/S9-16	11/17	11/8	11200	11/23	212.31									212.31	Ø
Bill 1 MO	11/24														
Prorated															
H/S should be															
created toward															
refund deposit															

Orig. Move-in Date 8-28 d same Exp. x # 1

BLDG. # NAME Kendall 1st

FIGURE 5.4

A manually completed payment record.

systems analyst. Figure 5.4 is a manually completed payment record for an apartment rental. An analyst can inspect a record in different ways, 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 through calculations and other data manipulation

DATA CAPTURE FORMS Before you set out to change the information flows in an organization, you need to be able to understand the system that is currently in place. Check with managers to determine which forms are available online to customers as well as those that are exclusively used internally by employees. You or one of your team members may want to download, 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 actual forms in use.) 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.

Blank forms, along with their instructions for completion and distribution, can be compared with filled-in forms to see whether 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. When creating a catalog of forms to help you understand the information flow currently in use in the business, follow these steps:

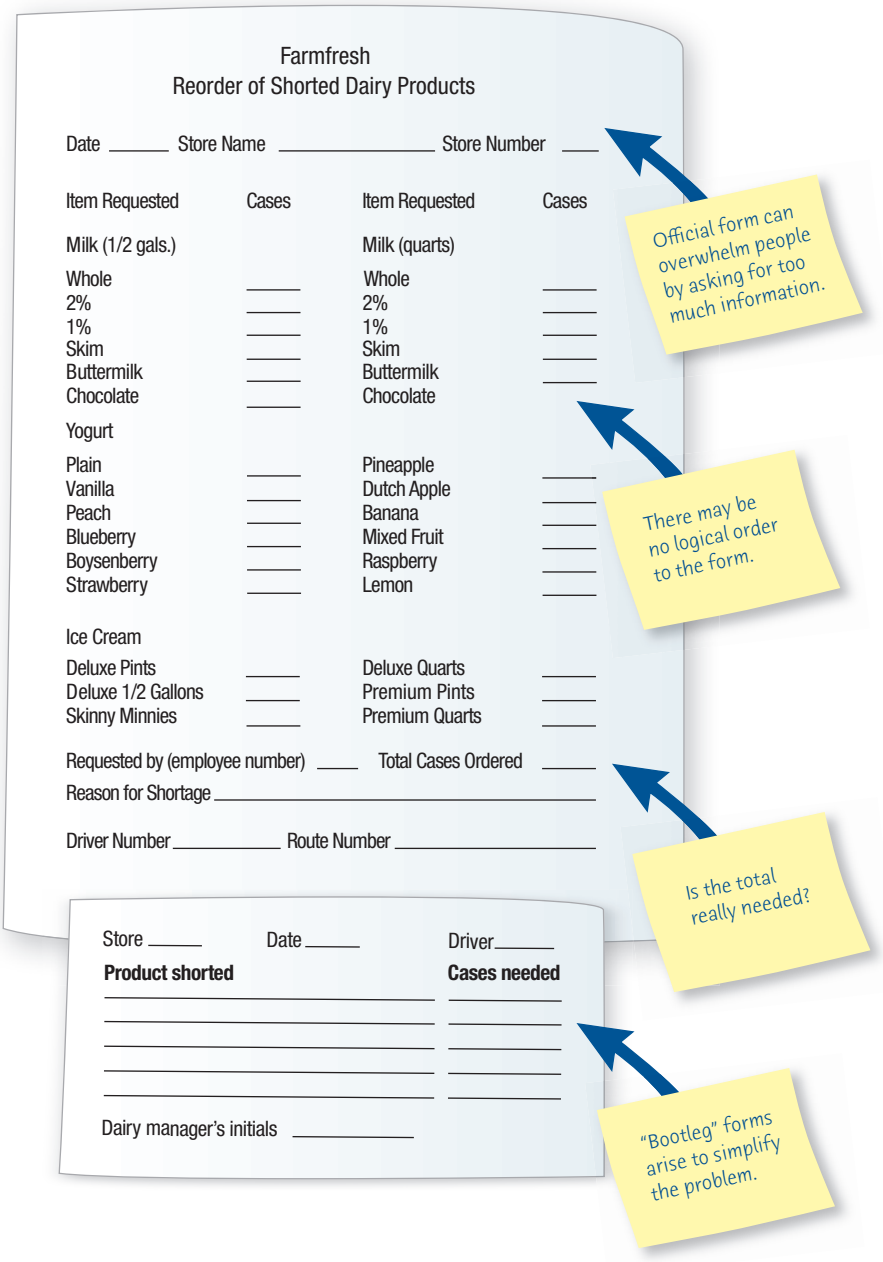
1. Collect examples of all the forms in use, whether officially sanctioned by the business or not (official versus bootleg forms).
2. Note the type of form (printed in-house, handwritten, computer-generated in-house, online forms, Web fill-in forms, printed externally and purchased, and so forth).
3. 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. An analyst must keep in mind many particular questions, as illustrated in Figure 5.5. They include the following aspects of human–computer interaction (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?

FIGURE 5.5

Questions to ask about official and bootleg forms that are already filled out.



2. Are some forms 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? Check on permissions needed and whether links to forms are functioning properly.
4. If a paper form is offered as an alternative to a Web-based form, compare the completion rates for both.
5. Are "unofficial" or bootleg forms being used on a regular basis? (This may indicate a problem in standard procedures or may indicate political battles in the organization over who is controlling the type of input and who enters data.)

Analyzing Qualitative Documents

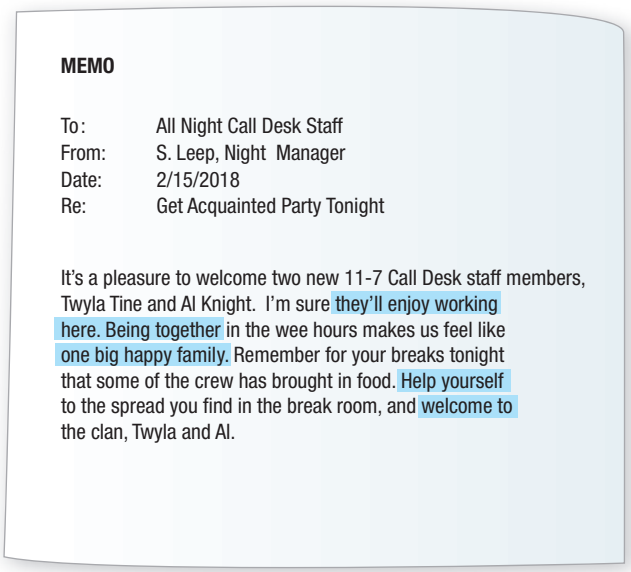
Qualitative documents include written email messages, memos, signs on bulletin boards and in work areas, web pages, procedure manuals, and policy handbooks. Many of these documents are rich in details that reveal the expectations for behavior of others that their writers' hold and the ways in which users expect to interact with information technologies.

Systematically Examining Qualitative Documents

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 to 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.

It is important to examine documents for key or guiding metaphors 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." An 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



MEMO

To: All Night Call Desk Staff
From: S. Leep, Night Manager
Date: 2/15/2018
Re: Get Acquainted Party Tonight

It's a pleasure to welcome two new 11-7 Call Desk staff members, Twyla Tine and Al Knight. I'm sure they'll enjoy working here. Being together in the wee hours makes us feel like one big happy family. Remember for your breaks tonight that some of the crew has brought in food. Help yourself to the spread you find in the break room, and welcome to the clan, Twyla and Al.

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 Mr. Evan'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.

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, an analyst should consider who sends memos (check email threads) 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 work groups and individuals. Memos reveal a lively, continuing dialogue in the organization. Analysis of memo content provides the analyst with a clear idea of the values, attitudes, and beliefs of organization members.

SIGNS OR POSTERS ON BULLETIN BOARDS OR IN WORK AREAS Although signs may seem incidental to what is happening in an organization, they serve as subtle reinforcers of values to those who read them. Slogans posted such as "Quality Is Forever" or "Safety First" give an analyst a sense of the official organizational culture.

CORPORATE WEBSITES An analyst should view websites used for business-to-consumer (B2C) ecommerce as well as those used for business-to-business (B2B) transactions. 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 website 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 website is available for each user? How much personalization of the website is possible? If the analyst is not designing ecommerce sites for the organization, how does what the analyst sees on its website affect the systems being investigating? Remember to note the level of interactivity of the website or sites, the accessibility of the messages, and the security level. Many of these metrics are available from the company's Internet provider and they can provide a different look at the company. Analysts should ask for access to this type of data if it is thought to be relevant to the systems being proposed.

MANUALS Other qualitative documents an analyst should examine are organizational manuals, including manuals for computer operating procedures and online manuals. Analyze manuals 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 shelves, 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, a

systems analyst is primarily concerned with those that address policies about computer services, use, access, security, and charges. Examining policies allows a systems analyst to gain awareness of the values, attitudes, and beliefs guiding the corporation.

Using Text Analytics

Text analytics is software that can analyze unstructured qualitative data from any source including transcripts of interviews, written reports, or customers' communication collected through email, wikis, blogs, chat rooms, and other social networking sites. These data provide analysts and decision makers with insights about the organization. You may have the opportunity to develop systems that help an organization's users interpret and understand the unstructured data in their companies. Unstructured, qualitative, or "soft" data are generated through blogs, chat rooms, questionnaires using open-ended questions, online discussions conducted on the Web, and exchanges occurring on social media such as Facebook, Twitter, and other Web-generated dialogues between customers and an organization. Text analytics can help organizational decision makers realize valuable insights from unstructured data into what customers are thinking about the organization, the values and actions of the company, as well as customer or vendor motivations for beginning, maintaining, improving, or discontinuing a relationship. (In contrast, you will learn in Chapter 13 that structured data is well organized and searchable by standard queries and algorithms through data analytics. An example is data stored in a relational database or data gathered from machine sensors. The largest portion of an organization's information comes from this type of analysis.)

Many large and small analytics software solutions are available, both proprietary and open source. If you have been active in helping an organization develop and implement an online presence, then incorporating text analytics into the new systems makes a lot of sense. As you design systems to support an online presence, text analytics should be included to help the company make use of its online presence.

Text analytics provide insights for an organization's members who want to have a rapid and visual yet decidedly qualitative approach to analyzing text data. Leximancer, a powerful text analytics software tool from an Australian company, offers a straightforward approach for which no setup is required. Rather, the role of the organizational user who will use the software is to contribute relevant knowledge about what is to be fed into the system so concepts and other diagrams generated by the software are useful.

In general terms, users of Leximancer software submit documents and then omit words they don't want to include in analysis (such as *a* and *the*); then the software performs a keyword count. The body of the text is then broken up into segments, and the concepts that result form a "thesaurus" of words that journey through the text document together.

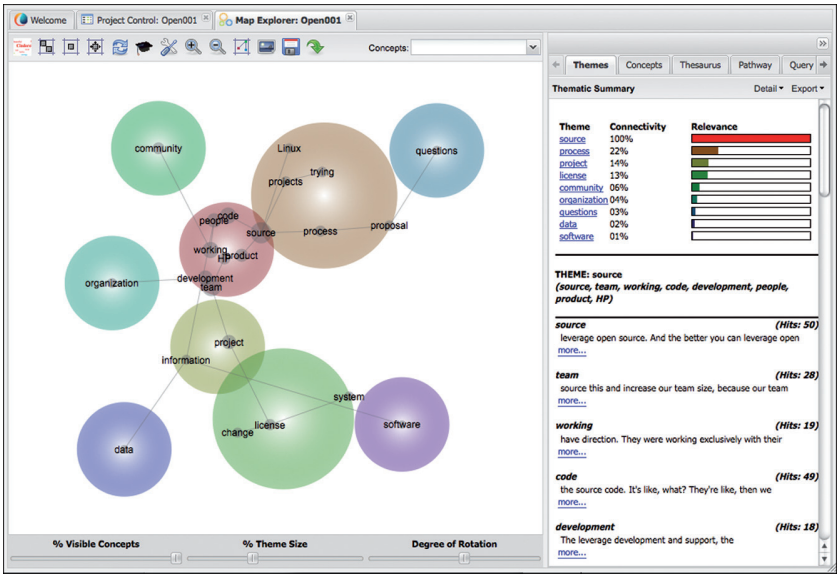
Figure 5.7 shows a concept map generated with some interview data from the Open Source Communities project, creating a different visual display of the text from interviews. As mentioned previously, submitting your documents to the software generates a concept map. Notice how different the data appear, with the user's thesaurus words, such as *Linux*, *projects*, *trying*, and *process* conceptually hanging together and the term *community* separate but related to those concepts through *people*.

Figure 5.8 shows the ranked concepts for the Open Source Communities project using Leximancer. This ranked bar chart format shows the most prominent concepts within the designated category. Notice the prominence of the relationship between the category "community" and the use of the word *development*. The user can visually see the prominent relationship between the category "license" and use of the word *project*.

Your expertise in designing an interface as well as the system is especially critical here. Part of what you must do is demonstrate to the organization the value of using analysis of unstructured, qualitative data to identify and predict future trends in customer, vendor, and supplier behavior. Another important element is to design the human activities surrounding the use of text analytics software. Incorporating the tools is not enough. Remember that you are not just converting qualitative data to quantitative data. Instead, you are developing systems that include text analytics software as a useful means to an end. Include guidelines and suggestions for how decision makers should view the qualitative results, how they might interpret the qualitative results, and how the evidence from those results can be used to make well-reasoned, logically based recommendations, which in turn can be acted on to improve the organization.

FIGURE 5.7

Concept map showing prominence and relationships of concepts in Open Source Communities project interview data.



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 a systems analyst may use to gain insight into what is actually done, not just what is documented or explained. In addition, through observation of the decision maker, an analyst can see firsthand the relationships that exist between decision makers and other members of the organization. Observation of decision makers' interactions with technologies also reveals important clues regarding HCI concerns, such as how well the system fits with the user.

Category: community				Category: license			
Concept	Rel Freq (%)	Strength (%)	Prominence	Concept	Rel Freq (%)	Strength (%)	Prominence
development	2	5	4.1	project	11	4	8.6
information	2	5	4.1	system	5	3	7.1
source	4	4	2.9	source	5	2	3.7
system	< 1	< 1	0.0	team	< 1	< 1	0.0
project	< 1	< 1	0.0	organization	< 1	< 1	0.0
team	< 1	< 1	0.0	development	< 1	< 1	0.0
organization	< 1	< 1	0.0	product	< 1	< 1	0.0
product	< 1	< 1	0.0	information	< 1	< 1	0.0

FIGURE 5.8

Ranked concepts for categories overview for the Open Source Communities project using the Leximancer Insight Dashboard. (Two screenshots from Leximancer software. Copyright © by Leximancer Pty Ltd. Reprinted with permission.)

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. A systems analyst can grasp how managers characterize their work by using interactive interviews and questionnaires. 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. When you set up a playscript, you list the actor in the left-hand column and all of his or her actions in the right-hand column, as shown in Figure 5.9. All activities are recorded with action verbs; for example, a decision maker would be described as "talking," "sampling," "corresponding," and "deciding."

Using a playscript is an organized and systematic approach that demands that 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

Playscript Analysis Company: Solid Steel Shelving Scenario: Quality Assurance
Analyst: L. Bracket Date: 1/3/2018

Decision Maker (Actor)	Information-Related Activity (Script)
Quality Assurance Manager	Asks shop floor supervisor for the day's production report
Shop Floor Supervisor	Prints out daily computerized production report
	Discusses recurring problems in production runs with quality assurance (QA) manager
Quality Assurance 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
	Observes onscreen results of QA model
	Calls steel suppliers to discuss deviations from quality standards
Shop Floor Supervisor	Attends meeting on new quality specifications with quality assurance manager and vice president of production
Quality Assurance Manager	Drafts letter to inform suppliers on new quality specifications agreed on in meeting
	Sends draft to vice president via email
Vice President of Production	Reads drafted letter
	Returns corrections and comments via email
Quality Assurance Manager	Reads corrected letter on email
	Rewrites letter to reflect changes

FIGURE 5.9

A sample page from an analyst's playscript describing decision making.

major or frequent decisions made by the observed people. For instance, from the quality assurance manager example in the playscript, it is clear that even though this decision maker is on the middle management level, he or she 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 observation 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 take place there. Many HCI concerns can be identified through structured observation and confirmed using 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 whether 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, a 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.

*STR*uctured *OB*servation of the *E*nvironment is referred to as STROBE. Successful application of STROBE requires that an analyst explicitly observe seven concrete elements commonly found in offices. The seven observable elements and some key questions that may arise are listed in Figure 5.10. These elements can reveal much about the way a decision maker gathers, processes, stores, and shares information, as well as information about the decision maker's credibility in the workplace.

FIGURE 5.10

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?

Characteristics of Decision Makers	Corresponding Elements in the Physical Environment
Gathers information informally	Warm, incandescent lighting and colors
Seeks extraorganization 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

FIGURE 5.11

A summary of decision maker characteristics that correspond to observable elements in the physical environment.

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."	⬭	○	○
Adams says, "Our company doesn't change much."	○	✓	○
The operations staff works all night sometimes.	○	⬭	○
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

⬭ Cue to look further

□ Modify the narrative

○ Supplement the narrative

FIGURE 5.12

An anecdotal list with symbols for use in applying STROBE.

MAC APPEAL

Collecting data unobtrusively seems easy until one realizes that all the data collected must be organized, stored, and retrieved for analysis. A simple solution to this problem 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 such as DEVONthink Professional Office. The metaphor of an office is a bit ambitious because using the application is more like tossing all sorts of data into a desk drawer and 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 (AI). DEVONthink doesn't help an analyst determine the sample size or keep track of errors, but it does help the analyst collect, store, retrieve, use, and share the information gathered.

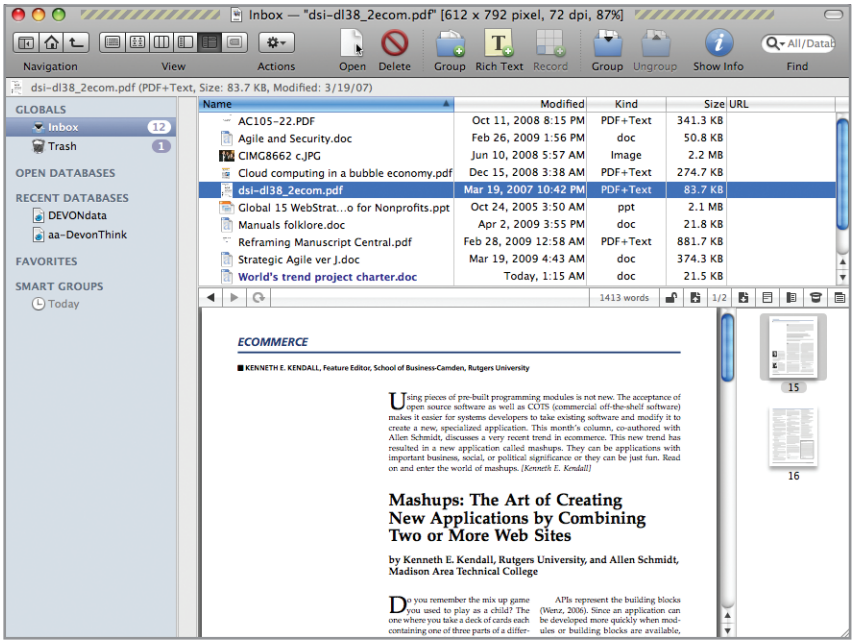


FIGURE 5.MAC

DEVONthink Professional Office from DEVONtechnologies. (Screenshot from DEVONTHINK PRO OFFICE. Copyright © by DEVONtechnologies. Reprinted by permission.)

Through the use of STROBE, a 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 5.11.

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.

In Figure 5.12, the system analysts used five shorthand symbols to evaluate how observation of the STROBE elements compared with the organization 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.
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 analyst first writes down key organizational themes growing out of interviews. Then he or she observes and records the elements of STROBE. The analyst then compares the narrative and observations and uses one of the five appropriate symbols to characterize the relationship. The analyst thus creates a table that first documents and then aids in the analysis of observations.

Summary

This chapter has covered unobtrusive methods for information gathering, including sampling, investigation of quantitative and qualitative data in current and archived forms, and 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 emails, 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: (1) determine the population itself, (2) determine the type of sample, (3) calculate the sample size, and (4) plan the data that need to be collected or described.

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 that reveal where the organization has been and where its members believe it is going. Text analytics uses software to examine unstructured, qualitative data from blogs, wikis, social media sites, and other online customer interactions to support decision makers in interpreting qualitative material.

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, a systems analyst should observe the decision maker's surroundings for important clues as to how well the system fits the user. One method is 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.

A systems analyst can observe and interpret several concrete elements in the decision maker's environment. 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. A systems analyst can use STROBE to gain a better understanding of how decision makers actually gather, process, store, and share information in order to get their work done.

HYPERCASE EXPERIENCE 5.2

"We'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 Mr. Evans' and Mr. 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.

Keywords and Phrases

analyst's playscript
business-to-business (B2B) ecommerce
business-to-consumer (B2C) ecommerce
cluster sampling
complex random sample
confidence level
convenience sample
corporate websites
external information sources
office lighting and color
purposive sample
qualitative documents
quantitative documents
sample population
sampling
simple random sample
stratified sampling
STROBE
systematic observation
systematic sampling
text analytics

Review Questions

1. Which two key sampling issues does a systems analyst need to address?
2. List four reasons a 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. List seven steps used by systems analysts to determine sample size under ideal conditions.
7. What is the overriding variable that determines how many people a systems analyst should interview in depth?
8. List the guidelines for a systematic examination of qualitative documents.
9. What are the sources of big data for text analytics that an analyst might use? List them.
10. Company A has 500 employees and Company B has 800 employees. Would the analyst working with Company B need to interview more employees than the analyst working with Company A? Why or why not?
11. List five steps to help an analyst observe a decision maker's typical activities.
12. Explain the importance of a playscript for a systems analyst during observation.
13. Discuss the role of the physical environment of a decision maker in the determination of their HCI requirements.
14. Describe how a systems analyst implements STROBE through an anecdotal checklist and symbols.
15. List the seven concrete elements of a decision maker's physical environment that a systems analyst can observe using STROBE.

Problems

1. You are hired as a systems analyst by an organization that is planning to redesign its website. Consider the following situations and describe the most appropriate sampling method for each of them.
   a. To gauge employee perception towards website redesign, you post a notice on the intranet portal asking the employees to post their opinions.
   b. You design a customer survey to find out which website features they wish to see redesigned.
   c. You seek customer opinions through forms available at three of the company's 20 helpdesks.

   Explain why the answer to each situation would vary.
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. In a paragraph, explain what each kind of document contributes to a systems analyst's understanding of the business.

b. While you are speaking with Betty, you realize that 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, 2017

   It has come to my attention that I have been waging a war against requests for computer and printer supplies (USBs, toner, paper, and so on) 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 Gl 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.
   e. Write a paragraph about how text analytics could help the organization do a review of the content of employee policies posted online. Write a second paragraph stating whether you would recommend this approach and why or why not.

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 Steak Your Claim, 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. A systems analyst is part of an information systems project for a firm, and while gathering information, she gets a chance to observe its physical environment. She finds that this large firm has assigned offices for representatives and executives on different floors, and there are vast spaces between the staff and the executive offices demarcated by a large door that displays a strict schedule for meeting the executives. Generally, each of these offices has two or three chairs for visitors in addition to the usual file storage cabinets, CD cabinets, etc., but almost all of them seem to be in disuse. All the rooms have PCs, but the analyst observes a lack of proper electrical equipment and wiring that connects these machines to other parts of the office and to the Internet. In addition, there is no stationary found at the desks in these offices, though it is scattered across the desks of the other staff in abundance. All the rooms are adequately lit, with some executives using brighter lighting than others. Some of the leaders are casually dressed, while most of them are in formal attire. During information gathering, a lot of employees refrained from discussing their relationships with the management. The

executives often reported using external sources of information to take non-routine decisions. They also said that they overlooked all the information on personal matters passed around in the office.

a. What are the organizational narratives or themes that emerge from this scenario?
b. List the elements of STROBE that the systems analyst has reported.
c. For each of the elements listed, prepare a summary of the characteristics of executives that correspond to the observable elements in the physical environment.
d. Construct a table first by listing the organizational themes or narratives emerging from the scenario. Then, for each narrative, using shorthand symbols from the anecdotal list, indicate the relationship between the narrative and the observation, elucidating whether the narrative confirms, reverses, needs further investigation, needs modification, or supplements the observable elements of the environment.
e. The analyst also heard executives often stating that employees get open access to their offices to discuss their ideas, opinions, and problems. With your interpretation of the STROBE elements observed by the analyst, would you agree with the executives' statement? Why or why not?

Group Projects

1. Assume that 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: developing the analyst's (1) playscript or (2) using STROBE. Many of these strategies can be employed during one-on-one interviews, whereas some require formal organizational meetings. To accomplish several objectives during your visit to the organization, schedule your visit at a time that allows 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. Alternatively, if you are working on this problem as a face-to face group in a school or university setting, arrange to visit one of your school or university's departments during working hours and follow the instructions given above.
3. The members of your group should meet and discuss their findings after completing Group 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). Write down the list and share it with the entire group.
4. With your group, research software solutions that can help analysts keep track of a variety of data such as observations, surveys, and so on. (Hint: One app is Devonthink Professional Office highlighted in Mac Appeal in this chapter). Allow each group member to work on his or her own to find a suitable package, noting advantages and drawbacks. Take about 20 minutes to do so. Once your research is completed, collaborate on creating a table of all the software found by team members. List each piece of software and also give advantages and drawbacks of each.

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6

Agile Modeling, Prototyping, and Scrum

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. Understand agile modeling and the core practices that differentiate it from other development methodologies.
3. Understand Scrum as an agile method to improve development of complex projects.
4. Learn about DevOps as a cultural shift in the way to organize rapid systems development and operations.
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 it takes up the agile approach later in the chapter.

Agile modeling is distinct from structured methods as a systems development approach that helps develop systems rapidly. Scrum is an agile method that is suitable for more complex systems projects. Using Scrum, a limited number of features or tasks are selected for completion in a sprint, typically lasting two to four weeks. The result of the sprint is a potentially shippable product. Once the sprint ends, the process begins again with new priorities and features to be finished in the next sprint. There are specific roles to play in Scrum, and there are also specific actions to take.

DevOps (derived from Development and Operations) is a cultural shift in the organization. It can create two approaches in the organization that run on parallel tracks, one track supports developing rapid innovative applications, and the other supports the maintenance and operations of those processes already in place.

Prototyping

A systems analyst presenting a prototype of an information system is keenly interested in the reactions of users and management to the prototype. The analyst wants 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 an analyst to set priorities and redirect plans inexpensively, with minimal disruption. Therefore, prototyping and planning go hand in hand.

Kinds of Prototypes

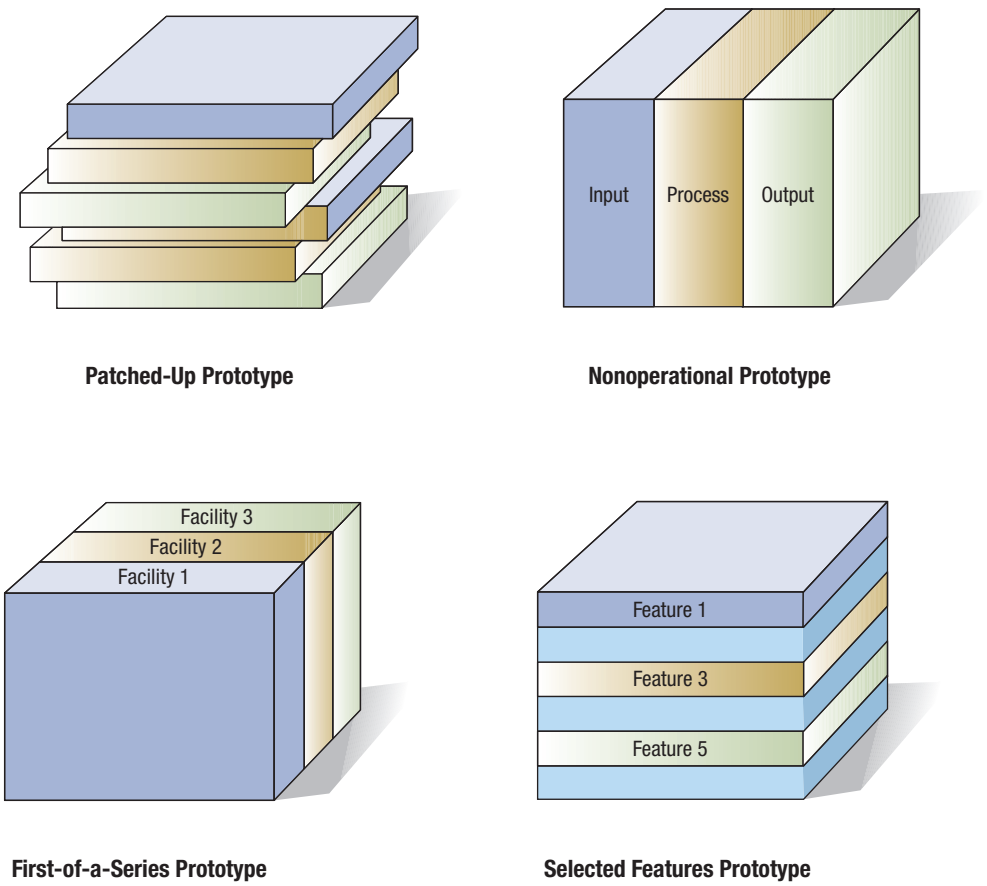
The word *prototype* is used in many different ways. Rather than attempt to synthesize all these uses into one definition or try to mandate one correct approach to the somewhat controversial topic of prototyping, we illustrate how each of several conceptions of prototyping may be usefully applied in 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 and get accustomed to the interface and the types of output available. The retrieval and storage of information may be inefficient, however, because applications were written rapidly, with the objective of being workable rather than efficient.

FIGURE 6.1

Four kinds of prototypes.



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. At 24 years of age, Paul (introduced in Consulting Opportunity 2.3) is the "boy king" of Pyramid, Inc., a small but successful independent 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.

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 that are 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 and then seeing whether 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 it presents. For example, when a retail grocery chain intends to use blockchain (see Chapter 13) to check in suppliers' shipments in a number of outlets, a full-scale implementation might be done in one store so users could work through any problems before blockchain is implemented as part of the supply chain 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 also can help with suggestions on what features to add next.

When this kind of prototyping is done, the system is accomplished in modules so prototyped features evaluated by users as successful 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 mock-ups, as in nonoperational prototyping. Unless otherwise mentioned, all further references to prototyping in this chapter refer to selected features prototypes.

The 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 a systems analysis team must encourage and welcome input and guard against their own natural resistance to changing the prototype.

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. Some of the variables you should observe include user reactions to the prototype, user suggestions for changing or expanding the prototype, any innovations (such as suggestions for using the system in completely new ways), and any revision plans that might arise from working with the users. 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.

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 sections. Agile methods have been credited with many successful systems development projects and, in numerous cases, have rescued companies from a failing system 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. Agile analysts must adhere to the following values and principles as developed by Beck (2000) in his work on agile modeling, which he called "extreme programming," or "XP."

FOUR VALUES OF AGILE MODELING Four values create an environment in which both developers and businesses can adequately be 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 analysts 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 6.2.

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 coders 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, coders may be punished for even bringing up problems to managers, people may leave or join the project in midstream without proper updates, and so the litany goes.

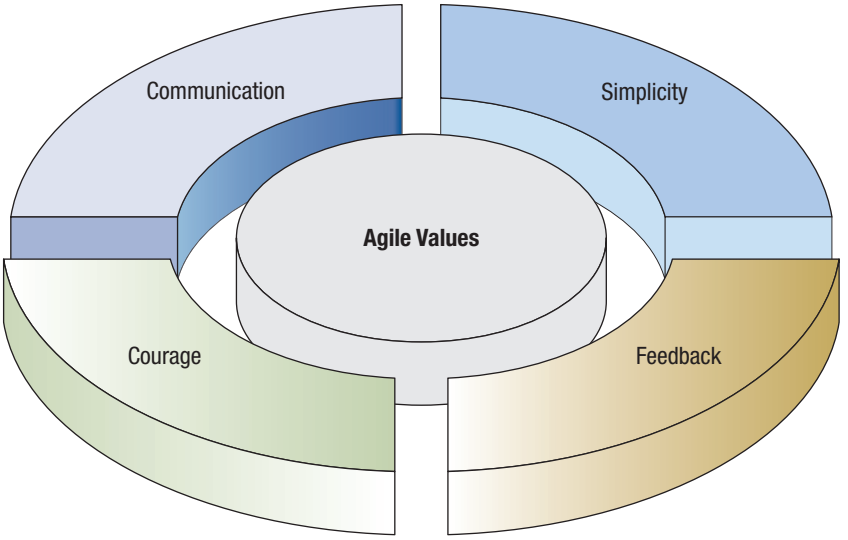


FIGURE 6.2

Values are crucial to the agile approach.

Typical agile practices such as pair programming (where two coders collaborate, described later in the chapter), tasks estimation, 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 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 beginning with the simplest possible thing we can do.

The agile value 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 coder 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 the stories that coders 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 coders 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 in agile programming. Courage has to do with the level of trust and comfort that must exist in a development team. It means not being afraid to throw out an afternoon or a day of coding 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' hunches when they believe that they have a simpler, better way to accomplish a 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 that requires 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 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

CONSULTING OPPORTUNITY 6.2

Clearing the Way for Customer Links

World's Trend (see Chapter 7 for a detailed corporate description) is building a website solely to sell clearance merchandise usually sold through the company's main website 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 your clearance website."

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 load if a customer is accessing the Web via their mobile phone." Mary continues, 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 press on a tab to access 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. I do know that customers like the look and feel of a sale in which merchandise is kind of jumbled together."

Linc continues Mary's line of thought, saying, "Yeah, I wonder how customers want the information organized. Have you actually observed them using 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 online are different?"

As a third member of the World's Trend website 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 clearance website. 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.

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 a software development team would see eye to eye, and communication would not be necessary. We would all be in agreement at all times. But we know that the ideal world doesn't exist. So 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 the systems development life cycle (SDLC) or object-oriented methodologies.

Agile principles were first described by Beck (2000) and have evolved ever since. These principles can be expressed in a series of sayings:

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.
14. Adopt simplicity.

Often you will hear agile developers communicate their point through sayings like these 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. Catchy phrases are easy to understand, easy to memorize, and easy to repeat. They are very effective. These sayings (some call them proverbs) are discussed in detail in Chapter 16.

Activities, Resources, and Practices of Agile Modeling

Agile modeling involves a number of activities that need to be completed 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 Agile methods use four basic activities of development: coding, testing, listening, and designing. An 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. Beck (2000) states that the most valuable thing we receive from code is "learning." The process is basically this: have a thought, code it, test it, and see whether the thought was a logical one. Code also can be used to communicate ideas that would otherwise remain fuzzy or unshaped. When others see your code, they may get a new thought (Beck, 2000).

Testing is the second basic activity of development. The agile approach views automated tests as critical. The agile approach advocates writing tests to check 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 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, so listening becomes a paramount skill.

A 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 answers to their questions. A 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 systems designed using the agile approach are conceptualized as evolving, as 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 a project on time and within all the constraints is admirable. As you have probably realized by now, however, 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, and 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 a 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 left the U. S. to return to Hong Kong to get married. Since he was trained as a chef, the owner placed himself in the kitchen so the food was served on time, but he stopped greeting his customers out front in the usual way. He sacrificed the listening activity to achieve another activity, but in this case he found out it was hurting his business. Customers wanted the attention the owner had always shown them and which they expected.

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 extend 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 the activities of coding, designing, testing, and listening are weighing down the project 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 coders, 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 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 down the original members 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 productivity doesn't always follow. Tired computer programmers are less effective than alert computer programmers. Tired computer 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 to facilitate finishing a project? Perhaps. A variety of tools are available to support analysts and coders. These tools are often wise investments. Analysts, for example, use graphical packages such as Microsoft Visio to communicate ideas about a 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, mice, and more powerful graphics cards also may 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 to ensure that software quality is high.

The agile philosophy allows an analyst to adjust the quality 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 an application 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 application act reliably (or do software bugs still exist)? Are the reports generated by the system effective? Do system-generated reports 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 a 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 a good approach. Developers may be using extreme programming as one of their agile practices, so don't be surprised when your PC software applications (not to mention your operating system and Web browser) are updated often.

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 is needed to complete each of these stories and would 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 required reservations.

Once again, agile practices allow extreme measures, so to maintain quality, manage cost, and complete a project on time, an 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, an 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 available trade-offs 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 on-site customer, and using pair programming:

1. Short releases means that the development team compresses the time between releases of the product. Rather than release a full-blown version in a year, using the short release practice, the team will tackle the most important features first, release that system or product, and then improve 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 they are relaxed and less stressed when they return. This helps team members spot problems more readily and prevents costly errors and omissions due to ineffectual performance or burnout.

3. On-site customer means that a user who is an expert in the business aspect of the systems development work is on-site 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 6.3.

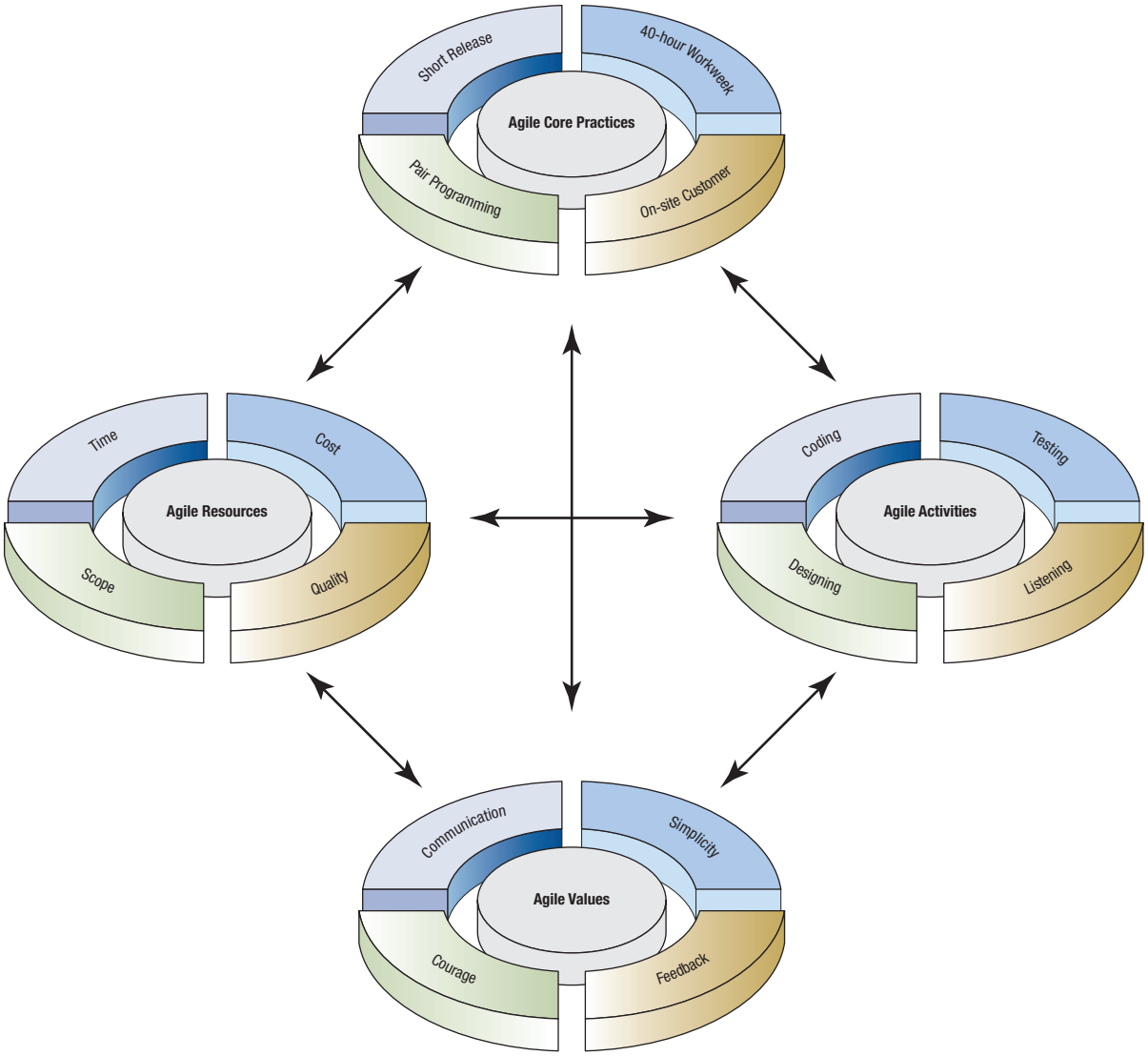


FIGURE 6.3

The core practices are interrelated with agile modeling's resources, activities, and values.

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.
4. Develop some display prototypes. In doing so, show the customers what sort of interface they will have.
5. Use feedback from the prototypes and the logical workflow diagrams to develop the system until you have created 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. A systems analyst needs to have the ability and the methods to create dynamic, context-sensitive, scalable, and evolutionary applications. Agile modeling is therefore 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 written communication. In user stories, a 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, movies, 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 merchant out in the open. Although there is not enough of a story to begin coding, an agile developer might begin to see the overall picture clearly enough to begin estimating what it will take 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 home page.

Show any 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, a video clip from a movie, 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.

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 about whether the prototype should be delayed in order to add more features or it should be delivered on time with fewer features completed.

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 an opportunity 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 along with the option to enclose a gift card.

Need or Opportunity:	Apply shortcut methods for faster checkout.					
Story:	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.					
		Well Below	Below Average	Average	Above Average	Well Above
Activities:	Coding			✓		
	Testing			✓		
	Listening			✓		
	Designing				✓	
Resources:	Time				✓	
	Cost		✓			
	Quality				✓	
	Scope			✓		

FIGURE 6.4

User stories can be recorded on cards. The user story should be brief enough for an analyst to determine what systems features are needed.

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. An agile analyst needs to choose a few stories, complete the coding, and release the 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 the 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 6.4. On paper 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.

Just as rugby teams will come to a game with an overall strategy, development teams begin a 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 owner 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 (two to four weeks for development), just as a rugby team would play in a strict time constraint of a game.

Scrum has become very popular in software development. It is an agile method that is suitable for more complex projects in which action needs to be continuous. In the development method Scrum, a limited number of features or tasks are selected for completion in a sprint,

CONSULTING OPPORTUNITY 6.4

This Prototype Is All Wet

"It 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 report 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 looking through the multiple pages of the new computer-generated reports. "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 computer reports as well as changing some of the features of the system to make reports accessible online. 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 were late.

Lather is visibly upset with Sandy's suggestions for altering the prototype and its printed reports. "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 information system, but he is concerned about Lather's unwillingness to change the prototyped reports because he has been encouraging users to think of the system 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.

typically lasting two to four weeks. The result of the sprint is a potentially shippable product. Once the sprint ends, the process begins again with new priorities and features to be finished in the next sprint.

Roles Played in Scrum

There are three roles in Scrum.

1. Product owner
2. Scrum Master
3. Team member

The product owner might be viewed as a project creator because he or she expresses the vision for the product. The product owner also is responsible for initial plans for the project, releases of the product, and the final assessment.

The Scrum Master plays many roles, including serving as the team's coach, a knowledgeable adviser, an experienced developer, and a facilitator. The Scrum Master is indeed a coach, but he or she may take on additional roles such as captain of a ship, a jungle guide who clear paths for the team, or even a guardian. A Scrum Master needs to be both knowledgeable in agile practices and have the experience to help the team. The Scrum Master is a facilitator of the team, but sometimes takes on the role of clearing obstacles for them (like the jungle guide). The culture of the group depends on the Scrum Master. He or she selects the team members, organizes and moderates Scrum meetings, and moderates conflict internally and externally.

Team members play a more significant role in Scrum. Team members:

1. Work to create and improve user stories.
2. Generate estimates.
3. Self-organize to complete the work.
4. Exhibit willingness to participate in any activity to help the project.

Teams members are chosen for their soft and technical skills. Recall that soft skills include communication and building relationships. Members may include designers, coders, a user interface expert, a tester, and a domain expert who knows about the business and the customer.

The Product Backlog

The product backlog is composed of features and other deliverables designers intend for the product based on user stories. In addition to listing features to add to an application, a product backlog also lists bugs to fix or even applications that need to be documented.

Figure 6.5 is product backlog registry. User stories are briefly described in the second column. Other columns describe who will benefit from completing each user story, what resources will be required, and how we will know when the user story is completed and accepted.

The list of user stories is reorganized so that the most important user stories appear on the top. There are many ways to prioritize user stories, but small items that can be tackled quickly are well suited for the top of the list. Although the list is not strictly in order of shortest processing time, it is encouraging to get things done. Completing many small tasks can be more encouraging than tackling one large task. User stories need to be understood by everyone on the team in order to work on the list. User stories that are not clear can be placed further down on the product backlog list.

The Sprint Cycle

Keeping a list in product backlog is one thing, but the registry doesn't accomplish anything unless the team starts working on user stories in the list. A sprint backlog is created to select the user stories that need to be completed soon. Stories are deliverables the team accomplishes. Tasks, on the other hand, are parts of the story or units of work that each team members does.

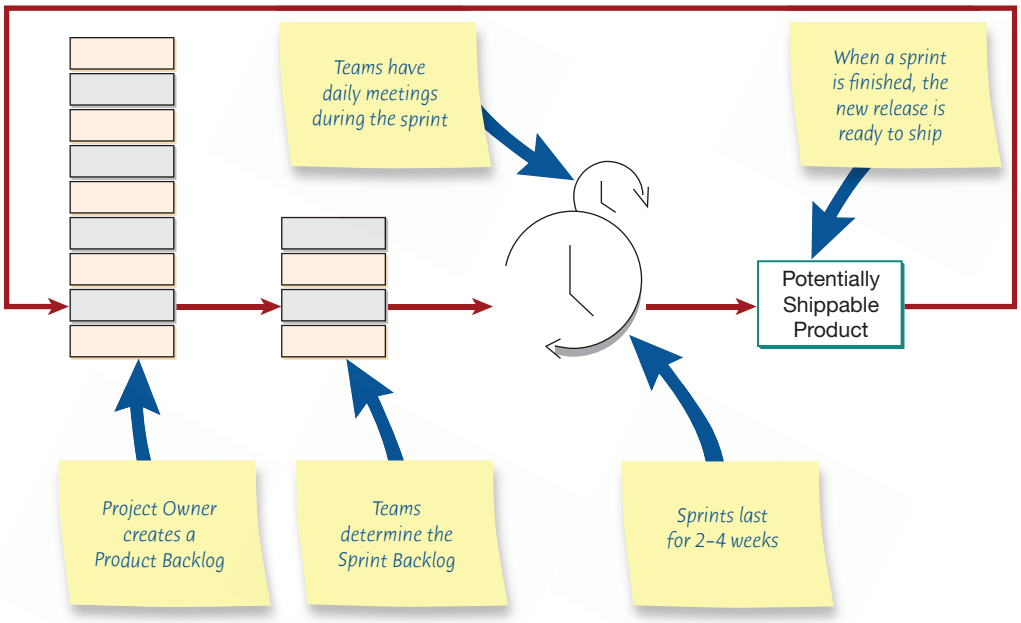
Number	Tasks based on user stories	Who will benefit	Resources required	Will be accepted when
W212	Make it easier to continue shopping once an item is placed in the shopping cart	Visitors to the website	Minor coding effort, testing	Users react positively to the prototype, coding is completed and tested
W210	Offer options for shipping earlier in the online ordering process	Visitors to the website	Dynamically calculating rates based on zip code and preferred delivery speed, coding, testing	Validity is checked, code is tested, information is approved as understandable to users
W211	Add product reviews by peers	Users who would feel more confident having these reviews available	Collaborative filtering, redesign of product pages, coding, testing	Users approve of the prototype and the collaborative system is thoroughly tested

FIGURE 6.5

A product backlog registry.

FIGURE 6.6

How teams work together to accomplish a sprint cycle for developing a new release.



The sprint cycle can vary in length, but we find that most companies set two weeks as the length of a sprint cycle. That gives the team two weeks to dispatch with a few user stories and then decide whether the product is ready to be released. That may seem impossible at first, but once a team gets into the habit of a two-week cycle, it begins to become routine and satisfying at the same time.

At the end of the two-week cycle, the team needs to determine whether the product should be released. The first question is, "Does this potential product release have value?" The product (the app or the website the team has been working on) should have value over the previous release. The second question is, "Is the product release ready to ship?" The team must have completed and tested the new features based on user stories. It must work and be free from errors.

Two-week releases have many advantages. The spirit of the team remains high because it is easy to measure accomplishments. Completing the product is more real to the team. If the team can tackle issues in a short period of time, it just takes a number of two-week releases to get the entire project completed.

Other advantages include the continual feedback the team gets from the customers. Short releases are prototypes. Customers' reactions are very valuable.

Figure 6.6 shows the process and people involved in a sprint cycle. Notice that the project owner, teams of developers, and newly developed software products all have a part to play. Sprints are short cycles of team development activity lasting only two to four weeks, with teams meeting daily during the sprint to create a new release that is ready to ship.

Other Unique Scrum Features

A few other aspects are unique to Scrum. They include a planning meeting, daily Scrum meetings, charts than monitor progress, and a sprint review.

SCRUM PLANNING MEETING There are two parts to a Scrum planning meeting. First, the product owner presents the list of features on the wish list of user stories. At this point, the team asks questions of the product owner.

The second part involves estimating the resources needed to complete all of the features. A common way to do this is to play planning poker, which is described in the next section. A card game approach to estimating makes the atmosphere of the meeting more enjoyable. Team members need to socialize, and Scrum planning meetings provide good opportunities to do so. The team members lead this part of the Scrum planning meeting. The team chooses the deliverables (user stories) that need to be accomplished. The team also divides the work into tasks. Team members are in control from this point on. They prioritize the selected user stories and make a commitment to finish a certain number of them by the end of the current sprint cycle.

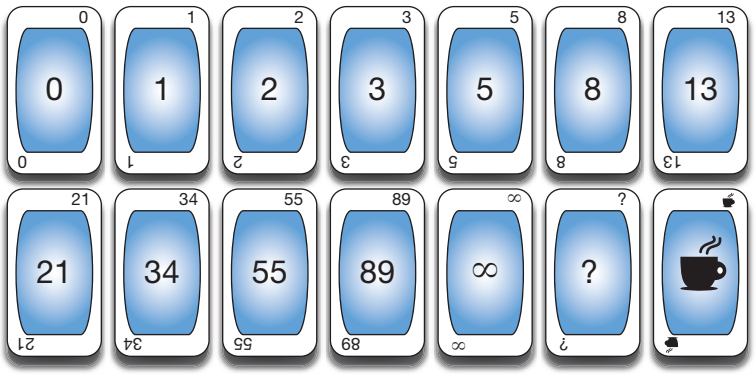


FIGURE 6.7

A Fibonacci number-based deck of cards is used to play planning poker during a Scrum. Play the coffee card if you need a break.

SCRUM PLANNING POKER Planning poker is a way to help the team determine estimates for completing the features that arise from user stories. Planning poker is played using a deck of cards as shown in Figure 6.7. The sequence of numbers starts low and rapidly grows larger. The rationale is that there is much uncertainty in estimating larger user stories. A commonly used deck is based on Fibonacci numbers, 0, 1, 2, 3, 5, 8, 13, 21, 34, 55, and 89. (A Fibonacci number is generated by adding the two previous numbers, which guarantees that the interval between numbers becomes larger as the numbers get bigger.) In addition, decks sometimes include an infinity symbol representing a number too big to surpass, a question mark, and a coffee cup (used when members need a break from estimating). Here are the rules of the game:

1. A moderator keeps the estimation meeting running efficiently.
2. The product owner presents one of the user stories that needs to be estimated.
3. Each team member chooses a card with a number on it and lays it face down. A lower numbered card means that a project can be completed faster than higher cards estimates. The numbers may represent the number of days it may take to finish a feature, story points, or even difficulty in abstract terms.
4. Team members turn over their cards at the same time. (This avoids the problem of anchoring, or giving importance to the first estimate mentioned.)
5. The team members with the highest and lowest estimates have the opportunity to defend their ratings.
6. The entire team can now discuss the estimates. Ideally, the moderator should place a time limit on the discussion. A timer on a smartphone is a good way to limit the discussion.
7. A new hand is then played and so on. When a consensus on the time estimate for developing the features is reached, the team can move on to the next user story.

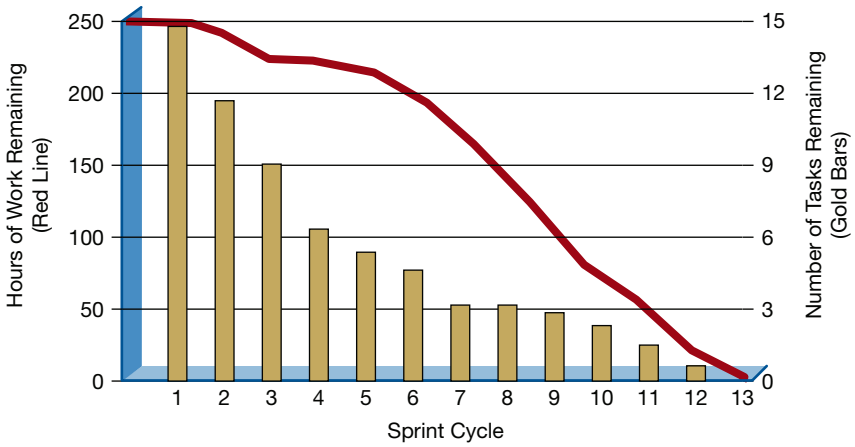
Planning poker can be a highly useful (and fun) way to develop estimates of completion times for the work designers are doing on user stories. Good estimates are difficult for inexperienced developers, so a tool like this can improve the reliability of the team's estimates without placing undue burden on newer team members.

DAILY SCRUM MEETINGS The meeting that starts off the daily Scrum is called a stand-up meeting because it lasts only a few minutes (the concept implies that team members will stand, but only for a short time). At this meeting team members tell each other what tasks they've been working on since the previous daily Scrum, what tasks they expect to complete during the current daily Scrum, and what obstacles might get in their way. Most of the time, these obstacles can't be solved during the 15-minute meeting, but it is important to identify them then.

USING BURNDOWN CHARTS One way to keep track of performance is to use a sprint burndown chart. An example of a burndown chart, which can be updated on a daily basis, is shown in Figure 6.8. The horizontal axis tracks the time that has elapsed. The vertical axis may track the number of tasks remaining or the number of hours to completion of the remaining tasks. The red line shows the hours of work remaining, and the yellow bars show the number of tasks remaining, all plotted against time (in this case in terms of a sprint cycle). Burndown charts are useful ways to graphically show the progress of an agile software development project.

FIGURE 6.8

A burndown chart shows progress on the systems project, depicting work remaining versus the time (measured in sprint cycles).



SPRINT REVIEW At the end of a sprint, the team gets together in a meeting to review the work that was done and note any tasks that were not completed. The user stories completed are prominently documented, and user stories the team committed to that were not finished are noted. The team is not making decisions for the next sprint. That will occur when the team repeats the steps starting with creating a new product backlog. This meeting is a retrospective in which the team articulates accomplishments and lessons learned. By stating what went well and what did not, the team can improve the process in anticipation of the next sprint.

Kanban

Kanban is a concept developed by Toyota to achieve a more effective and efficient way of delivering products. The word's meaning in English is "signboard," a method of directing consumers to certain areas to find products or directing employees to a location to replenish items. The concept of kanban is widely used in software development today.

Key elements of the kanban system as applied to software development are:

1. Visualize the workflow.
2. Keep work-in-process (WIP) as small as possible.
3. Reevaluate the workflow, reassigning priorities if need be.
4. Strive for continual improvement, eliminating bottlenecks and evaluating WIP limits.

It is desirable to set up a workflow summary similar to that shown in Figure 6.9, a kanban board adapted for Scrum. It was created by a company in the Netherlands and has a proprietary tool called patboard, which helps developers visually display progress on their agile projects. The cards are magnetic and washable and can be reused. They are easy to pick up and place as your project progresses, and they are small enough to depict many parts of the project but large enough to be seen from across the room where the patboard is displayed. All of this can be done using software, but the tactile nature and the easy movement of a magnetic card from one column to the next makes this process more interactive and enjoyable.

Kanban is based on a pull system. Here is an example: A new user story is introduced that states the company website must be updated. This notice means that a kanban "card" should be created. This work happened to be high priority, so it is pulled from the "backlog" column to the "sprint" column. Soon it is pulled into the "to-do" column. When the Web designers begin to work on it, they pull the task into the "doing" column. Once the new web pages are created, the task is pulled into the "verify" column so links can be tested and validated. When testing is completed, the task is pulled into the "done" column.

Note that the task was never *pushed* into another column. The concept of a pull system helps ascertain accountability and responsibility when projects require teams of people.

Cycle time is the time it takes for a task to enter the system as a "backlog" item until it reaches the "done" column. The shorter the time, the better. Throughput is the average number of items that move from the "backlog" column to the "done" column in a certain period of time or cycle. You can calculate throughput using the following equation:

$$TP = WIP/CT$$

where WIP is the work-in-progress and CT is the cycle time.

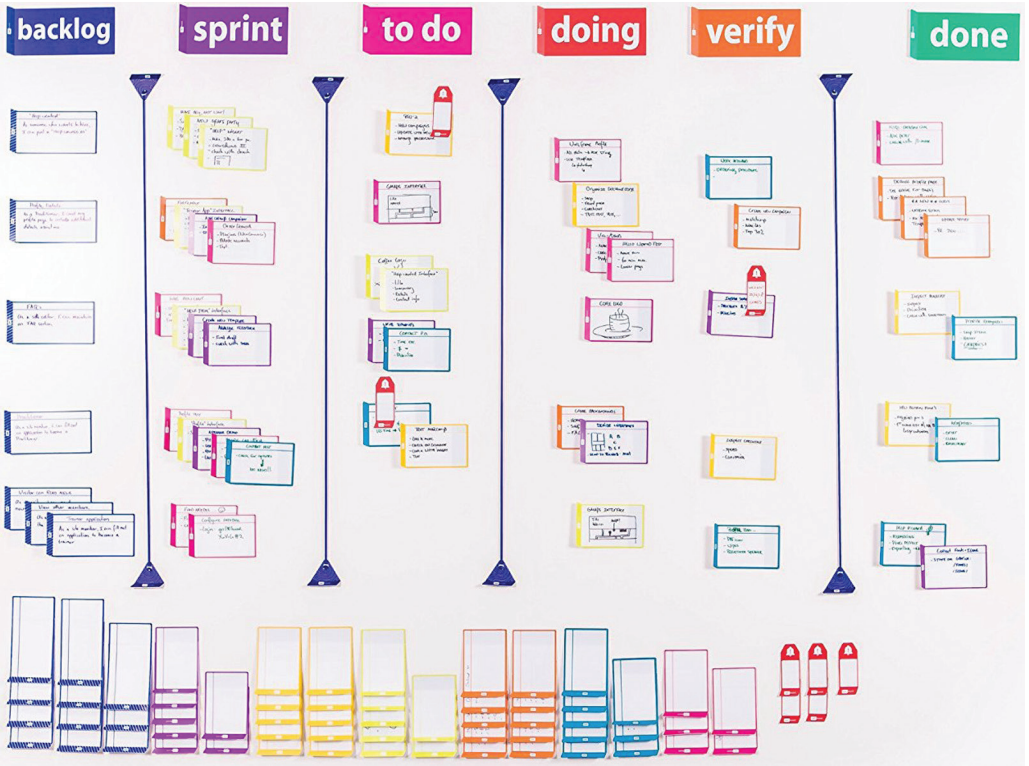


FIGURE 6.9

A kanban board can be created using the tools visible at www.patboard.com.

So if there are 12 user stories in progress during a four-week period, throughput is calculated as 12 divided by 4, resulting in a throughput of 3 user stories per cycle. This is, of course, a guideline. The actual number of user stories completed may vary depending on a number of factors.

The concept of kanban is applicable to all forms of agile methods. When applied to Scrum, some have used the term scrumban. They point out that scrumban is different from kanban because fixed scrum sprints are employed.

Scrum Advantages and Disadvantages

Scrum has many advantages, including:

1. Quick product development
2. Exercising a user-oriented approach
3. Encouraging teamwork
4. Being less confusing than more formal approaches
5. Flexibility
6. Being satisfying to team members
7. Rewarding smaller but meaningful accomplishments
8. Providing feedback
9. Adaptability

As one can see, Scrum has many advantages. Its disadvantages include:

1. Documenting features improperly
2. Releasing products with errors
3. Releasing products too soon for the user
4. Completing the sprint backlog under pressure
5. Working as a geographically dispersed team may be difficult
6. Working as a team when special skills are required may be challenging
7. Replacing team members who leave the team is difficult

Developers need to pay attention to minimize the effect of any disadvantages.

Scrum is a high-intensity methodology that has many advantages for developing complex and innovative packages. It is one approach that adopts the philosophy of agile modeling; however, if it becomes too intense, an organization may decide to use another agile method.

DevOps: A Cultural Shift for App Development

DevOps, which is derived from the words "Development" and "Operations," is one way to decrease the deployment time for newly developed applications and maximize profit by rapidly addressing market opportunities and getting customer feedback in a timely manner. DevOps tries to merge these processes.

DevOps is depicted in Figure 6.10. Development and operations are working in parallel streams within a DevOps culture. Notice that development is focused on the rapid development of new applications, planning, prioritizing, designing, and coding. Operations works on testing, releasing, configuring, monitoring, and then maintaining new releases and established application software.

DevOps has been described as a culture rather than as a methodological approach such as SDLC or agile development because it requires a different mind-set to analyze systems problems in this way. Rather than waiting for a systems problem that arises to be solved by the development team, or arguing about where the error occurred or who is responsible (which wastes time in fixing the problem), DevOps creates two approaches in the organization that run on parallel tracks: one track supports developing rapid innovative applications, and the other supports the maintenance and operations of those processes already in place.

DevOps uses a process organization centered on value streams. Analysis of 12 to 15 processes can be drawn around each stream. Small teams of 5 to 10 people are entirely responsible for a value stream. If you're wondering how big a DevOps team should be, you can use the Amazon two-pizza rule as a guide for team size. If the team is not small enough to be fed satisfactorily by two large pizzas, then the team is too big. The teams limit their multitasking, working on one to three projects at most. They work in small batches and small steps. They reduce the number of handoffs they do to customers who are outside the organization (external) or other departments (internal customers). They cut down or eliminate waste by avoiding partially completed work, extra processes, task switching, and tracking down defects. To detect errors early, team members "swarm" a problem so that it can be fixed immediately and not passed on at a higher cost, and so they can learn to avoid those mistakes. Quality is pushed to the team where the work is being done.

DevOps works to make their systems development efforts resilient, and they have "fire drills." Netflix calls these drills "Chaos Monkey": Shutting down all servers and processes to make sure the company is able to cope with worst-case scenarios. Security vulnerabilities are

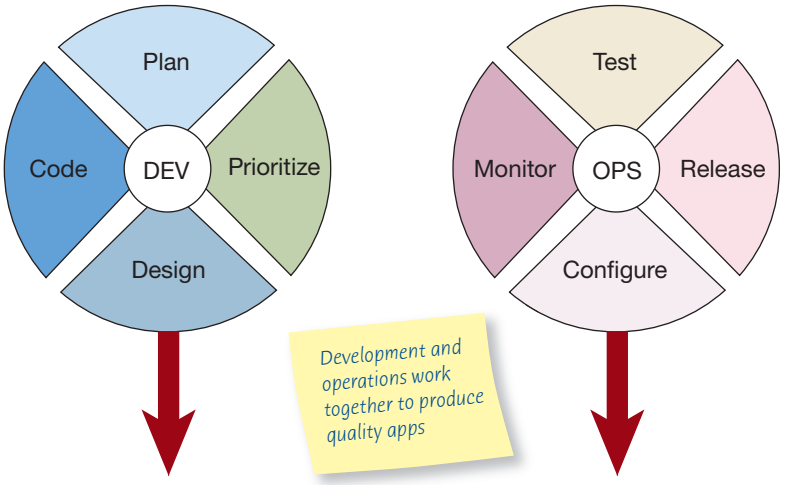


FIGURE 6.10

DevOps exists in its own culture in which two parallel streams work to produce a new software release.

pushed to the DevOps teams and integrated into shared code repositories. At the conclusion of the drill, everyone is debriefed to evaluate whether the project was a success or a failure and whether it met the business's goals. If there is a security problem, a postmortem evaluation is conducted on all security breaches so that teams can learn from those problems and will not repeat them.

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. Although it is true that projects developed using agile methods often require tweaking to work properly, agile developers state that tweaking is part of the process. The agile approach implies many short releases, with features added along the way.

Lessons Learned from Agile Modeling

Often posed as an alternative way to develop systems, the agile approach seeks to address common complaints arising about the traditional SDLC approach: being too time consuming, focusing on data rather than on humans, and being too costly. The agile approach is 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 websites. Many of them were successes, some have been failures. We can learn a great deal from studying them and the agile values, principles, and core practices. Following are the six major lessons we draw from our examination of agile modeling. Figure 6.11 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.

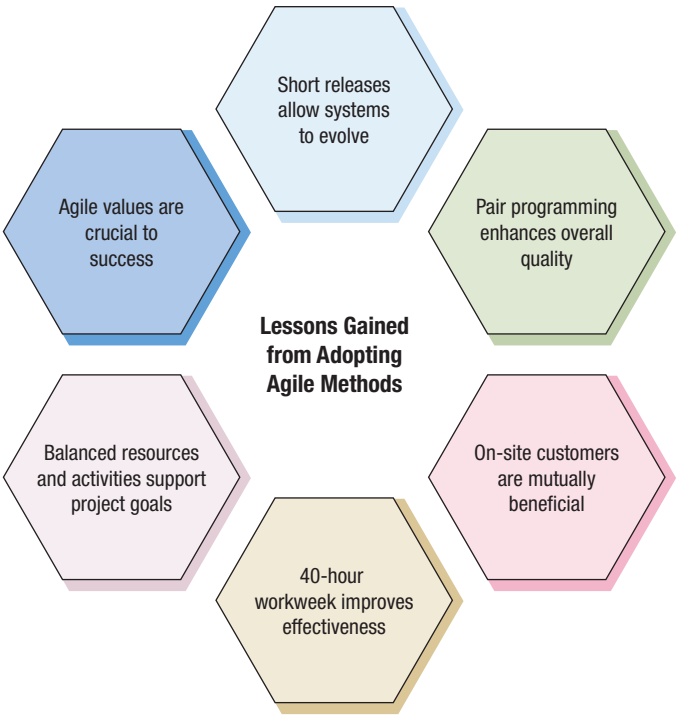


FIGURE 6.11

Six vital lessons can be drawn from the agile approach to systems.

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 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 on-site customers are mutually beneficial to the business and the agile development team. Customers serve as a ready reference and a reality check. The focus of the system design is 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 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 these values, will fail. True dedication to these values is fundamental to successful development using the agile approach.

Improving Efficiency in Knowledge Work: SDLC versus Agile

Researchers Davis and 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. Based on their study of a group of programmers, Davis and Naumann claim that the best programmers are 5 to 10 times more productive than the worst ones. They further point out this ratio is only 2:1 for workers in clerical or physical tasks. Their suggestion is that software can help improve many situations.

Adopting more software may indeed improve performance, but it is reasonable to suggest that changing an approach or a methodology may also improve performance. Consequently, we use the traditional systems development approach to examine each aspect of knowledge work productivity through the lenses of both structured and agile methodologies. Figure 6.12 lists the original seven strategies for productivity improvement and explains what methods are used to improve the efficiency of systems development for both structured and agile methodologies.

In the following sections we 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 coders 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 an application, enter the required information, and retrieve it when it is needed again.

Strategies for Improving Efficiency in Knowledge Work	Implementation Using Structured Methodologies	Implementation Using Agile Methodologies
Reduce interface time and errors	Adopting organization 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	Managing project; 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 on-site 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

FIGURE 6.12

How Davis and Naumann's strategies for improving efficiency can be implemented using two different development approaches.

Structured approaches encourage adopting standards for everything. Rules set forth include items such as "Google Chrome will be the default on office desktops for browsing rather than Firefox." There 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 requiring all personnel to document their procedures are useful and are necessary in case another programmer must take over during the project.

In an agile approach, forms and procedures work well too, but another element is added. The additional practice of pair programming ensures 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 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. With two people working on the same design and code, interface time is not an issue; it is an integral part of the process. Davis and Naumann (1999) 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 but others still need to learn them. Typically, we ask that developers learn these products as 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 are 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 analysts and programmers to spend most of their time on system development rather than on learning specific tools.

MAC APPEAL

Just as agile methodologies are an alternative to the SDLC, OmniFocus is an alternative to Microsoft Project and 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, stay 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 (2015), 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 goes through five actions: collect, process, organize, review, and do.

A systems analyst using OmniFocus collects items from his or her Web browser, address book or calendar, and most other applications on a Mac. The analyst can categorize the data 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.

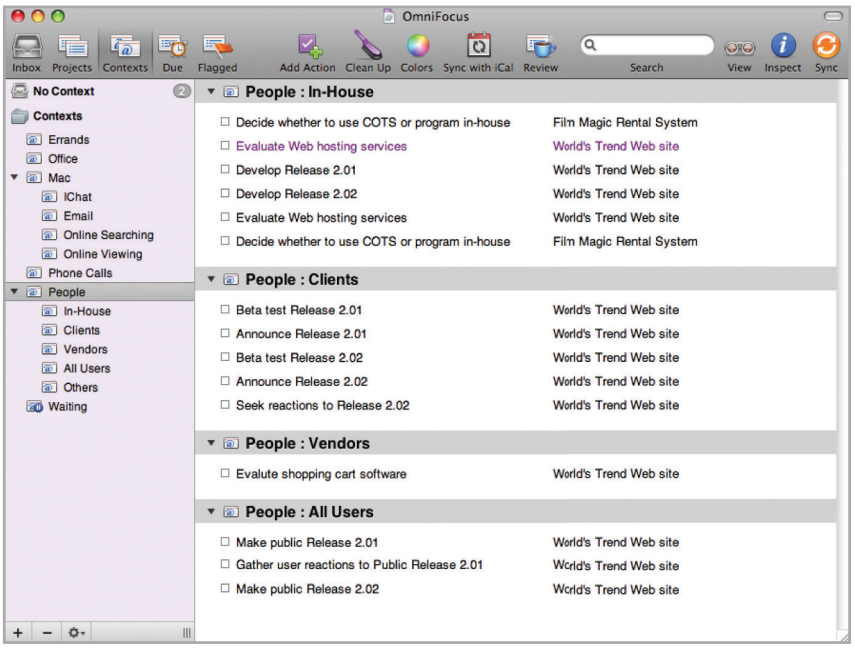


FIGURE 6.MAC

OmniFocus from The Omni Group. (Used by permission of the Omni group.)

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, 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 entity-relationship 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 possess fewer features, but additional features are added with each new release.

REDUCING THE NONPRODUCTIVE EXPANSION OF WORK Parkinson's law states that "work expands 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 in 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 coders 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 an organization, goals, priorities, and details about current information systems before they can proceed to develop a new system. Data-gathering methods include interviewing, administration of 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 Structured Observation of the Environment (STROBE) would encourage an analyst to specifically observe key elements and form conclusions based on the observations of the physical environment. A sampling plan would be determined quantitatively to provide the systems analyst with select reports and memos to examine.

Knowledge searches are less structured in an agile modeling environment. The practice of having an on-site customer greatly enhances access to information. The on-site 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: when the system developers want to know something, they can just ask. The downside, however, is that the on-site 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 at the root of multiple development problems. We know that communication increases when more people join a 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 groups and setting up barriers often introduces 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, and the developers communicate effectively as a team. Communication is one of the four values of the agile philosophy, and 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 coders.

A traditional approach would filter information to shield analysts and coders 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 coders are expected to stick to a 40-hour workweek. Some might view this as a questionable practice. How will all the work ever get done? The agile philosophy states 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 workweek schedule, agile methodology claims that 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.

In a 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 6.13 shows many of the variables that need to be considered when assessing the risk of adopting organizational innovation.

ORGANIZATIONAL CULTURE A key consideration in organizational innovation 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 a systems development group. Analysts and other developers must use caution in introducing new techniques into this type of setting because their success is far from assured and long-standing

FIGURE 6.13

Adopting new information systems involves balancing several risks.

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 welcome agile innovations in systems development. 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, taking all other projects and factors (internally and externally) 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 coders in the new approach. This may involve either costly off-site seminars and courses or hiring consultants to work with current staff on-site. Furthermore, 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 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 on-site 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.

Although there is ample anecdotal evidence that agile methodologies are superior for development under some conditions, their history has been brief and the methods are 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, a module, an interface, a form, or a web page. In the case 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 an organization as well as to individuals. We have examined the risks to an organization as a whole as well as the risks to an individual systems analyst involved in the organization's desire to innovate.

HYPERCASE EXPERIENCE 6

"Thank 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, 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 on-site 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 Department 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.

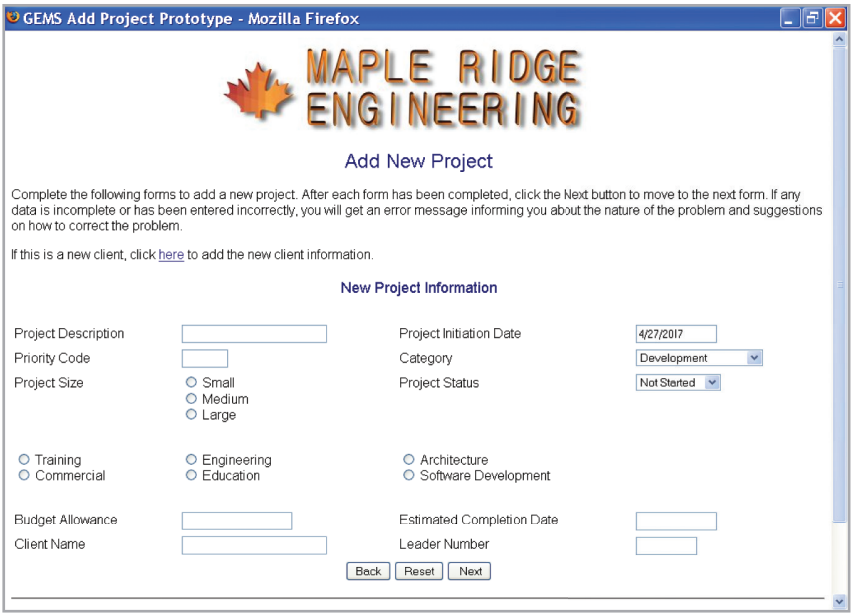


FIGURE 6.HC1

One of the many prototype screens found in HyperCase.

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.

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.

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) on-site 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.

Scrum is an agile method suitable for more complex projects. In the development method Scrum, a limited number of features or tasks are selected for completion in a sprint, typically lasting two to four weeks. The result of the sprint is a potentially shippable product. Once the sprint ends, the process begins again with new priorities and features to be finished in the next sprint. Specific roles are played in Scrum and specific actions are taken. Members include designers, coders, a user interface expert, a tester, and someone who is a domain expert (who knows about the business and the customer). The product backlog is composed of features and other deliverables that designers intend for the product based on user stories. In addition to listing features to add to an application, a product backlog also lists bugs to fix or even applications that need to be documented. A sprint backlog is created to select the user stories that need to be completed soon. Stories are deliverables the team accomplishes. Tasks, on the other hand, are parts of the story or units of work that each team members does. The sprint cycle can vary in length, but we find that most companies set two weeks as the length of a sprint cycle. That gives the team two weeks to complete work on a few user stories and then decide whether the product is ready to be released. Then the cycle begins again.

DevOps (derived from Development and Operations) is a cultural shift in the organization. It can create two approaches in the organization that run on parallel tracks, one track supports developing rapid innovative applications, and the other supports the maintenance and operations of those processes already in place.

Systems development life cycle and agile approaches handle improving knowledge work efficiency differently. There are several inherent dangers to organizations that adopt 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
agile modeling
agile principles
agile values
assume simplicity
burndown chart
DevOps
embracing change
extreme programming (XP)
first-of-a-series prototype
implementation
incremental change
kanban
modifying the prototype
nonoperational prototype
on-site customer
pair programming
patched-up prototype
product backlog
prototype
requirements planning phase
Scrum methodology
Scrum planning poker
selected-features prototype
short release
sprint
sprint backlog
sprint review
stressing the user interface
throughput
user involvement with prototyping
user stories
working in manageable modules

Review Questions

1. What four kinds of information is an 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. Which type of prototyping would you recommend for an organization with multiple locations around the world, each with similar needs?
7. What are the two main problems identified with prototyping?
8. What are the four values that must be shared by the development team and business customers when taking an agile approach?
9. What are agile principles? Give five examples.
10. Discuss the four basic activities of development used in the agile method.
11. Name the four resource control variables used in the agile approach.
12. How do the core agile practices interrelate with activities, resources, and values?
13. What is a user story? Is it primarily written or spoken? State your choice, then defend your answer with an example.
14. What is the meaning of agile modeling, and why is it known as a change-embracing method?
15. What is Scrum?
16. Discuss the feature of Scrum used for time estimation.
17. What are four actions team members take in Scrum?
18. What should be listed in a product backlog registry?
19. List ways in which the performance of Scrum can be measured during sprint cycles.
20. What are two questions the team should ask of itself after a two-week sprint cycle has been completed?
21. What are the nine advantages of Scrum?
22. Discuss key elements of the kanban system as applied to software development.
23. What are the seven disadvantages of Scrum?
24. How does DevOps differ from methodological approaches?
25. Explain the role of "fire drills" in systems development using DevOps.
26. What two parallel tracks are used for running DevOps?
27. List the six lessons learned from agile modeling.
28. Name the seven strategies for improving efficiency in knowledge work.
29. 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 believe 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. In a paragraph, suggest how an interactive website featuring a prototype might address Flo's concerns about capturing user information requirements.

4. Harold, a district manager for the multioutlet chain Sprocket's Gifts, thinks that building a prototype can mean only one thing: a nonworking scale model. He also believes that this 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, in a paragraph, 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. Suppose you have just been hired for a systems development project that involves designing a mobile application that enables students to pay fees to educational institutions. As you only have a few months before product launch, discuss the strategies you would adopt to increase the efficiency of development.
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 website. Following the format shown in Figure 6.4, write a user story for these features:
   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. Create a product backlog registry for any two user stories identified in Problem 9, listing probable beneficiaries, resources required, and indication of completion.
11. Visit an online course provider like edX and write up a dozen brief user stories to improve their website.
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 united group, assign some of the roles that people take on in agile development. Make sure that one person is an on-site 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 on-site customer choose an ecommerce business with which he or she is familiar. Assume that the customer wants to add some functionality to the website. 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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7

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.

A systems analyst needs to make use of the conceptual freedom afforded by data flow diagrams (DFDs), which graphically characterize data processes and flows in a business system. In their original state, DFDs 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 DFDs may be used to represent and analyze detailed procedures in the larger system. 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 DFDs, and (4) analysis of a proposed system to determine whether the necessary data and processes have been defined.

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), a systems analyst can put together a graphical representation of data processes throughout an organization. By using combinations of only four symbols, a systems analyst can create a pictorial depiction of processes that will eventually provide solid system documentation.

Conventions Used in Data Flow Diagrams

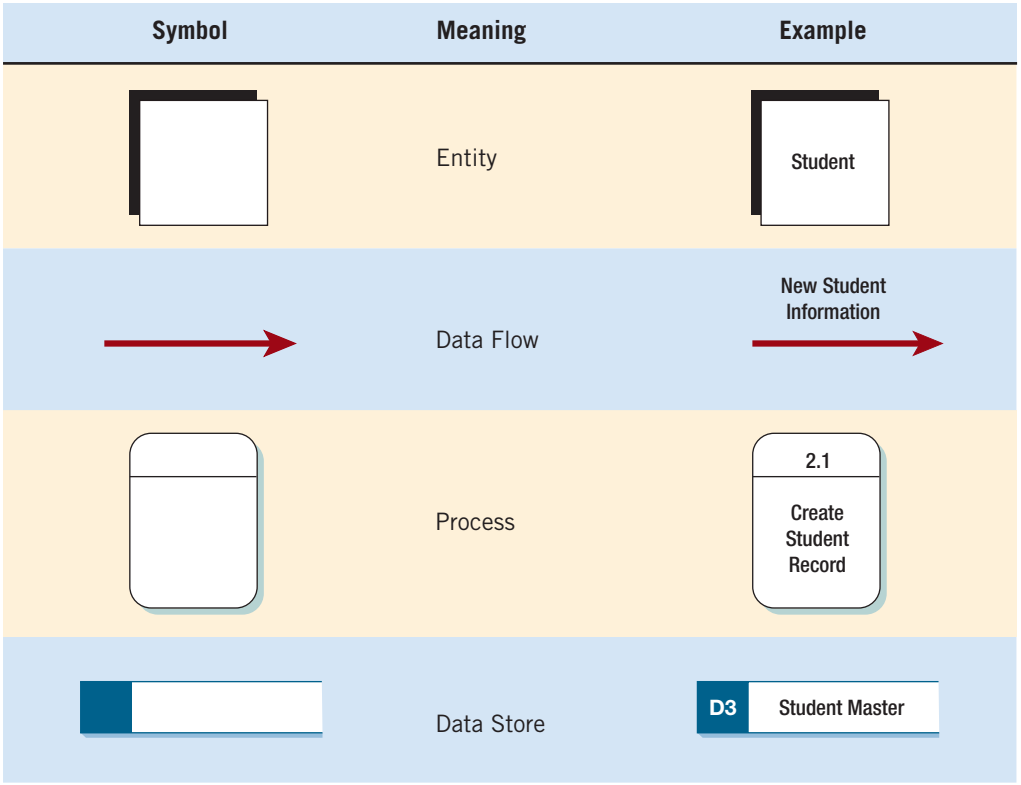
Four basic symbols are used to chart data movement on DFDs: a double square, an arrow, a rectangle with rounded corners, and an open-ended rectangle (closed on the left side and open on the right), as shown in Figure 7.1. An entire system and numerous subsystems can be depicted graphically with these 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 being outside the boundaries of the system. An entity should be named with a noun. The same entity may be used more than once on a given DFD 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.

FIGURE 7.1

The four basic symbols used in data flow diagrams, their meanings, and examples.



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 from the one entering it. Processes represent work being 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 that indicates its level in the diagram. This organization is discussed later in the 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 DFDs 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 on the right side. These symbols are drawn only wide enough to allow identifying lettering between the parallel lines. In logical DFDs, 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 DFD. 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 DFDs. First, a systems analyst needs to conceptualize data flows from a top-down perspective.

To begin a DFD, collapse the organization's system narrative (or stories) 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. A DFD must have at least one process, and it 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, DFDs move from general to specific. The first diagram helps a systems analyst grasp basic data movement, but its general nature limits its usefulness. The initial context diagram should be an overview, including basic

FIGURE 7.2

Steps in developing data flow diagrams.

Developing Data Flow Diagrams Using a Top-Down Approach

1. Make a list of business activities and use it to determine various
   - External entities
   - Data flows
   - Processes
   - Data stores
2. Create a context diagram that shows external entities and data flows to and from the system. Do not show any detailed processes or data stores.
3. Draw Diagram 0, the next level. Show processes, but keep them general. Show data stores at this level.
4. Create a child diagram for each of the processes in Diagram 0.
5. Check for errors and make sure the labels you assign to each process and data flow are meaningful.
6. Develop a physical data flow diagram from the logical data flow diagram. Distinguish between manual and automated processes, describe actual files and reports by name, and add controls to indicate when processes are complete or errors occur.
7. Partition the physical data flow diagram by separating or grouping parts of the diagram in order to facilitate programming and implementation.

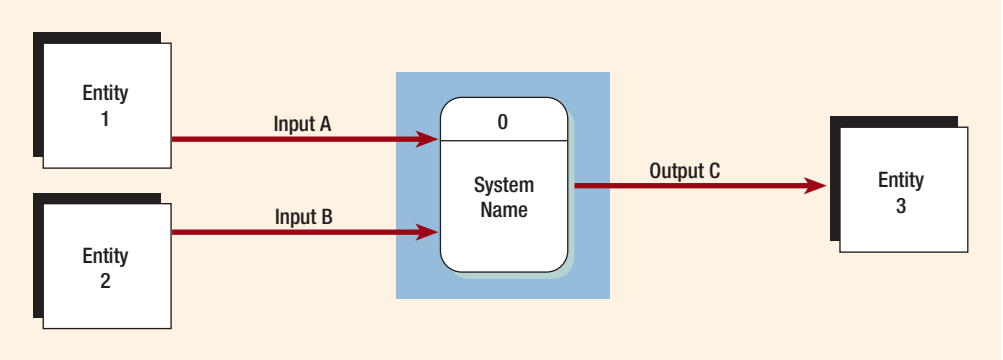
inputs, the general system, and outputs. This diagram will be the most general one, providing a bird's-eye view of data movement in the system and the broadest possible conceptualization of the system.

The context diagram is the highest level in a DFD and contains only one process, representing the entire system. The process is given the number zero. All external entities are shown 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 DFD. 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



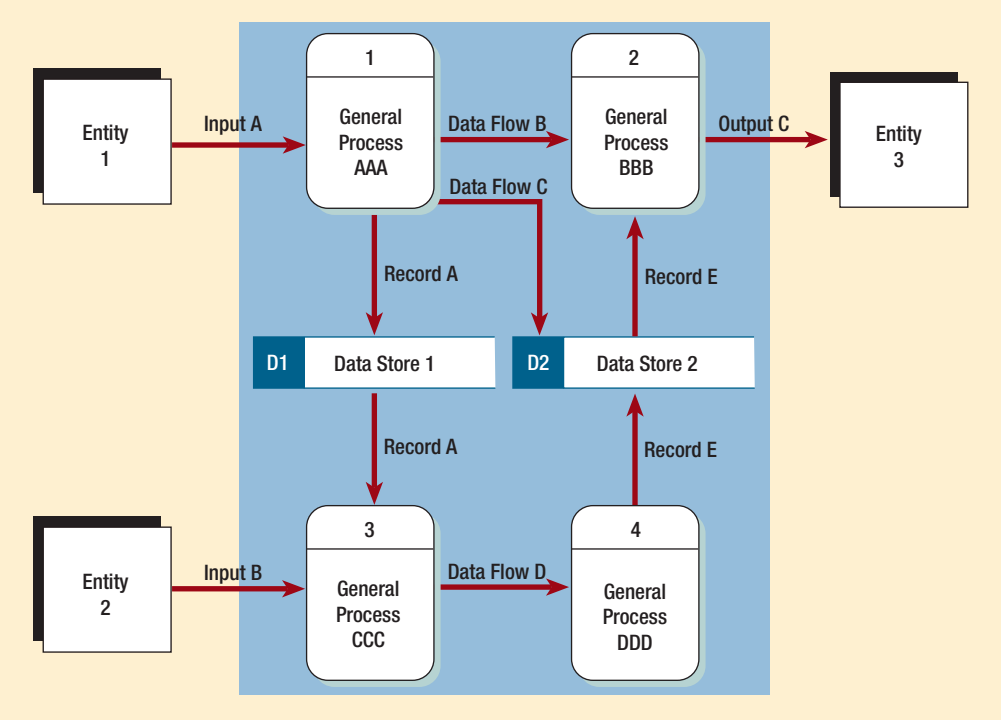


FIGURE 7.3

Context diagrams (top) can be "exploded" into Diagram 0 (bottom). Note the greater detail in Diagram 0.

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 DFD 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:

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 is vertical balancing, which 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 DFD.

Checking Diagrams for Errors

Several common errors made when drawing DFDs 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 also is 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 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 DFD 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 DFD 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.

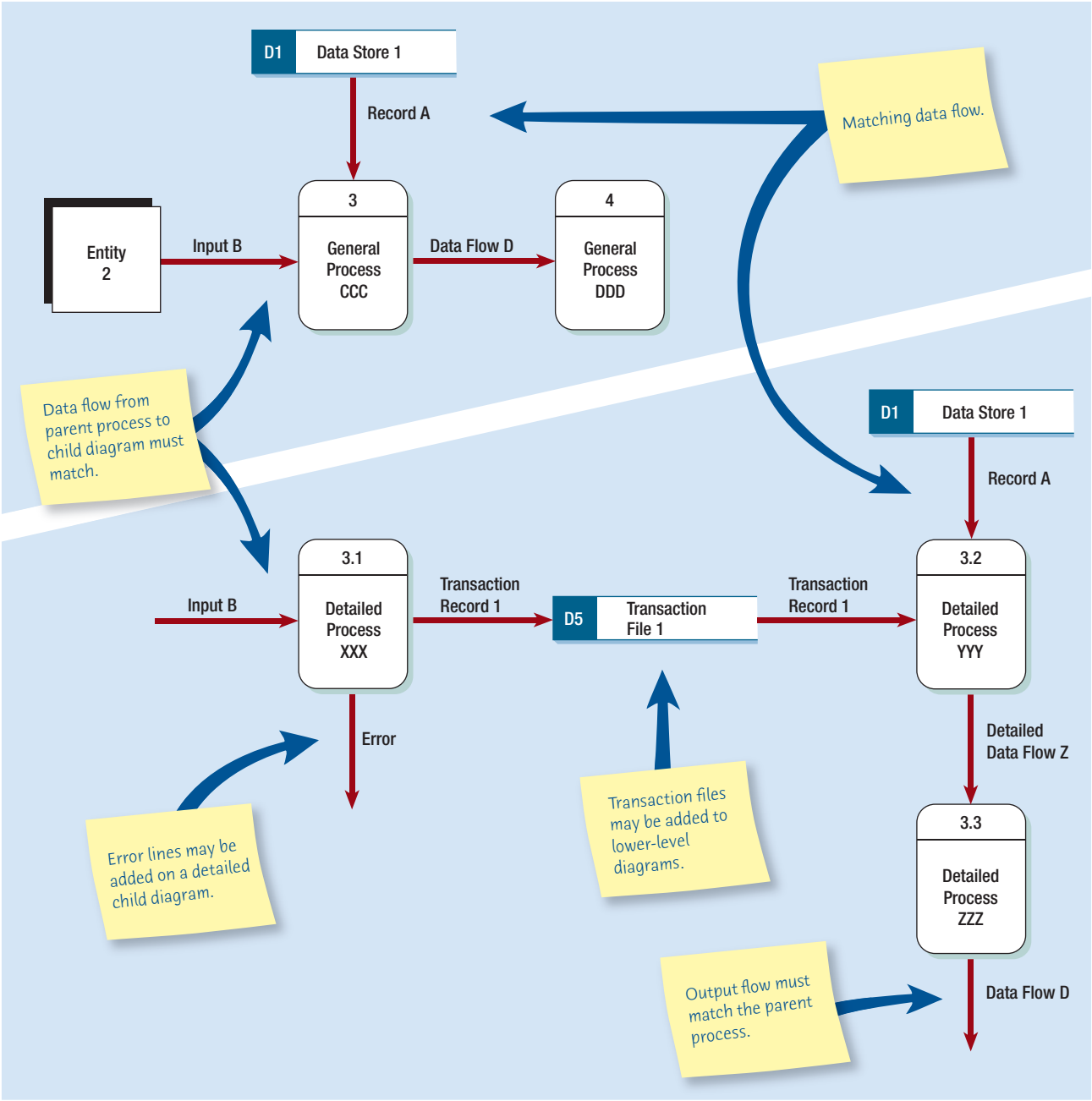


FIGURE 7.4

Differences between the parent diagram (top) and the child diagram (bottom).

4. ***Including more than nine processes on a DFD***. 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.
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 DFDs, 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

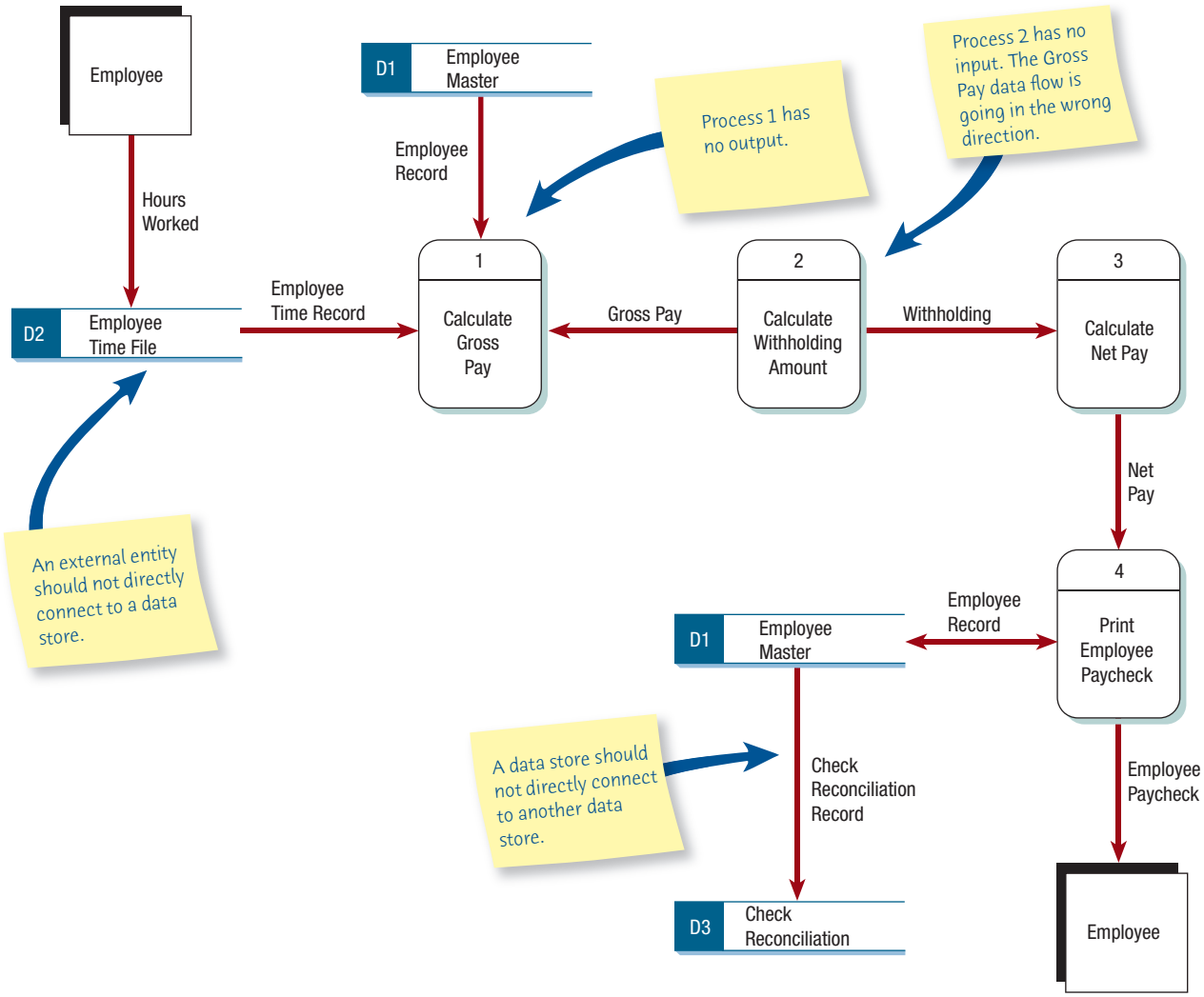


FIGURE 7.5

Typical errors that can occur in a DFD (payroll example).

alone; it also needs to include an EMPLOYEE NAME and 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 DFD 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 DFD focuses on the business and how the business operates. It is not concerned with how the system will be constructed. Instead, this conceptual diagram describes the business events that take place and the data required and produced by each event. Conversely, a physical DFD 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, and the physical model depicts the system.

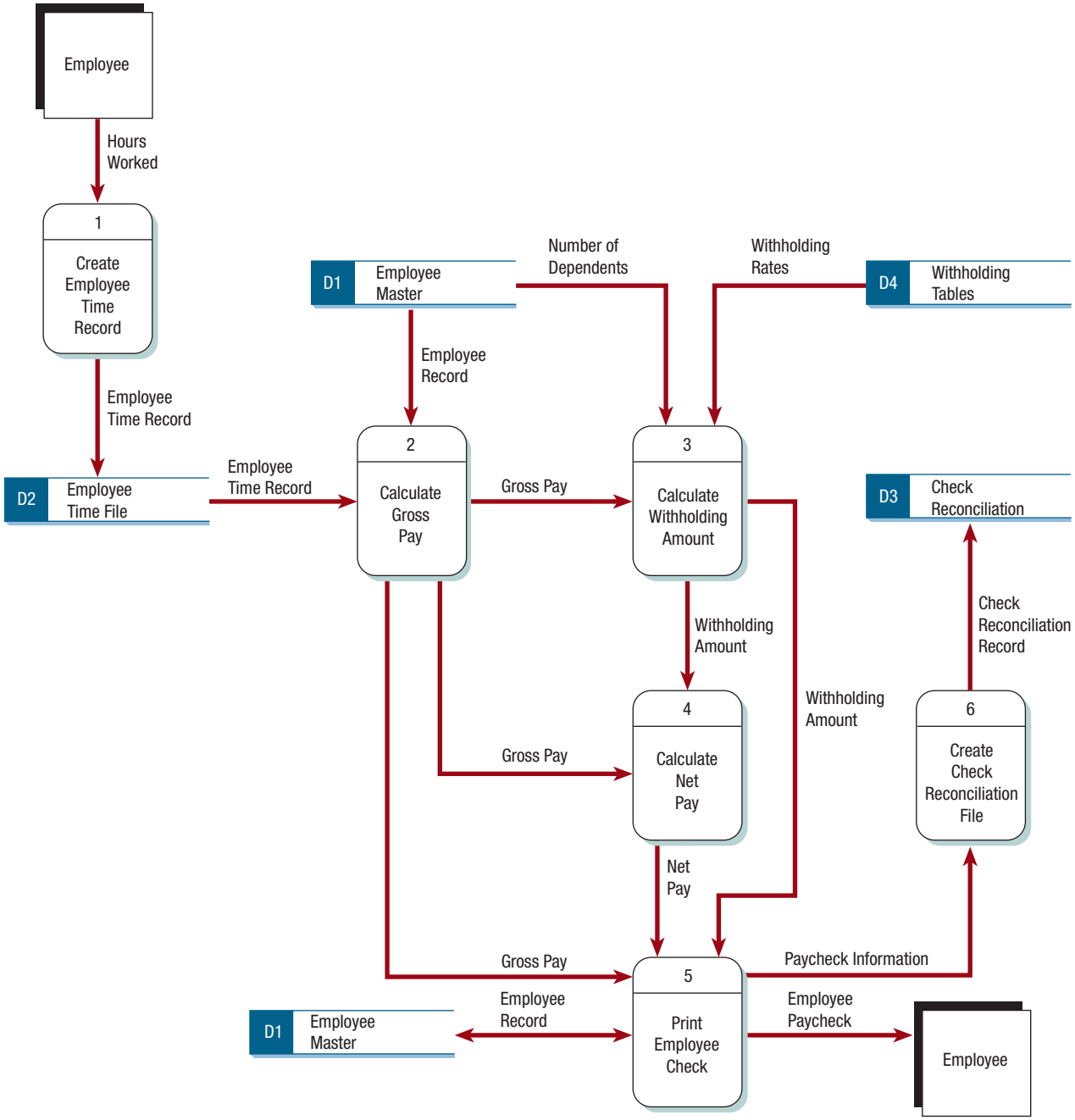


FIGURE 7.6

The correct data flow diagram for the payroll example.

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 DFD for the current system affords a clear understanding of how the current system operates, and it is a good starting point for developing the logical model of the current system. One argument in favor of taking the time to construct the logical DFD of the current system is that it can be used to create the logical DFD of the new system. 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

FIGURE 7.7

Features common to both logical and physical data flow diagrams.

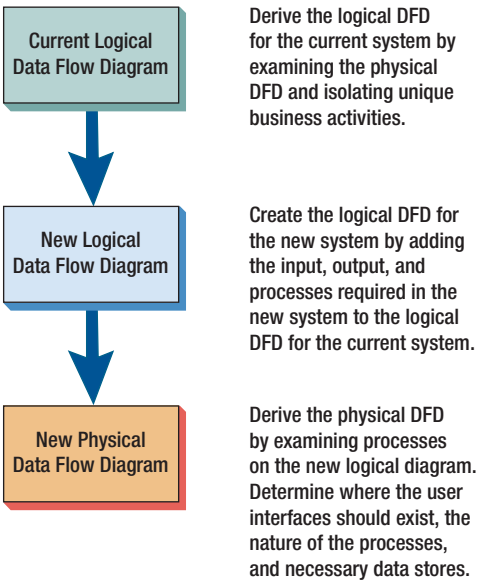
Design Feature	Logical	Physical
What the model depicts.	How the business operates.	How the system will be implemented (or how the current system operates).
What the processes represent.	Business activities.	Programs, program modules, and manual procedures.
What the data stores represent.	Collections 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).

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 DFD for the new system.

Figure 7.9 shows a logical DFD and a physical DFD 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 DFD illustrates the processes involved without going into detail about the physical implementation of activities. The physical DFD shows that a bar code—the universal product code (UPC) BAR CODE found on most grocery store items—is used. In addition, the physical DFD mentions manual processes such 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.

FIGURE 7.8

The progression of models from logical to physical.



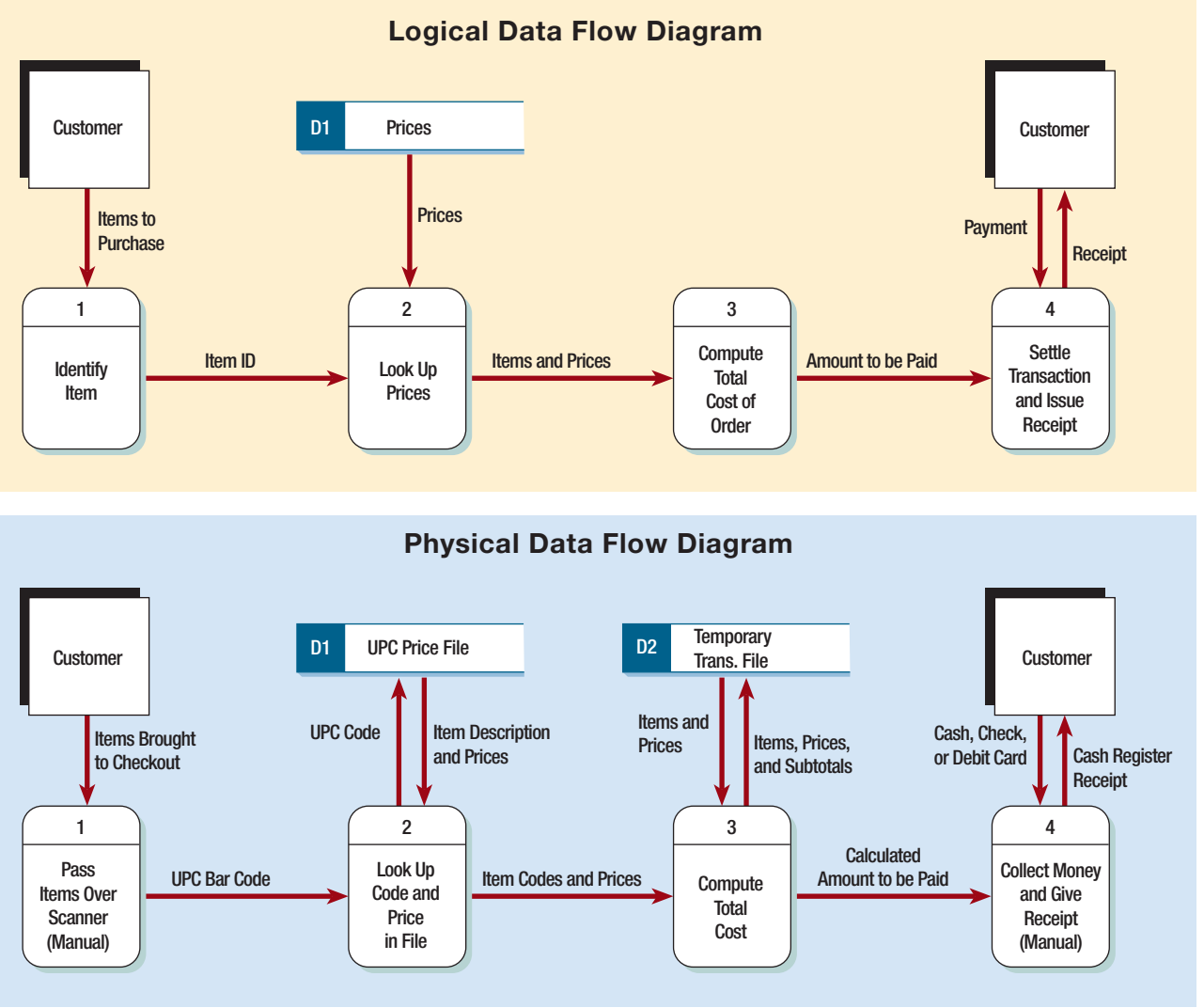


FIGURE 7.9

The physical data flow diagram (bottom) shows certain details not found on the logical data flow diagram (top).

Developing Logical Data Flow Diagrams

Construct a logical DFD for the current system before you construct a physical DFD. There are a number of advantages to using a logical model:

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

A logical model is easiest to use when communicating with users of the system because it is centered on business activities. Users will be familiar with the essential activities and many of the human information requirements of each activity.

Systems formed using a logical DFD are often relatively stable because they are based on business events and not on a particular technology or method of implementation. Logical DFDs represent features of a system that would exist regardless of the physical means of doing business. For example, activities such as applying for a fitness club membership, accumulating rewards points, and paying for annual dues would all occur whether the club had an automated, manual, or hybrid system.

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

Developing Physical Data Flow Diagrams

After you develop the logical model of a new system, you may use it to create a physical DFD. The physical DFD 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 DFDs have certain advantages, physical DFDs have some advantages:

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

Physical DFDs are often more complex than logical DFDs 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 online store. Notice that some of the processes include more than one activity. Data entry processes such as keying and verifying also are part of physical DFDs.

FIGURE 7.11

A CRUD matrix for an online store. 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

Physical DFDs 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

Each of these five activities would be represented by a separate process on a physical DFD, 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!). Storing the groceries in bags once they are home would be inefficient, 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, cup, and utensils 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 website before the amount charged to a credit card may be verified with the financial institution. Note that because of such considerations, a physical DFD may appear more linear than a logical model.

You create the physical DFD for a system by analyzing its output and input. When creating a physical DFD, 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. You need to 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 DFDs are illustrated later in this chapter.

EVENT MODELING AND DATA FLOW DIAGRAMS A practical approach to creating physical DFDs is to create a simple DFD 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 DFD fragment is represented by a row in the table. Each DFD fragment is a single process on a DFD. 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 DFDs for the first three rows of the event response table.

The advantage of building DFDs 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.

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.

USE CASES AND DATA FLOW DIAGRAMS We use the use case concept (introduced in Chapter 2) in creating DFDs. 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 an analyst to work with users to understand the nature of the processes and activities and then create a single DFD fragment. When creating use cases, you should 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. Then you can decide what the names should be and provide a brief description of each activity. List the activities, inputs, and outputs for each one.

Document the steps in each use case in the form of business rules that list or explain the human and system activities completed for each use case. If at all possible, you should list them in the sequence that they would normally be executed. Next, you can determine the data used by each step. This step is easier if a data dictionary has been completed. Finally, you need to ask the users to review and suggest modifications to the use cases. It is important that the use cases be 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 DFD and determining how it should be divided into collections of manual procedures and collections of computer applications. Analyze each process to determine whether it should be a manual or an automated procedure. Then you can group

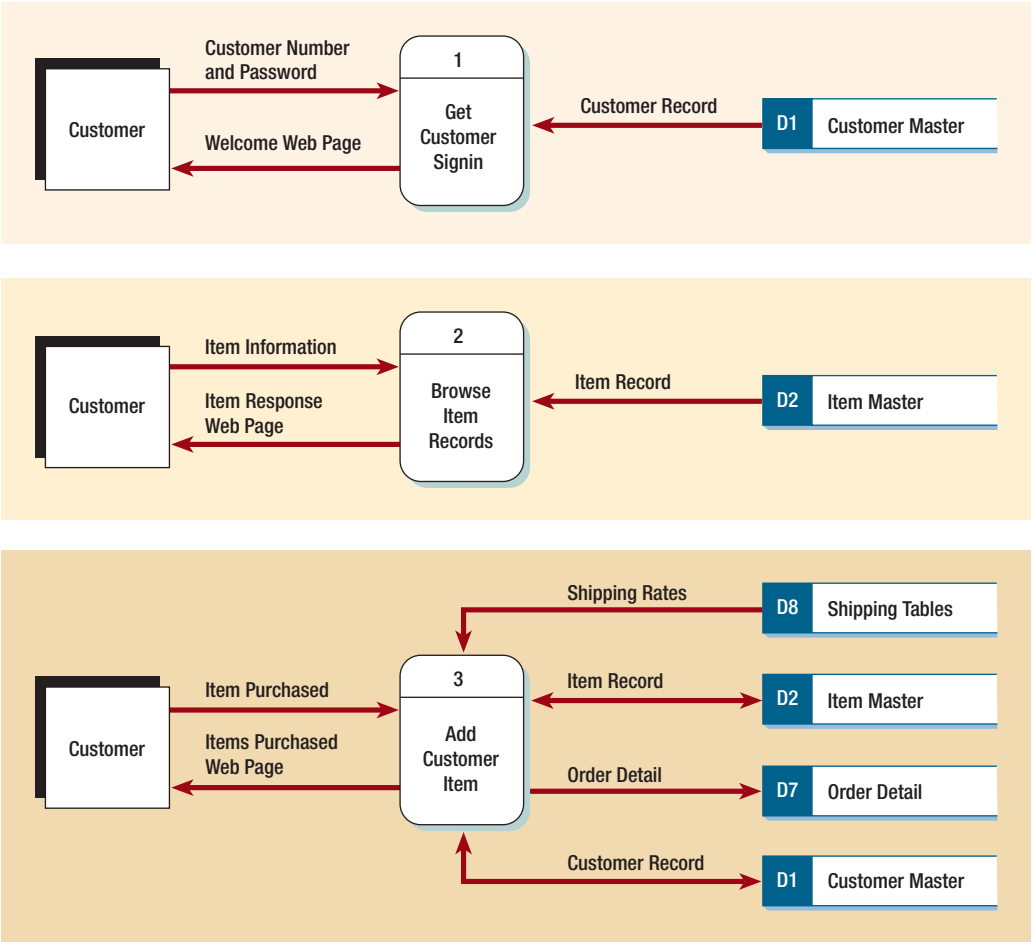


FIGURE 7.13

Data flow diagrams for the first three rows of the Internet storefront event response table.

automated procedures into a series of computer programs. It can be helpful to draw a dashed line around a process or group of processes that should be placed into a single application.

There are six reasons for partitioning DFDs:

1. ***Different user groups***. Do several different user groups, often at different physical locations in the company, perform the processes? If so, they should be partitioned into different computer programs. An example is the need to process customer returns and customer payments in a store with locations in New York as well as San Francisco. Both processes involve obtaining financial information that is used to adjust customer accounts (subtracting from the amount the customer owes), but different people at different locations perform the two processes. Each group needs a different screen for recording the particulars of the transaction, either a credit screen or a payment screen.
2. ***Timing***. It is important to examine the timing of the processes. If two processes execute at different times, they cannot be grouped into one program. Timing issues also may 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.
3. ***Similar tasks***. If two processes perform similar tasks, they may be grouped into one application.
4. ***Efficiency***. Several processes may be combined into one program for efficient processing. For example, if a series of reports needs to use the same large input files, producing them together may save considerable computer run time.
5. ***Consistency of data***. Processes may be combined into one program for consistency of data. For example, a credit card company may take a "snapshot" and produce a variety of reports at the same time just so figures are consistent.

FIGURE 7.14

A use case form for the Internet storefront describes the Add Customer Item activity and its triggers, input, and output.

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 ■ Temporal □			
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.	Item Number, Item Record
2. Store item data on Order Detail Record.	Order Detail Record
3. Use the Customer Number to find the Customer Record.	Customer Number, 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.	Zip Code, Item Weight, Shipping Table
5. Modify the Customer Total using the Quantity Purchased and the Item Price. Add the Shipping Cost. Update the Customer Record.	Item Record, Quantity Purchased, Shipping Cost, Customer Record
6. Modify the Item Quantity on Hand and update the Item Record.	Quantity Ordered, Item Record

6. ***Security***. Processes may be partitioned into different programs for security reasons. A dashed line may be placed around web pages that are on a secure server to separate them from those web pages on a server that is not secured. A web page that is used for obtaining the user's identification and password is usually partitioned from order entry or other business pages.

A Data Flow Diagram Example

The following example is intended to illustrate the development of a DFD by selectively looking at each of the components explored earlier in this chapter. This example, called "World's Trend Catalog Division," is used to illustrate concepts covered in Chapters 8 and 9 as well.

FIGURE 7.15

A summary of business activities for World's Trend Catalog Division.

World's Trend
1000 International Lane
Cornwall, CT 06050

World's Trend is a mail order supplier of high-quality, fashionable clothing. Customers place orders by telephone, by mailing an order form included with each catalog, or via the website.

Summary of Business Activities

1. When customer orders come in, the item master and the customer master files are both updated. If an item is out of stock, the inventory control department is notified.
2. If the order is from a new customer, a new record is created in the customer master file.
3. Picking slips are produced for the customer order and sent to the warehouse.
4. A shipping statement is prepared.
5. The process of shipping a customer order involves getting the goods from the warehouse and matching up the customer shipping statement, getting the correct customer address, and shipping it all to the customer.
6. The customer statement is generated and a billing statement is sent to a customer once a month.
7. An accounts receivable report is sent to the accounting department.

Developing the List of Business Activities

A list of business activities for World's Trend is shown 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 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 the list of activities is developed, you can 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 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).

Drawing Diagram 0

Next, you need to 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 shown 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 have drawn 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. Take 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.

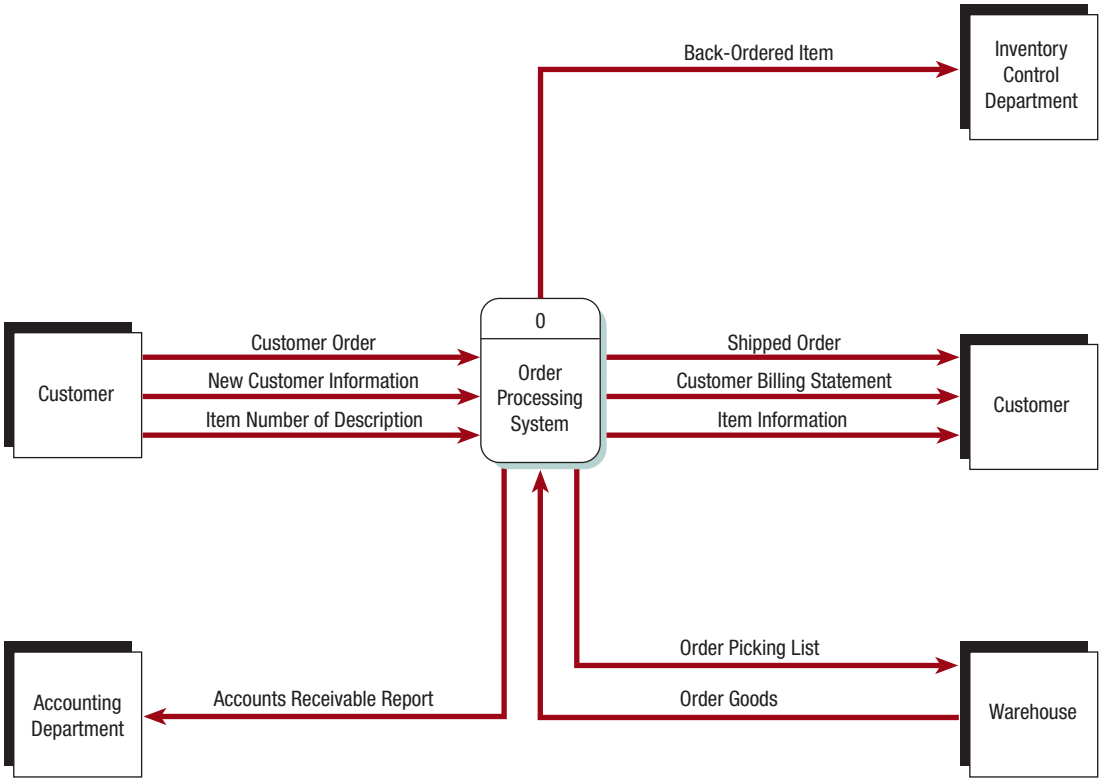


FIGURE 7.16

A context-level data flow diagram for the order processing system at World's Trend.

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 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) DFD to identify these entities. Label the subprocesses 1.1, 1.2, 1.3, and so on. Take time to check for errors and make sure the labels make sense.

Creating a Physical Data Flow Diagram from the Logical DFD

If you want to go beyond the logical model and draw a physical model as well, look at Figure 7.19, which is an example of a physical data flow child diagram of process 3, PRODUCE PICKING SLIPS. Physical DFDs give you the opportunity to identify processes for scanning bar codes, displaying 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 WAREHOUSE. 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.

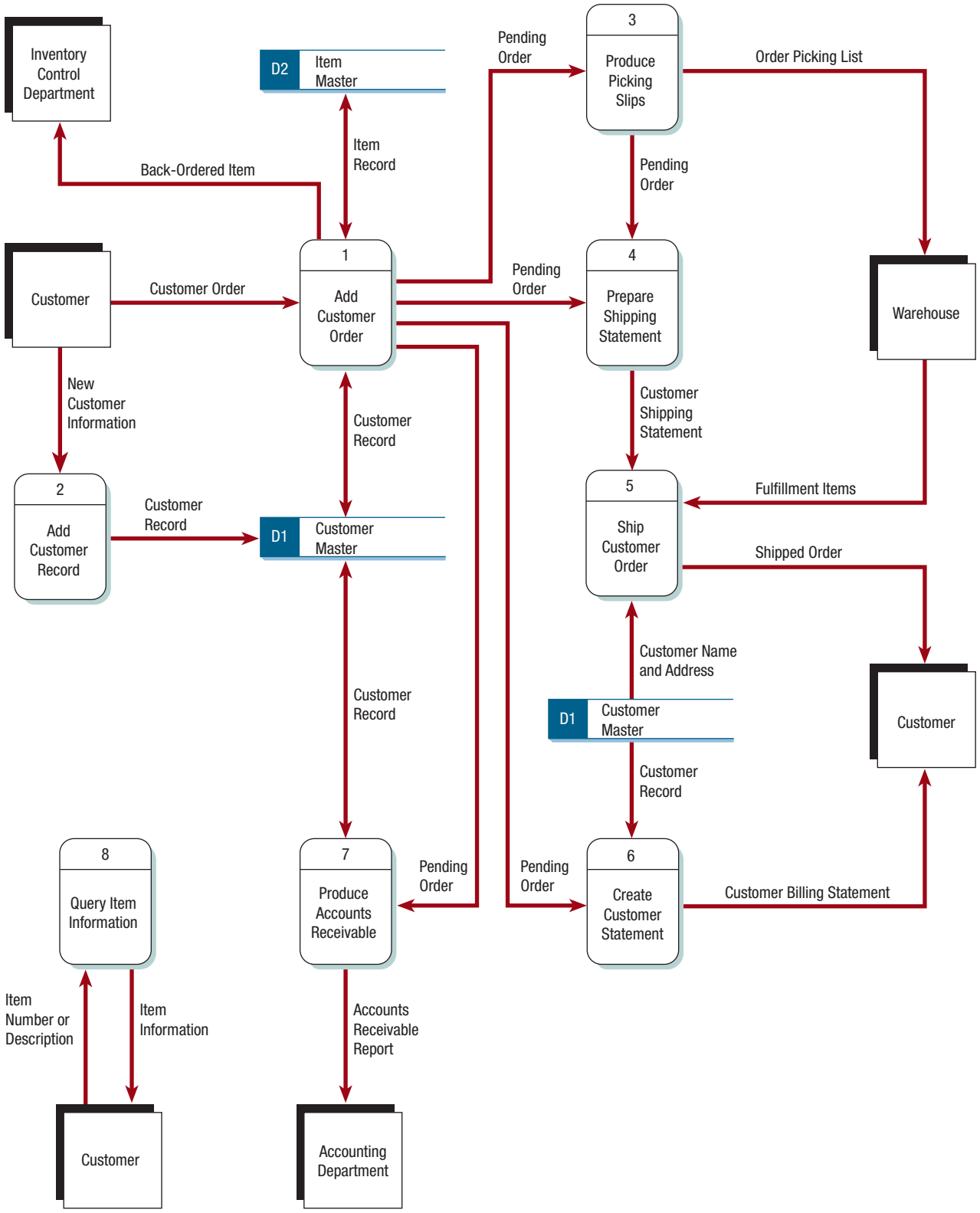


FIGURE 7.17

Diagram 0 of the order processing system for World's Trend Catalog Division.

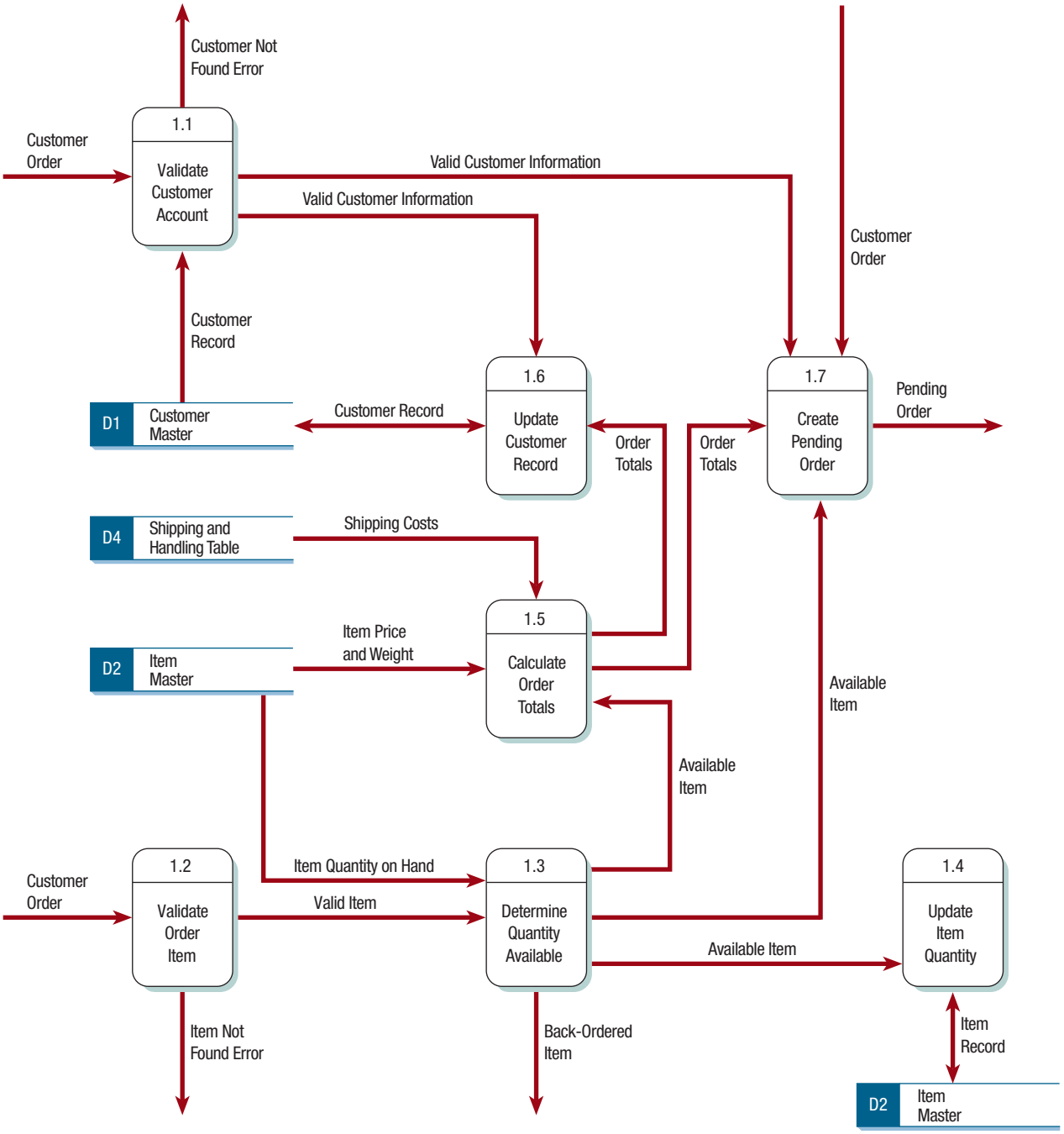


FIGURE 7.18

Diagram 1 of the order processing system for World's Trend Catalog Division.

Partitioning the Physical DFD

Finally, you suggest partitioning of the physical DFD 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 is placed. You would then put processes 3 and 4 in

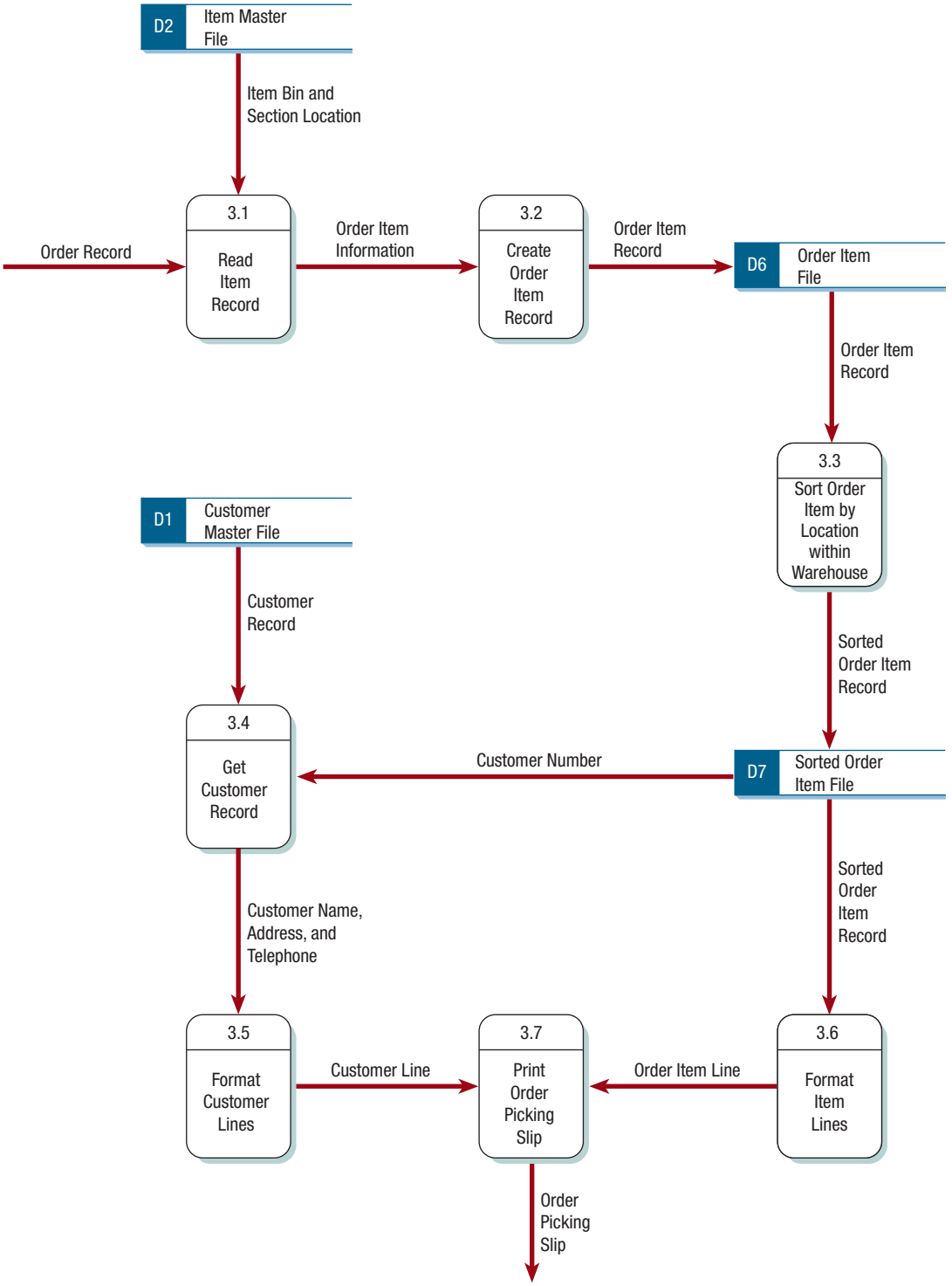


FIGURE 7.19

A physical data flow child diagram for World's Trend Catalog Division.

two separate partitions because these must be done at different times and cannot be grouped into a single program.

The process of developing a DFD is now complete from the top down. You first drew a companion physical DFD to accompany the logical DFD and then partitioned the DFD by grouping or separating the processes. The World's Trend example is used again in Chapters 8 and 9.

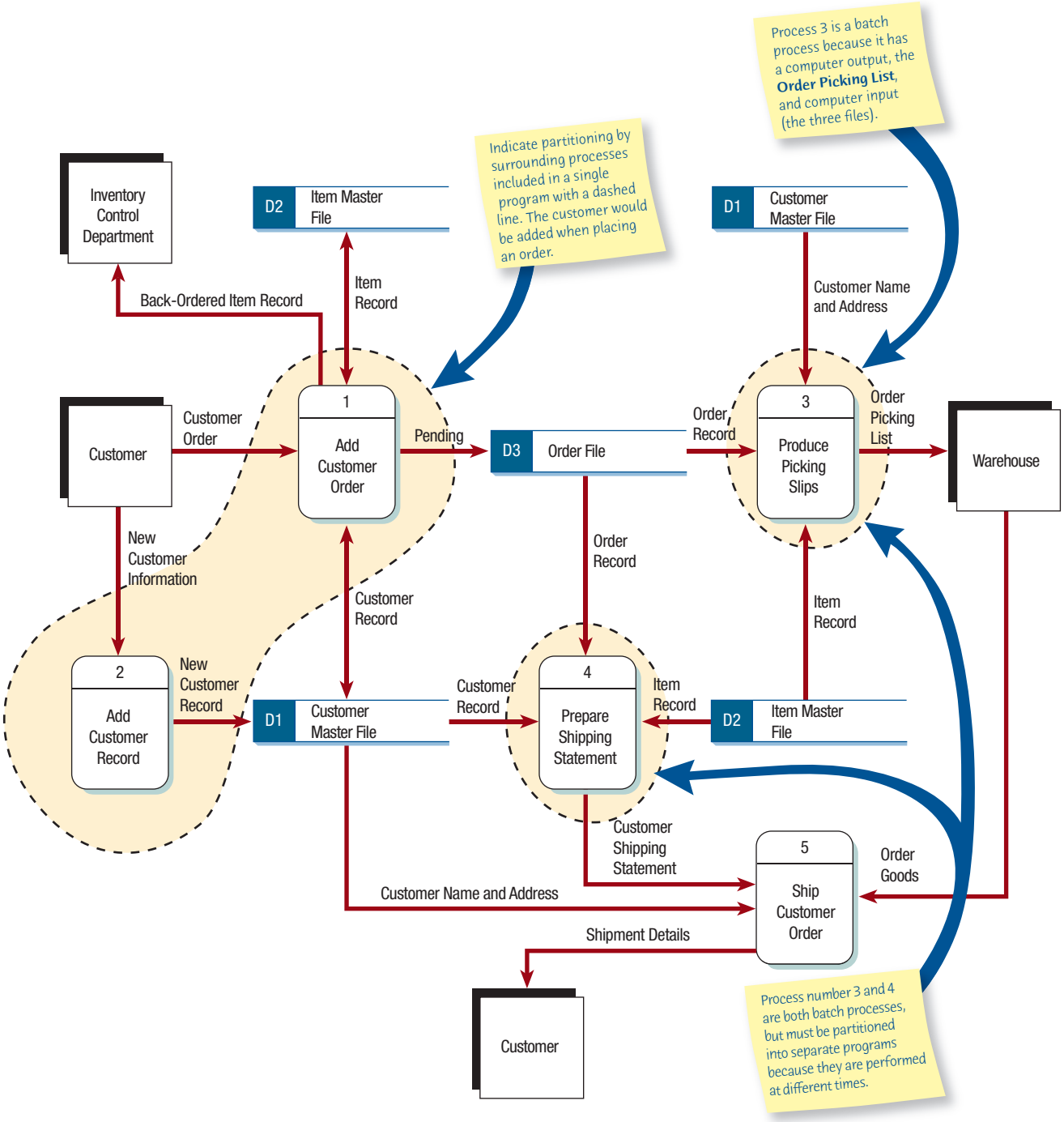


FIGURE 7.20

Partitioning the data flow diagram (showing part of Diagram 0).

Partitioning Websites

Partitioning is a very useful principle when designing a website. Website designers who use forms to collect data may find it appropriate to divide a website 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 website designer might consider creating a unique Web form and DFD process to validate and process the data.

A 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 that contain 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 that is obtained may contain fields from different database tables and may be passed to one process. However, if different databases are involved, an 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 website, shown 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 concierge service 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. 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 large amount of time that is unacceptable to a human user trying to complete a transaction.

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 a small program partitioned for determining whether 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 websites for human–computer interaction. It also means that processing will take place more quickly; 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. Most airline websites now use pop-up windows in which customers point to their seat selection.

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.

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 website is secure, efficient, and more easily maintained.

Communicating Using Data Flow Diagrams

Data flow diagrams are useful throughout the analysis and design process. You use original, unexploded DFDs 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 DFDs, but to make the diagrams truly communicative to users and other members of the project team, meaningful labels for all data components are 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 DFD need to be more specific than that.

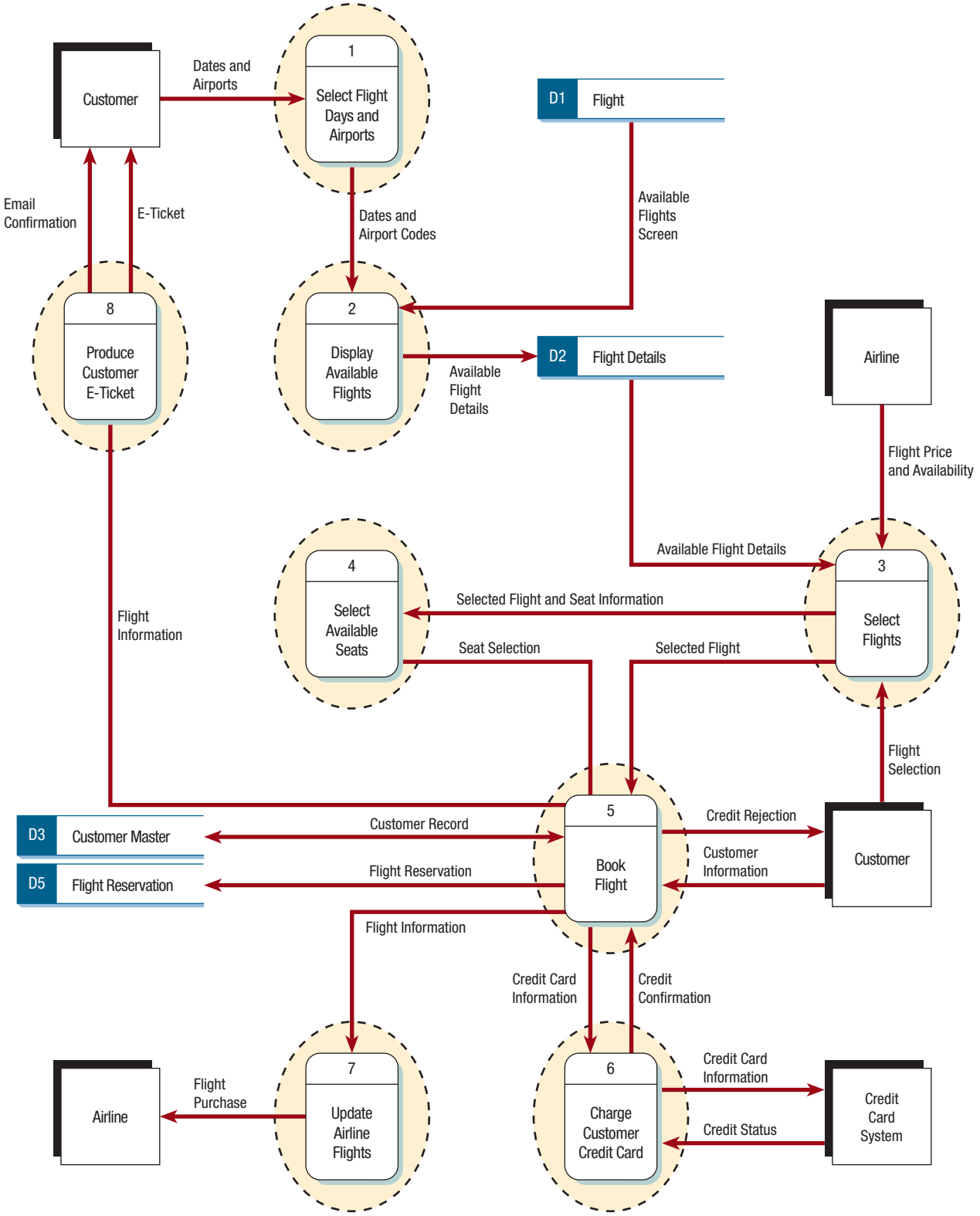


FIGURE 7.21

Partitioning is important for Web-based systems, as this physical data flow diagram of an online ticket purchasing system demonstrates.

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 bears. 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 a rental such as the one Annie is doing for the 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."

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.

Merman's shop (more aptly visualized as a warehouse) has 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.[1] 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 DFD given earlier. Remember that timely returns are critical for keeping the spotlight on costumes rented from Merman's.

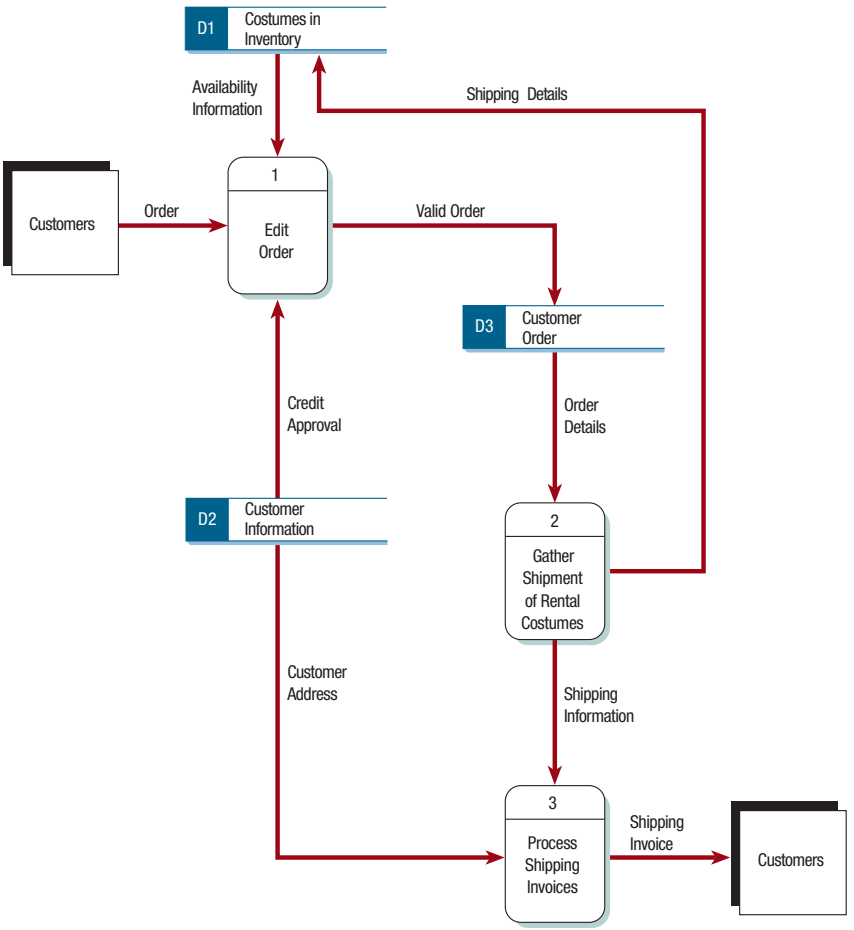


FIGURE 7.C1

A data flow diagram for Merman's Costume Rentals.

[1]Western Costume Company in Hollywood, California, is said to have more than 1 million costumes, worth about $40 million.

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

1. Find the data flow diagrams already drawn in MRE. Make a list of those you found and add a column to your list to show where in the organization you found them.
2. Draw a context-level diagram to model the Training Unit Project Development process, one that is based on interviews with relevant Training Unit staff. Then draw a level 0 diagram that details the process.

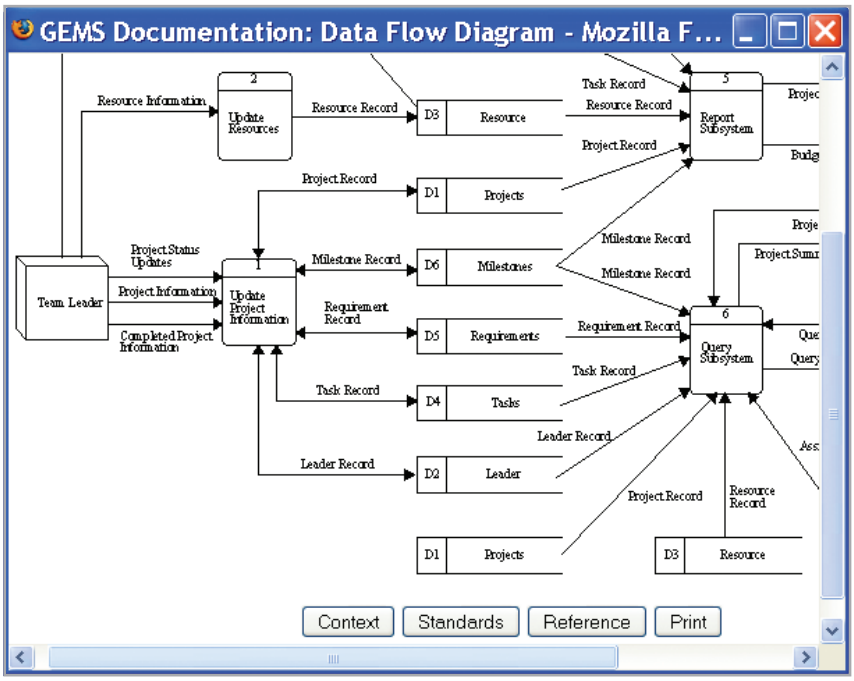


FIGURE 7.HC1

In HyperCase you can click on elements in a data flow diagram.

Finally, remember that DFDs are used to document the system. Assume that data flow diagrams will persist longer than the people who drew them, which is, of course, always true if an external consultant is drawing them. DFDs 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, a systems analyst draws graphical representations called 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. Data flow diagrams have four chief advantages over other diagramming approaches: (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, and (4) analysis of a proposed system to determine whether the necessary data and processes have been defined.

Data flow diagrams 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 (the source or receiver of data), an arrow to depict data flow, and an open-ended rectangle to show a data store.

A 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 coding. Each process is analyzed to determine whether it should be a manual or an automated procedure.

Six considerations for partitioning data flow diagrams are whether processes are performed by different user groups, whether processes execute at the same times, whether processes perform similar tasks, whether batch processes can be combined for efficient processing, whether processes may be combined into one program for consistency of data, and whether processes may be partitioned into different programs for security reasons.

Keywords and Phrases

Ajax
base element
child diagram
context-level data flow diagram
data flow diagram (DFD)
data flow diagram fragment
data store
derived element
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
transaction data store
transforming process
unified modeling language (UML)
use case
vertical balancing

Review Questions

1. List the symbols used to chart movement of data in data flow diagrams along with their meanings and relevant examples.
2. What are the four advantages of using a data flow approach over narrative explanations of data movement?
3. What are the steps involved in developing a data flow diagram using a top-down approach?
4. Explain the importance of process numbers in DFDs and assigning “zero” to a process in a context-level 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 is a child diagram and an interface data flow? Explain the primary rule for creating child diagrams.
8. Why is labeling data flow diagrams so important? What can effective labels on data flow diagrams accomplish for those who are unfamiliar with the system?
9. What is the role of a CRUD matrix in developing a physical data flow diagram?
10. List three reasons for creating a logical data flow diagram.
11. List five characteristics of a physical data flow diagram that a logical data flow diagram does not have.
12. How is a physical DFD created by analyzing inputs and outputs?
13. Discuss how the timing information of tasks can be included in a physical DFD.
14. List the major sections of a use case.
15. How can a use case be used to create a data flow diagram?
16. Why is partitioning useful when designing a website?

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. Explain how a DFD serves as an important tool of documentation.

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 DFDs 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. Henry has been hired as a systems analyst to work on an information system project for a library. Currently, books are ordered manually. Three librarians receive a checklist containing details of forthcoming books and journals every week. Each one places checkmarks against the books they think should be ordered. The three marked lists are then reviewed by a head librarian, who finalizes the list of books and the quantity to be ordered. The final list is sent to a clerk, who mails it to the appropriate publishers for orders.
   a. Draw a context diagram for this situation.
   b. Draw a level 0 data flow diagram for this situation.
3. You have been hired as a systems analyst to design an e-commerce website. The website offers merchandise across three broad categories: men, women, and kids. Each of these is further categorized into apparel, footwear, accessories, and so on. At specific times, the website hosts stock clearance sales, during which the entire website's products are on sale for a short duration, like three to four hours, at discounted prices. In addition, it has been found that customers browse for a complete wardrobe look, pairing dresses with footwear and accessories that match. The website has thus now introduced a "pair preview" feature based on the selection of products by a customer.
   a. Identify the processes involved in the design and development of such a website.
   b. Do you think the principle of partitioning is applicable to the design of this system? Justify your answer.
   c. As the design includes a lot of human–computer interaction, how would it meet the usability and usefulness criteria?
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.

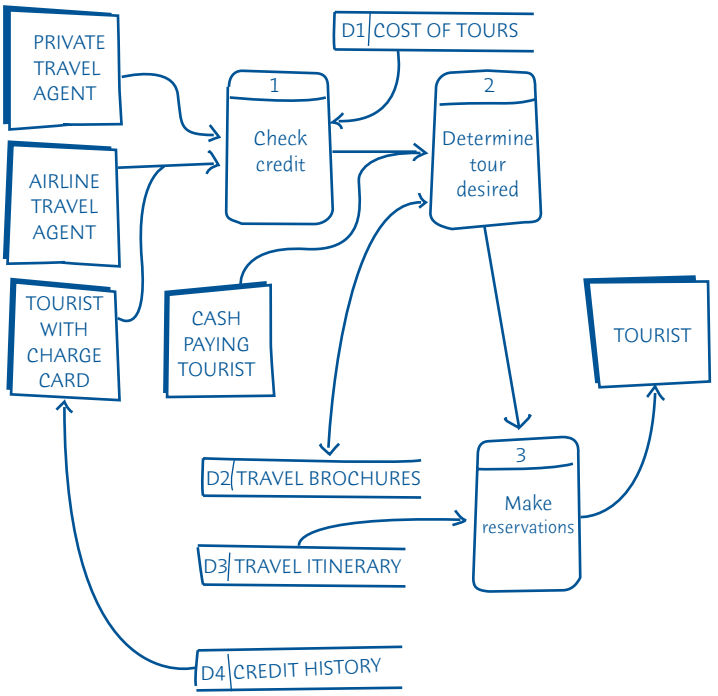


FIGURE 7.EX1

A hand-sketched data flow diagram for Marilyn's Tours.

a. List and number the errors you 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, and cuts down on repetitions and duplications where possible.

5. KinLee Pizza is a popular take out and delivery restaurant that wants to install a system to record orders for pizza and chicken wings. When regular customers call KinLee 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 kitchen, where the cooks prepare the items. A receipt is printed. Occasionally, special offers (coupons) are printed so the customer can get a discount the next time he or she orders. Customers can pick up phone orders in person, and they get a receipt, a coupon (if any are issued), and their food order. Drivers who make deliveries of phone orders 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 KinLee Pizza.
6. Draw a context-level data flow diagram for KinLee Pizza (described in 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 (that is, has never ordered from KinLee 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 for sale.
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 the 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. A child's parents download a mobile app to track the immunization status of the child. The first action is to register with the child's details and their own. The app fetches the latest immunization plan from a server and computes a schedule for the registered child. This schedule lists the deadlines for immunization, the names of the vaccines, their purpose, and the names of the hospitals where specific vaccination services are available. The app places reminders in the phone calendar whenever a deadline approaches. Once the child is immunized, the parents update the status on the app to "complete," upload photos of the child being immunized, and enter the hospital details. The hospital server generates a weekly report of immunization statuses for all registered children that is emailed to the staff and authorities concerned. They review the report and ensure that the immunization was received on time. For those who missed it, appropriate interventions, such as reminder emails, are generated.
    a. Make a list of business activities in the scenario.
    b. Identify the entities, processes, data flows, and data stores in the scenario.
    c. Create a context-level diagram for any one of the processes, such as the patient registration system or the immunization schedule generation.
    d. Is it possible to explode this context-level diagram? Justify your answer.
    e. Is it possible to create a child diagram from this scenario? Explain whether partitioning can be applied in this scenario when creating a physical DFD.

Group Projects

1. 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 modeling the entire organization.)

2. Using the context-level diagram developed in Group Project 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.
3. 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.
4. 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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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. Understand the concept of a repository for analysts' project information and the role of computer-aided software engineering (CASE) tools in creating them.
3. Create data dictionary entries based on data flow diagrams (DFDs) for data processes, stores, flows, structures, and logical and physical elements of the systems being studied.
4. Recognize the functions of data dictionaries in helping users update and maintain information systems.

When successive levels of data flow diagrams (DFDs) 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, a systems analyst needs to work at making names meaningful but exclusive of other existing data component names. This chapter covers the data dictionary, which is another tool that aids in the analysis of data-oriented systems.

A data dictionary is a specialized application of the kinds of dictionaries used as references in everyday life. A data dictionary is a reference work of data about data (that is, *metadata*). Systems analysts compile data dictionaries to guide them through analysis and design. A data dictionary is a document that collects and coordinates specific data terms, and it confirms what each term means to different people in the organization.

Automated data dictionaries (part of the CASE tools) are valuable for their capacity to cross-reference data items, thereby allowing necessary program changes to all applications that share a common element. This feature supplants changing programs on a haphazard basis, and 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 are important for large systems that produce several thousand data elements requiring cataloging and cross-referencing.

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 coding 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.

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 male'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.

Need for Understanding the Data Dictionary

Despite the existence of automated data dictionaries, a systems analyst should understand what data compose a data dictionary, the conventions used in data dictionaries, and how a data dictionary is developed. Understanding the process of compiling a data dictionary can aid a systems analyst in conceptualizing the system and how it works. The data flow diagrams (DFDs) in Chapter 7 are an excellent starting point for collecting data dictionary entries.

The following sections describe the rationale behind contents of automated data dictionaries. In addition to providing documentation and eliminating redundancy, a 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 extensible markup language (XML).

The Data Repository

A data dictionary contains information about data and procedures; a larger collection of project information is called a *repository*. One of the benefits of using a CASE tool to develop the data dictionary is the ability to develop a repository, or a shared collection of project information and team contributions. The repository 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 in 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.

The four data dictionary categories—data flows, data structures, data elements, and data stores—should be developed to promote understanding of the data in 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, by a toll-free phone order system (or faxing the mail order form), and online 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.

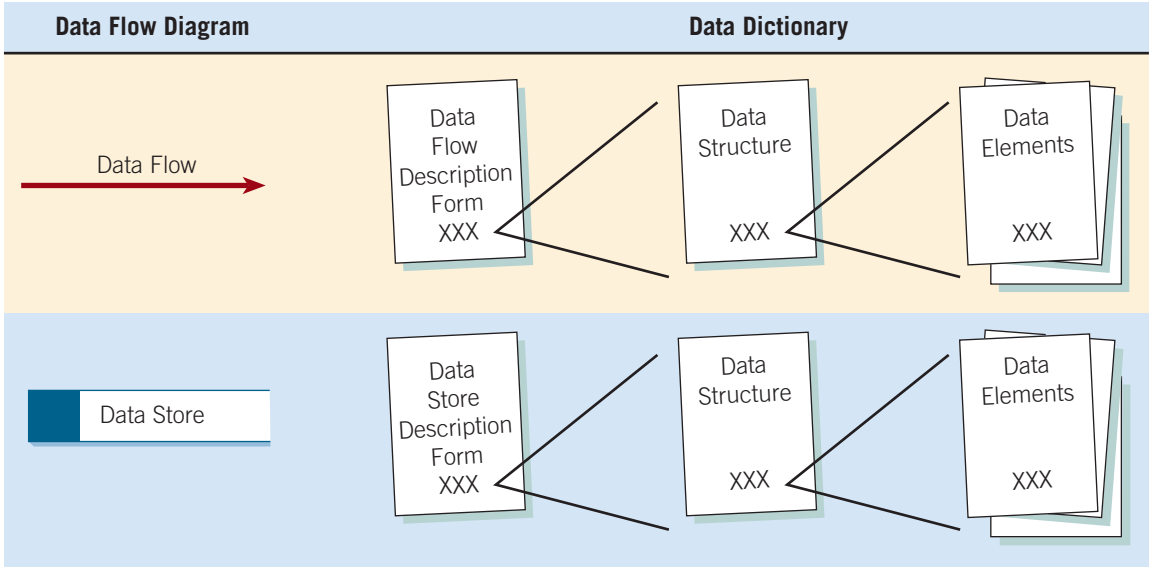


FIGURE 8.1

How data dictionaries relate to data flow diagrams.

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. A systems analyst determines system inputs and outputs by interviewing, observing users, and analyzing documents and other existing systems. The information captured for each data flow may be summarized using a form that contains the following information:

1. An optional identification number. Sometimes the ID is coded using a scheme to identify the system and the application in the system.

FIGURE 8.2

An online order form from World's Trend Catalog Division.

FIGURE 8.3

An example of a data flow description from World's Trend Catalog Division.

Data Flow Description

ID

Name Customer Order

Description Contains customer order information and is used to update the customer master and item files and to produce an order record.

Source	Destination
Customer	Process 1

Type of Data Flow

☐ File ☑ Screen ☐ Report ☐ Form ☐ Internal

Data Structure Traveling with the Flow	Volume/Time
Order Information	10/hour

Comments 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.

2. A unique descriptive name for the 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.

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 DFD. The checked box for "Screen" indicates that the flow represents an input screen. It could be any screen, such as a web page, graphic 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 an 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 elements 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 a group. The repeating group may have conditions, such as a fixed number of repetitions, or upper and lower limits for the number of repetitions.
4. Brackets [] are used for an either/or situation. Either one element or another may be present, but not both. The elements listed between the brackets are mutually exclusive.
5. Parentheses () are used for 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.

Structural records and elements that are used in many different systems are given a non-system-specific name, such as street, city, and zip code, 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, a supplier city, or an 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 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 have learned from human–computer interaction (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. The following are examples of physical design elements:

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 website.

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

FIGURE 8.4

Data structure example for adding a customer order at World's Trend Catalog Division.

```
Customer Order =        Customer Number +
                        Customer Name +
                        Address +
                        Telephone +
                        Catalog Number +
                        Order Date +
                        {Available Order Items} +
                        Merchandise Total +
                        (Tax) +
                        Shipping and Handling +
                        Order Total +
                        Method of Payment +
                        (Credit Card Type) +
                        (Credit Card Number) +
                        (Expiration Date)

Customer Name =         First Name +
                        (Middle Initial) +
                        Last Name

Address =               Street +
                        (Apartment) +
                        City +
                        State +
                        Zip +
                        (Zip Expansion) +
                        (Country)

Telephone =             Area Code +
                        Local Number

Available Order Items = Quantity Ordered +
                        Item Number +
                        Item Description +
                        Size +
                        Color +
                        Price +
                        Item Total

Method of Payment =     [Check ¦ Charge ¦ Money Order]

Credit Card Type =      [World's Trend ¦ American Express ¦ MasterCard ¦ Visa]
```

FIGURE 8.5

Physical elements added to a data structure.

```
Customer Billing Statement = Current Date +
                             Customer Number +
                             Customer Name +
                             Address +
                             5
                             1{Order Line} +
                             (Previous Payment Amount) +
                             Total Amount Owed +
                             (Comment)

Order Line =                 Order Number +
                             Order Date +
                             Order Total
```

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.

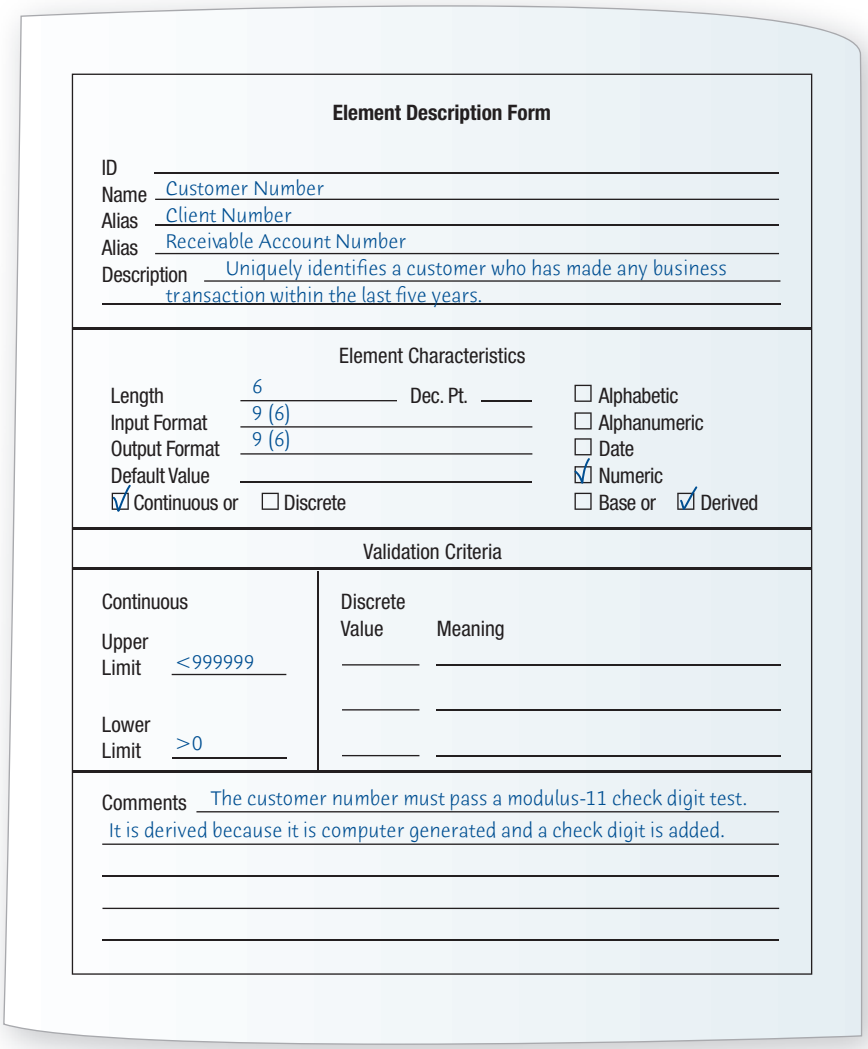
The repeating group notation may have several other formats. If the group repeats a fixed number of times, that number is placed next to the opening brace, as in 12 {Monthly Sales}, indicating the group repeats12 times, once for each month in the year. If no number is indicated, the group repeats indefinitely. 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 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.

Data Elements

Each data element is defined once in the data dictionary and may be entered on an element description form as well, 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.



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.

Element Characteristics

Length 6 Dec. Pt. ____
Input Format 9 (6)
Output Format 9 (6)
Default Value
☑ Continuous or ☐ Discrete

☐ Alphabetic
☐ Alphanumeric
☐ Date
☑ Numeric
☐ Base or ☑ Derived

Validation Criteria

Continuous
Upper Limit <999999
Lower Limit >0

Discrete
Value Meaning

Comments The customer number must pass a modulus-11 check digit test. It is derived because it is computer generated and a check digit is added.

FIGURE 8.6

An element description form example from World's Trend Catalog Division.

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 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:
   a. 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.
   b. 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.
   c. For other fields, it is often useful to examine or sample historical data found in the organization to determine a suitable field length. 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. Common lengths of fields are shown in Figure 8.7.

Field	*Length*	*Percentage of Data That Will Fit (U.S.)*
Last Name	11	98
First Name	18	95
Company Name	20	95
Street	18	90
City	17	99

FIGURE 8.7

Some examples of data formats used in PC systems.

Data Type	Meaning
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

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)

FIGURE 8.8

Format character codes.

7. **The type of data: numeric, date, alphabetic, varchar, or character.** Character data is also referred to as alphanumeric or text data. Varchar (variable character) 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 systems. Unicode is a standardized coding system for defining graphic symbols, such as Chinese or Japanese characters. Unicode is described in greater detail in Chapter 15. 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.** These should be included, and it is helpful to use 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.** Validation data ensures 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 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 (and 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 be stored in the system as well. Data stores are created for each different data 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.

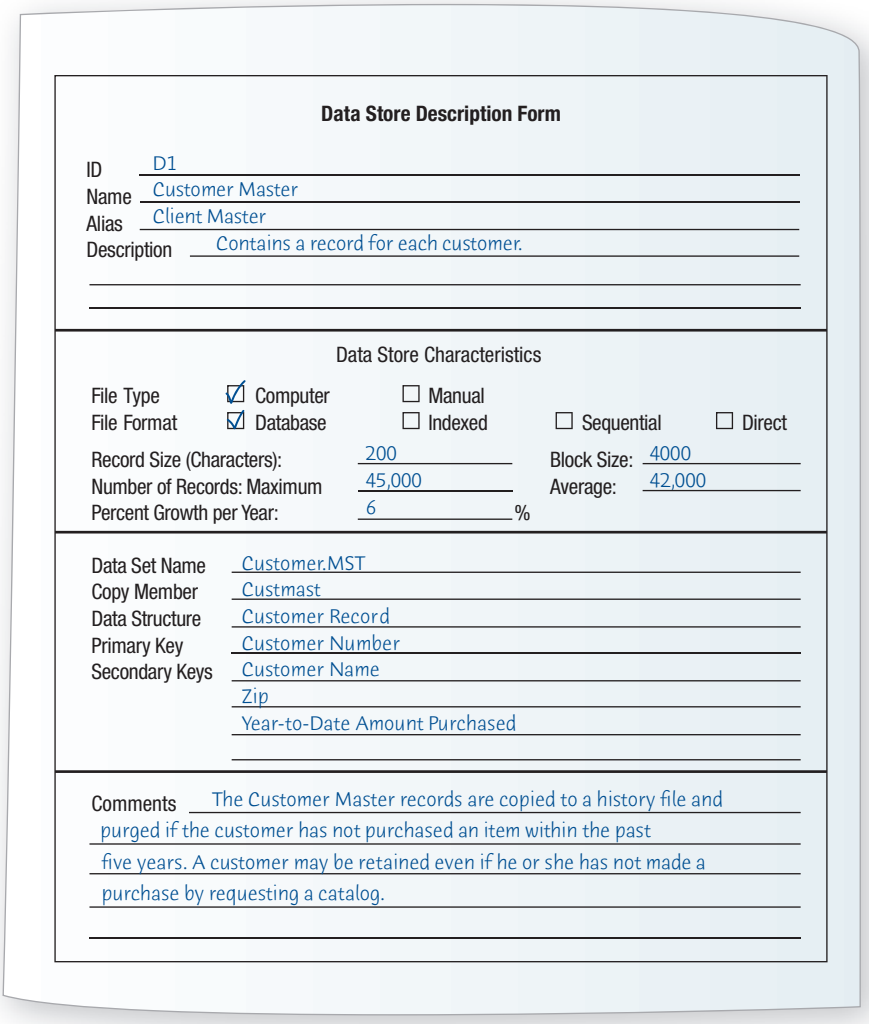
Because a given data flow may only show part of the collective data that a structural record contains, you may have to examine many different data flow structures to arrive at a complete data store description.

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.** It should be descriptive and unique.
3. **An alias for the table.** CLIENT MASTER can be an alias for the CUSTOMER MASTER.

FIGURE 8.9

An example of a data store description form for World's Trend Catalog Division.



Data Store Description Form

ID: D1
Name: Customer Master
Alias: Client Master
Description: Contains a record for each customer.

Data Store Characteristics

File Type: ☑ Computer ☐ Manual
File Format: ☑ Database ☐ Indexed ☐ Sequential ☐ Direct
Record Size (Characters): 200 Block Size: 4000
Number of Records: Maximum 45,000 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.

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 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 anticipated growth per year.** This information helps the analyst predict the amount of disk space required for the application and is necessary for hardware acquisition planning.
8. **The file or data set name.** In the initial design stages, this item may be left blank.
9. **The data structure name.** This name should be found in the data dictionary. A link to the elements for this data store should be provided.
10. **Primary and secondary keys.** These 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.)
11. **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 a 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 an analyst to develop the data dictionary and the DFDs 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 DFD 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 DFD 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 DFD 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 8.10 illustrates a portion of two DFD 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, data obtained early in the analysis. Similarly, TIMEFILE RECORD and the EMPLOYEE PAYCHECK also are defined as a series of structures.

It is important that the data flow names on the child DFD be 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 AMOUN TS (output from the parent process 5.3, COMPUTE CURRENT PAY AMOUNTS).

Analyzing Input and Output

An important step in creating a data dictionary is to identify and categorize system input and output data flow. Input and output analysis forms commonly include these 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

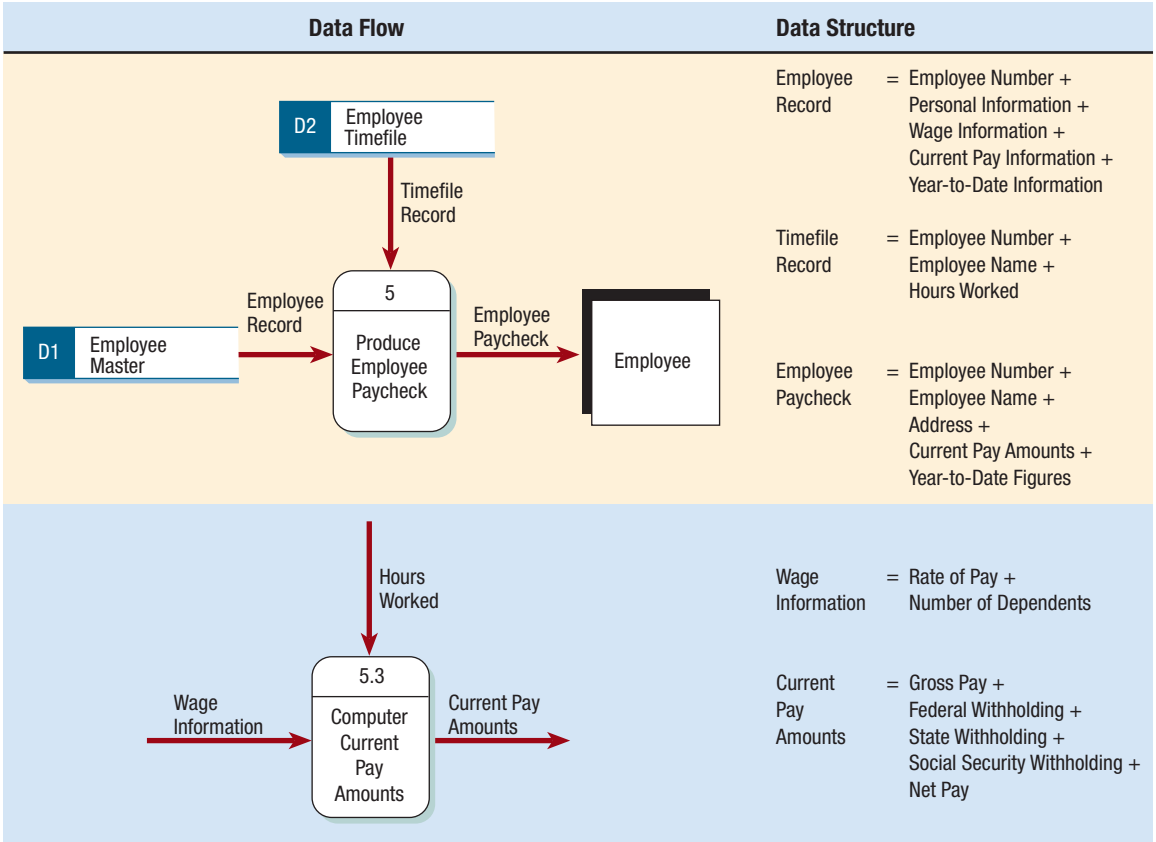


FIGURE 8.10

Two data flow diagrams and corresponding data dictionary entries for producing an employee paycheck.

input or output, 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. Elements 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 shown in Figure 8.11. In this example of a CUSTOMER BILLING 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 a data dictionary is developing data stores. Up to now, we have determined what data need 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.

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 manually in as much detail as possible. Prepare 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 preciseness will result in rave reviews. (Refer to Consulting Opportunity 7.1.)

For example, when an order arrives at World's Trend (see Figure 8.12), 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).

Input and Output Analysis Form

Input/Output Name: Customer Billing Statement
User Contact: Susan Han

File Type: ☑ Output ☐ Input
File Format: ☑ Report ☐ Screen ☐ 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	2	B	Valid State Abbr.
Zip	9	B	Numeric, Last 4 Opt.
Order Number	6	D	> 0
Order Date	8	B	MM/DD/YYYY
Order Total	9	D	Format: 9 (7) V99
Previous Payment Amount	5	D	Format: 9 (7) V99
Total Amount Owed	9	D	Format; 9 (7) V99
Comment	60	B	

Comments: Print one page for each customer. If there are more items than will fit on a page, continue on a second page.

FIGURE 8.11

An example of an input–output analysis form for World's Trend Catalog Division.

FIGURE 8.12

Data stores derived from a pending order at World's Trend Catalog Division.

Customer Master =	Customer Number + Customer Name + Address + Telephone + Corporate Credit Card Number + Expiration Date
Item Master =	Item Number + Price + Quantity on Hand
Order Record =	Customer Number + Catalog Number + Order Date + {Available Order Items} + Merchandise Total + (Tax) + Shipping and Handling + Order Total + Method of Payment + (Credit Card Type) + (Credit Card Number) + (Expiration Date)
Available Order Items =	Item Number + Quantity Ordered + Quantity Shipped + Current Price
Method of Payment =	[Check ¦ Charge ¦ Money Order]
Credit Card Type =	[World's Trend ¦ American Express ¦ MasterCard ¦ Visa]

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.

Using a Data Dictionary

An ideal data dictionary is automated, interactive, online, and evolutionary. As a systems analyst learns about an organization's systems, he or she adds data items to the data dictionary. The data dictionary is not an end in itself, however, and must never become so. To avoid becoming sidetracked with building a complete data dictionary, a 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 8.13.

Order Picking Slip =	Order Number + Order Date + Customer Number + Customer Name + Customer Address + Customer Telephone + {Order Item Selection} + Number of Items
Order Item Selection =	Item Number + Item Description + Size Description + Color Description + Warehouse Section + Shelf Number + Quantity Ordered + Quantity Picked
Customer Name =	First Name + (Middle Initial) + Last Name
Address =	Street + (Apartment) + City + State + Zip + (Zip Expansion) + (Country)
Telephone =	Area Code + Local Number

FIGURE 8.13

Data structure for an order picking slip at World's Trend Catalog Division.

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 8.14. Notice that FIRST NAME and LAST NAME are grouped together 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 DFD 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.

FIGURE 8.14

Order picking slip created from the data dictionary.

World's Trend
Order Picking Slip

Order Number: 999999 Order Date Z9/99/9999
Customer Number: 999999

Name: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Street: XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
Apartment: XXXXXXXX
City, State, Zip XXXXXXXXXXXXXXXXXXXXXXXXXXXX, XX 99999-ZZZZ
Country: XXXXXXXXXXXXXXXXXXXXXXXXXXXX
Telephone: (999) 999-9999

---- Quantity ----			Shelf	Item			
Picked	Ordered	Section	Number	Number	Item Description	Size	Color
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX
_____	ZZZZ9	XXXXX	99999	999999	XXXXXXXXXXXXXXXXXX	XXXXXXXXX	XXXXXX

Number of Items: Z9

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) 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 XML 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 RDBMS 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.

Using 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, a text editor, or an 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 Dictionary

Customer =	Name + Address + Current Balance + {Order Information} + Payment
Name =	Last Name + First Name + (Middle Initial)
Address =	Street + (Apartment) + City + State + Zip + Country
Order Information =	Order Number + Order Date + Ship Date + Total
Payment =	[Check ¦ Credit Card] + Payment Date + Payment Amt
Check =	Check Number
Credit Card =	Credit Card Number + Expiration Date

XML

```
<?xml version="1.0">
<customers>
<customer number="C15008">
  <name type="I">
     <lastname>Stadler</lastname>
     <firstname>Karen</firstname>
     <middle_initial>L</middle_initial>
  </name>
  <address>
     <street>123 Oak Street</street>
     <apartment>Suite 16</apartment>
     <city>Madison</city>
     <state>WI</state>
     <zip>43704</zip>
     <country>United States</country>
  </address>
  <current_balance>123.45</current_balance>
  <order customer_number="C15008">
     <order_number>00123</order_number>
     <order_date format="yyyymmdd">2008-06-23</order_date>
     <ship_date format="yyyymmdd">2008-06-25</ship_date>
     <total>1345.89</total>
  </order>
  <order customer_number="C15008">
     <order_number>00127</order_number>
     <order_date format="yyyymmdd">2008-09-18</order_date>
     <ship_date format="yyyymmdd">2008-09-26</ship_date>
     <total>240.00</total>
  </order>
  <payment>
     <check>
        <check_number>7234</check_number>
     </check>
     <payment_date format="yyyymmdd">2008-09-30</payment_date>
     <payment_amt>1585.89</payment_amt>
  </payment>
</customer>
</customers>
```

FIGURE 8.15

Using a data dictionary entry to develop XML content. The XML document mirrors the data dictionary structure.

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 also may include attributes, additional data included within the tag that describe something about the XML element.

Figure 8.15 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 <customers>, 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, </customers>, 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 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 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 because the analyst has worked with users and made decisions on the structure of the data.

Figure 8.16 illustrates the document type definition for the Customer XML document. Keywords, 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 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. 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

```
< !DOCTYPE   customers     [
< !ELEMENT   customers                    (customer) + >
< !ELEMENT   customer                     (name, address, current_balance, order*) >
< !ATTLIST   customer number              ID #REQUIRED>
< !ELEMENT   name                         (lastname, firstname, middle_initial?) >
< !ATTLIST   name type                    (I|C)  #REQUIRED>
< !ELEMENT   lastname                     (#PCDATA) >
< !ELEMENT   firstname                    (#PCDATA) >
< !ELEMENT   middle_initial               (#PCDATA) >
< !ELEMENT   address                      (street, apartment?, city, state, zip, country) >
< !ELEMENT   street                       (#PCDATA) >
< !ELEMENT   apartment                    (#PCDATA) >
< !ELEMENT   city                         (#PCDATA) >
< !ELEMENT   state                        (#PCDATA) >
< !ELEMENT   zip                          (#PCDATA) >
< !ELEMENT   country                      (#PCDATA) >
< !ELEMENT   current_balance              (#PCDATA) >
< !ELEMENT   order                        (order_number, order_date, ship_date, total) >
< !ATTLIST   order customer_number        IDREF  #REQUIRED>
< !ELEMENT   order_number                 (#PCDATA) >
< !ELEMENT   order_date                   (#PCDATA) >
< !ATTLIST   order_date format            (mmddyyyy|yyyymmdd|ddmmyyyy)  #REQUIRED>
< !ELEMENT   payment                      (check|credit_card) >
< !ELEMENT   check                        (check_number) >
< !ELEMENT   credit_card                  (credit_card_number, expiration_date) >
< !ATTLIST   credit_card type             (M|V|A|D|O)  #REQUIRED>
< !ELEMENT   credit_card_number           (#PCDATA) >
< !ELEMENT   expiration_date              (#PCDATA) >
< !ELEMENT   payment_date                 (#PCDATA) >
< !ATTLIST   payment_date format          (mmddyyyy|yyyymmdd|ddmmyyyy)  #REQUIRED>
< !ELEMENT   payment_amt                  (#PCDATA) >
      ] >
```

FIGURE 8.16

A document type definition for the customer XML document.

means that the attribute must be present. A keyword of #IMPLIED means that the attribute is optional. A document also may 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, 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 or status of an order or account. Examples of industry-specific XML document type definitions and schemas may be found at www.xml.org.

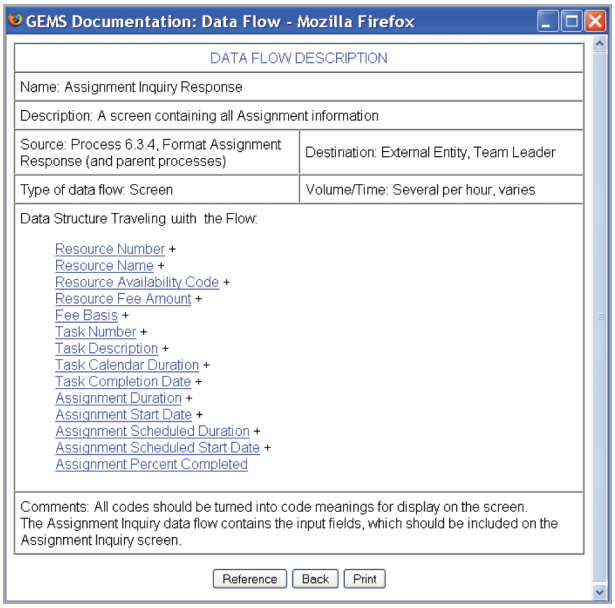
HYPERCASE EXPERIENCE 8

"You're really doing very well. Mr. Evans 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 Evans 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—Asian meditation 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 Mr. 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 and a new data flow 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.


GEMS Documentation: Data Flow - Mozilla Firefox

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:

Resource Number +
Resource Name +
Resource Availability Code +
Resource Fee Amount +
Fee Basis +
Task Number +
Task Description +
Task Calendar Duration +
Task Completion Date +
Assignment Duration +
Assignment Start Date +
Assignment Scheduled Duration +
Assignment Scheduled Start Date +
Assignment Percent Completed

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.

Reference Back Print

FIGURE 8.HC1

In HyperCase, you can look at the data dictionary kept at MRE.

Summary

Using a top-down approach, a systems analyst uses data flow diagrams to begin compiling a data dictionary, which is a reference work that contains 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 data dictionary is a specialized application of the kinds of dictionaries used as references in everyday life. A data dictionary is a reference work of data about data (that is,

metadata). Systems analysts compile data dictionaries to guide them through analysis and design. A data dictionary is a document that collects and coordinates specific data terms, and it confirms what each term means to different people in the organization. A 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, and (5) create XML.

Automated data dictionaries (part of the CASE tools) are valuable for their capacity to cross-reference data items, thereby allowing necessary program changes to all programs that share a common element. This feature supplants changing programs on a haphazard basis, and it prevents waiting until the program won't run because a change has not been implemented across all applications sharing the updated item. Clearly, automated data dictionaries are important for large systems that produce several thousand data elements requiring cataloging and cross-referencing.

A larger collection of project information is called a repository. CASE tools permit the analyst to create and share a repository with team members 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 also may contain information about project requirements and final system deliverables and about project management.

Each entry in a data dictionary contains the item name, an English description, aliases, related data elements, the range, the length, encoding, and necessary editing information. A 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 also can be used to create XML, enabling businesses with different systems, software, or database management systems to exchange data.

Keywords and Phrases

base element
binary format
data dictionary
data element
data structure
derived element
document type definition (DTD)
extensible markup language (XML)
ID
IDREF
packed decimal
physical data structure
repeating group
repeating item
repository
schema
structural record
system deliverables
varchar
zoned decimal

Review Questions

1. Define the term *data dictionary*. Define *metadata*.
2. Explain the rationale behind the contents of an automated data dictionary.
3. What information is contained in the data repository?
4. Discuss the algebraic notation for data structures.
5. Discuss the contents of a form that can be used to summarize the information captured for a data flow.
6. What are the characteristics that are commonly included in a form used to describe 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. What are some of the criteria used for validating data captured in a system?
11. Describe the creation of a data dictionary from the analysis of input and output forms.
12. Why shouldn't compiling the data dictionary be viewed as an end in itself?
13. List the five main ways to use 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 is an XML schema?

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. Refer to Problem 2, Chapter 7. Henry has defined the data flows as three librarians receiving a forthcoming publication checklist every week, librarians marking their preferences and submitting the list to the head librarian, and the head librarian preparing the final list and submitting it to the clerk for the order to be placed.
   a. For each of these data flows, write an entry in Henry's data dictionary.
   b. Write one data entry for each of the data stores involved in the situation.
3. Jack Philips, a systems analyst, and his team have attempted to analyze data movement of an online recruitment agency. The system receives recruitment requests from various firms and collects job seekers' résumés. Jack is composing a data dictionary for his findings from the recruitment system.
   a. Discuss whom Jack and his team should interview to clarify their concerns about data dictionary entries. Should they ask for minute system details, such as the field length required for storage?
   b. Write an entry in Jack's data dictionary for at least one data flow and one data store in the agency.
4. Karen Lichtman owns a store that specializes 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. Karen (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.

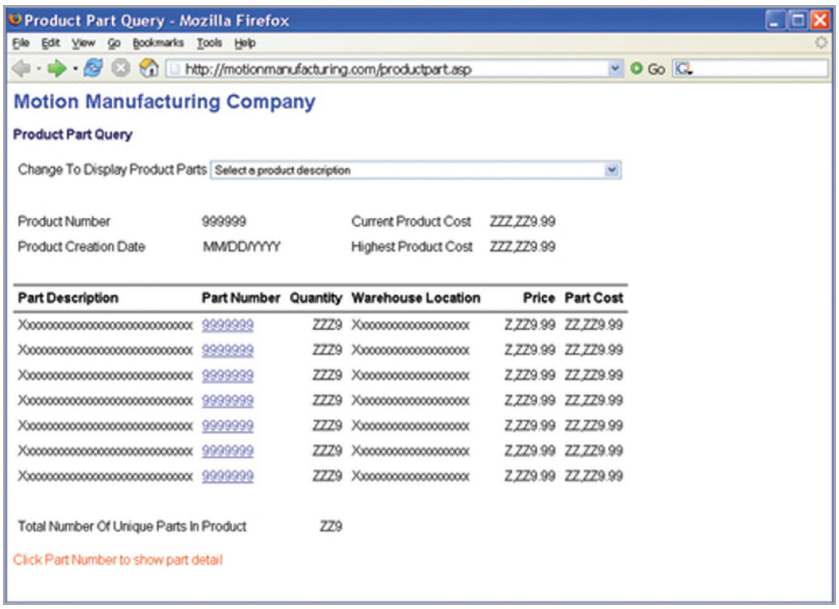


FIGURE 8.EX1

A prototype of the PRODUCT-PART web page.

```
                    CRUISE AVAILABILITY
MM/DD/YYYY                                                  HH:MM
ENTER STARTING DATE Z9-ZZZ-9999

- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -

CRUISE INFORMATION:
CRUISE SHIP              XXXXXXXXXXXXXXXXX
LOCATION                 XXXXXXXXXXXXXXXXXX
STARTING DATE            Z9-ZZZ-9999          ENDING DATE  Z9-ZZZ-9999
NUMBER OF DAYS           ZZ9
COST                     ZZ, ZZZ.99
DISCOUNTS ACCEPTED       XXXXXXXXXXX     XXXXXXXXXXXX     XXXXXXXXXXXX
OPENINGS REMAINING ZZZZ9
```

FIGURE 8.EX2

A screen prototype to show cruise availability.

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.
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 Barba Bowls, a company that sells personalized sets of wooden salad bowls, would like to send information to another company that maintains the warehouse and provides shipping services. Order information is obtained from a secure website, 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 Barba Bowls, 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. Nine Lives 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 postal 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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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.

A systems analyst approaching process specifications and structured decisions has many options for documenting and analyzing them. The methods 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. Structured decisions lend themselves particularly well to analysis with systematic methods that promote completeness, accuracy, and communication. In Chapters 7 and 8 we noted processes such as VERIFY AND COMPUTE FEES, but we did not explain the logic necessary to execute these tasks.

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 backorder.)"

"If the backorder 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 backorder date is 30 days or more, though, we send out a notice with a chef glaring at his egg timer."

"If the backorder 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."

You are the systems analyst 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.

Overview of Process Specifications

To determine the human information requirements of a decision analysis strategy, a 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. This 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 in 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 a process to a data flow diagram, and hence a data dictionary, as illustrated in Figure 9.1. Each process specification should be entered on a separate form or into a CASE (computer assisted software engineering) tool screen such as the one used by the CASE tool Visible Analyst. 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 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 the 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.

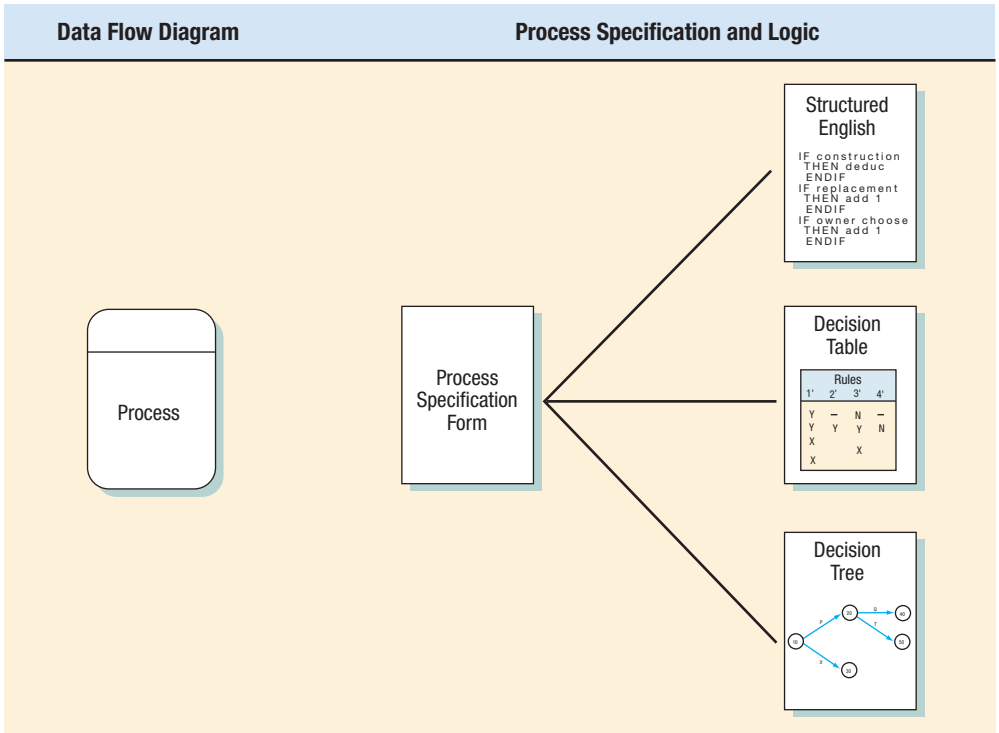

FIGURE 9.1

How process specifications relate to a data flow diagram.

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
   - 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. A list of 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 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).
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 similar 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.

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

FIGURE 9.2

An example of a completed process specification form for determining whether an item is available.

Process Specification Form

Number 1.3
Name Determine Quantity Available
Description Determine if an item is available for sale. If it is not available, create a backordered item record. Determine the quantity available.

Input Data Flow
Valid item from Process 1.2
Quantity on Hand from Item Record

Output Data Flow
Available Item (Item Number + Quantity Sold) to Processes 1.4 & 1.5
Backordered item to Inventory Control

Type of Process
☑ Online ☐ Batch ☐ Manual

Subprogram/Function Name

Process Logic:
IF the Order Item Quantity is greater than Quantity on Hand
Then Move Order Item Quantity to Available Item Quantity
Move Order Item Number to Available Item Number
ELSE
Subtract Quantity on Hand from Order Item Quantity
giving Quantity Backordered
Move Quantity Backordered to Backordered Item Record
Move Item Number to Backordered Item Record
DO write Backordered Record
Move Quantity on Hand to Available Item Quantity
Move Order Item Number to Available Item Number
ENDIF

Refer to: Name: _____
☐ Structured English ☐ Decision Table ☐ Decision Tree

Unresolved Issues: Should the amount that is on order for this item be taken into account? Would this, combined with the expected arrival date of goods on order, change how the quantity available is calculated?

the year 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.

CONSULTING OPPORTUNITY 9.2

Kneading Structure

Kit Chen has risen to the occasion and answered your questions concerning the policy for handling unfilled orders at Kit Chen Kaboodle, 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 sent by post.

In examining the foregoing statements, we notice 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 determining 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 we begin to work on the structured English, we find 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.

FIGURE 9.3

Examples of logic expressed in a sequential structure, a decision structure, a case structure, and an iteration.

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

```
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 continue
    ELSE write plan–error–message
    ENDIF
  ENDIF
  IF claim is greater than zero
    THEN print check
  ENDIF
  Print summary for claimant
  Update accounts
ENDDO
```

FIGURE 9.4

Structured English for the medical-claim processing system. Underlining signifies that the terms have been defined in the data dictionary.

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 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

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 +
	$_1^5${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

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.

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.

Structured English

Format the Shipping Statement. After each line of the statement has been formatted, write the shipping line.

```
GET Order Record
GET Customer Record
Move Order Number to shipping statement
Move Order Date to Shipping Statement
Move Customer Number to Shipping Statement
DO format Customer Name (leave only one space between First/Middle/Last)
DO format Customer Address lines
DO WHILE there are items for the order
        GET Item Record
        DO Format Item Line
        Multiply Unit Price by Quantity Ordered giving Extended Amount
        Move Extended Amount to Order Item Lines
        Add Extended Amount to Merchandise Total
        IF Quantity Backordered is greater than zero
                Move Quantity Backordered to Order Item Lines
        ENDIF
ENDDO
Move Merchandise Total to Shipping Statement
Move 0 to Tax
IF State is equal to CT
        Multiply Merchandise Total by Tax Rate giving Tax
ENDIF
Move Tax to Shipping Statement
DO calculate Shipping and Handling
Move Shipping and Handling to Shipping Statement
Add Merchandise Total, Tax, and Shipping and Handling giving Order Total
Move Order Total to Shipping Statement
```

FIGURE 9.6

Structured English for creating the shipping statement for World's Trend.

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 features 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.

FIGURE 9.7

The standard format used for presenting a decision table.

Conditions and Actions	Rules
Conditions	Condition Alternatives
Actions	Action Entries

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.

	Rules			
Conditions and Actions	**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

Developing Decision Tables

To build decision tables, an 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.
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 a 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 for 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:

$$\begin{array}{r} \text{Condition 1: } \times 2 \text{ alternatives} \\ \text{Condition 2: } \times 2 \text{ alternatives} \\ \text{Condition 3: } \times 2 \text{ alternatives} \\ \text{Condition 4: } \times \underline{2 \text{ alternatives}} \\ 16 \text{ possibilities} \end{array}$$

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

CONSULTING OPPORTUNITY 9.3

Saving a Cent on Citron Car Rental

"We 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 online. Draw an updated decision table that shows a 10 percent discount for booking a car over the Web.

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:	YN
Action 1:	XX

FIGURE 9.9

Constructing a decision table for deciding which catalog to send to customers who order only from selected catalogs.

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			

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.

A DECISION TABLE EXAMPLE Figure 9.9 is shows 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 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

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			

Conditions and Actions	Rules 1'	2'	3'
Customer ordered from Fall catalog.	—	—	—
Customer ordered from Christmas catalog.	Y	—	N
Customer ordered from specialty catalog.	Y	N	Y
Send out this year's Christmas catalog.		X	
Send out specialty catalog.			X
Send out both catalogs.	X		

FIGURE 9.10

Combining rules to simplify the customer-catalog decision table.

$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.

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

Conditions and Actions	Rules 1'	2'	3'	4'
Customer ordered from Fall catalog.	—	—	—	—
Customer ordered from Christmas catalog.	Y	—	N	—
Customer ordered from specialty catalog.	Y	N	Y	—
Customer ordered $50 or more.	Y	Y	Y	N
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

FIGURE 9.11

Adding a rule to the customer-catalog decision table changes the entire table.

FIGURE 9.12

Checking the decision table for impossible situations is important.

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 9.13

Checking the decision table for inadvertent contradictions and redundancy is important.

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		
Action 2			X			X	
Action 3		X					X

Contradiction — Redundancy

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.

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

CONSULTING OPPORTUNITY 9.4

A Tree for Free

"I know you've got a plane to catch, but let me try to explain it to you once again, 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.

actions possible were: 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.

A 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; in contrast, with decision tables, conditions and actions are all part of the same table. Conditions and actions that are critical are connected directly to other conditions and actions, whereas 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 an organization. Consequently, they are more appropriate as a communication tool.

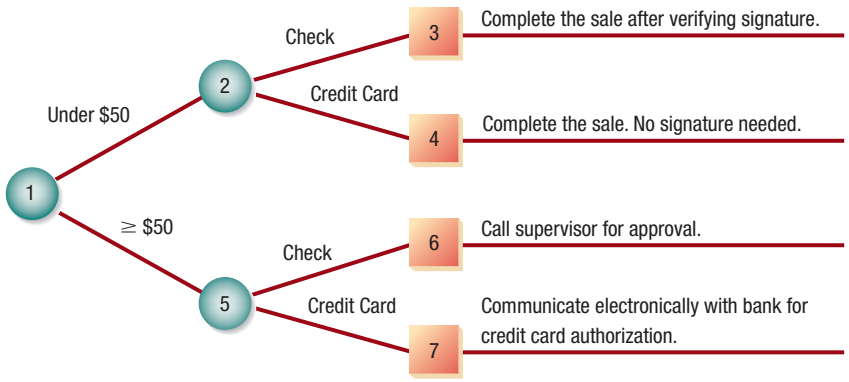

FIGURE 9.14

Drawing a decision tree to show the noncash purchase approval actions for a department store.

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 an analyst has worked with users to identify data flows and begun 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. All three methods help an analyst develop the logic for structured decisions made in the organization. Making structured decisions need not involve human judgment.

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 condition (or 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 to use a 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 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

"It'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 Mr. Evans 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, Mr. Evans 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 Questions

1. Assume that 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, email addresses, and phone numbers of new clients. Using structured English, write a procedure for carrying out the process of entering a new client name, address, email address, and phone numbers. (*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, email address, and phone number [if necessary] or add a new client's address, email address, and phone 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. List process categories that do not require specifications.
3. What four elements must be known for a 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 an organization?
7. What is a decision table? Discuss the standard format used to present one.
8. List the steps that provide a systematic method of development for decision tables.
9. List the four main problems that can occur in developing decision tables.
10. How do decision tables play an important role in the analysis of structured decisions to ensure completeness?
11. What are the main uses of decision trees in systems analysis?
12. List the four major steps in building decision trees.
13. Why is it not important for a decision tree to be symmetrical?
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 45 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 online 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. A systems analyst is designing an app that automates loan application processes. However, many factors must be considered before a loan can be processed or verified by the system. The analyst has described the different scenarios as follows:

   The app first checks whether the loan applicant is an existing customer or a new one. For existing customers, the system first verifies the age of the customer, followed by their source of income, the amount of monthly income, and the loan applied for. It then displays whether the application has been processed successfully.

   If the age of an applicant is less than 30 and they receive a monthly salary of up to $30,000, their eligibility ranges between a minimum of $200,000 for no less than five years' duration and a maximum amount of $500,000, payable in at least 10 years. Those who earn more than $30,000 a month are eligible for $500,000, payable in at least five years, and a maximum amount of $1,000,000, payable in at least 10 years. For those who earn from businesses, similar slabs apply, but an additional document verification and a registered TaxPayerID is required. Finally, those who earn less than $10,000 a month are not eligible for a loan.

   All the applicants aged between 30 and 60 years are eligible for a maximum amount of $500,000 for a minimum duration of five years. For those who have retired, the eligible amount is capped at $200,000, payable in at least five years.

   For new customers, their credit rating is verified first. If found acceptable, they too are eligible for loan applications according to the slabs mentioned above. The application is rejected if their credit rating is unacceptable.

   Draw a decision tree for requirement specification of the application.
9. Write structured English for the loan application process in Problem 8.
10. An e-retailer is famous for making their clearance sales very lucrative through offers bundled together. However, it is sometimes difficult to decide what the offers should be, so the manager has briefly explained how offers currently work at their store as follows:

    If customers purchase items worth $2,000 and above, they are eligible for a flat 10 percent discount. When they choose to shop from select clearance merchandise and the cart value exceeds $2,000, they get products chosen at the clearance price, an additional 10 percent discount, and a 5 percent cashback.

    If the customer increases the cart value to $5,000, then the discounts offered are based on the mode of payment chosen:

    If they pay through any of the listed online modes, they get products listed at the clearance price and an additional 20 percent off on the cart value. However, if they choose cash on delivery, they get an additional 5 percent off.

    If customers choose both clearance and fresh stocks and build up a cart value exceeding $5,000, they get the clearance stock at clearance prices and the fresh stock at a flat 20 percent off. If they also choose to share this discount and cart details with friends, they get cash coupons worth $5,000.

    Customers who buy clearance merchandise worth $10,000 or above get a loyalty badge qualifying them for a flat 20 percent discount on the entire stock for a month.

    Which process specification technique would be the most suitable for this scenario? Justify your answer.

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	X
Deduct discount	X	X														
Add sales tax		X	X	X		X	X	X								

11. Reduce the decision table in Figure 9.EX1 to the minimum number of rules.
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 villas have a 15 percent surcharge. The final price includes a discount of 4 percent for returning customers. Further conditions apply to how close to capacity the resort is 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. James, the operations manager at a manufacturing firm, is involved in forecasting exercises as part of his job. In one such recent exercise, he found an exponential increase in demand forecasts. To meet the increase in demands for the next two years, he pondered over a few options available to him. One was to upgrade the firm's manufacturing facility with new technology to introduce advancements in design and production. He estimated that one such facility could be set up at a cost of $5 billion, and he would need at least three such facilities. The second option is to expand the existing capacity by installing at least five more production plants at a cost of $2 billion each. The third option is to outsource the production to a third party, which would amount to approximately $25 million. However, James also calculated the difference in revenue estimated for each option, taking into account differences in demand estimates. He categorized demand estimates so that those resembling the forecast are labeled "high" and those resembling past estimates are labeled "moderate." For less than these two levels, he estimated no need for change in the current production cycle. For the first option, if the demand is high, the revenue is $30 billion; if it is moderate, the revenue is $25 billion. For the second option, if the demand is high, the revenue is $7 billion per plant; if moderate, $2 billion. Finally, for the third option, high demand would fetch $30 million in revenue while moderate demand would fetch $20 million.

    Develop an optimized decision table that clearly lists each available option for the manufacturing firm to meet changes in demand.
15. Develop a decision tree for the situation in Problem 14.

Group Projects

1. 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. As background for the problem, your group should know that Maverick Transport (first seen in Chapter 5) is a 15-year-old national U.S. trucking firm. 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. Each group should make a presentation of its preferred technique for making structured decisions.

2. After hearing each presentation, the entire 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. Write the group's recommendation for a decision technique in a paragraph.

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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 facilitates logical, rapid, and thorough methods for creating new systems that are 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 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 the approach. It makes intuitive sense that recycling program parts should reduce the costs of development in computer-based systems. It has proven to be very effective in the development of graphical user interfaces (GUIs) and databases. Although reusability is the main goal, maintaining systems is also very important. The object-oriented approach creates objects that contain both data and program code, and a change in one object has a minimal impact on other objects.

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* 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, and further details on other UML concepts are introduced later in this chapter.

Objects

Objects are persons, places, or things that are relevant to the system being analyzed. Object-oriented systems describe entities as objects. Typical objects may be customers, items, orders, and so on. Objects also may be graphical user interface (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 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 store similar information 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 because 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.

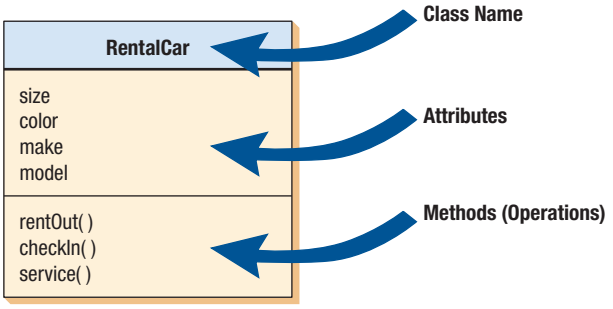


FIGURE 10.1

An example of a UML class. A class is depicted as a rectangle consisting of the class name, attributes, and methods.

An attribute describes some property that is possessed by all objects of the class. Notice that the **RentalCar** class possesses the attributes size, color, make, and model. All cars possess these 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 demonstrate how 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 **RentalCar, rentOut(), checkIn(),** and **service()** are examples of methods. When specifying methods, the first letter is usually lowercase.

Inheritance

A 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 making it easy to use common objects. 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. An analyst can therefore define once but use many times, and this 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 discuss this in more

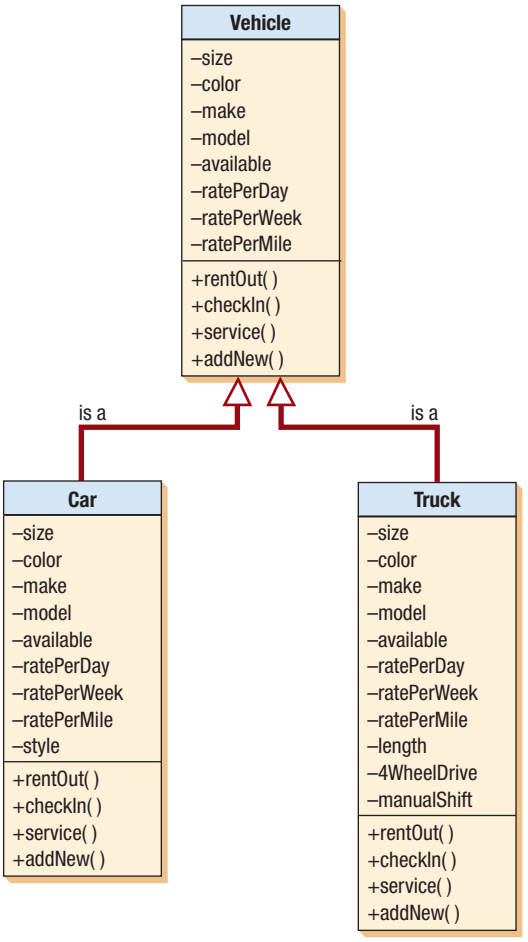


FIGURE 10.2

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

Because you have described the advantages of using object-oriented (O-O) approaches, Jules and Vern, two top executives at World's Trend (a mail order supplier of high-quality, fashionable clothing, whose customers place orders by phone, mail, or via their website), would like you to analyze their business using this approach. Here is a Summary of World's Trend Business Activities:

1. When customer orders come in, the item master and the customer master files are both updated. If an item is out of stock, the inventory control department is notified.
2. If the order is from a new customer, a new record is created in the customer master file.
3. Picking slips are produced for the customer order and sent to the warehouse.
4. A shipping statement is prepared.
5. The process of shipping a customer order involves getting the goods from the warehouse and matching up customer the customer shipping statement, getting the correct customer address, and shipping it all to the customer.
6. The customer statement is generated and a billing statement is sent to a customer once a month.
7. An accounts receivable report is sent to the accounting department.

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 getting 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.

detail later in the chapter, but for now 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).

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 found only 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. An analyst can use these concepts when beginning to talk about or model a 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.

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

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.

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 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; these are walkthroughs of system functions that use the 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 proceeds to refine the responsibility into smaller and smaller tasks, if possible. The object can fulfill these tasks 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, 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 dialogue 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**.

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 enable people to visualize the construction of an object-oriented system; similar to the way a set of blueprints helps people visualize the construction of a building. Whether you are working independently or with a large systems development team, the documentation created 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 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, annotational things are used to add notes to 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 things together in structural diagrams. Structural relationships include dependencies, aggregations, associations, and generalizations. Structural relationships show inheritance, for example. Behavioral relationships are used in

UML Category	UML Elements	Specific UML Details
Things	Structural Things	Classes Interfaces Collaborations Use Cases Active Classes Components Nodes
	Behavioral Things	Interactions State Machines
	Grouping Things	Packages
	Annotational Things	Notes
Relationships	Structural Relationships	Dependencies Aggregations Associations Generalizations
	Behavioral Relationships	Communicates Includes Extends Generalizes
Diagrams	Structural Diagrams	Class Diagrams Component Diagrams Deployment Diagrams
	Behavioral Diagrams	Use Case Diagrams Sequence Diagrams Communication Diagrams Statechart Diagrams Activity Diagrams

FIGURE 10.4

An overall view of UML and its components: things, relationships, and diagrams.

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 a 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.

Figure 10.5 illustrates how these diagrams relate to one another. We discuss each of these diagrams in the following sections.

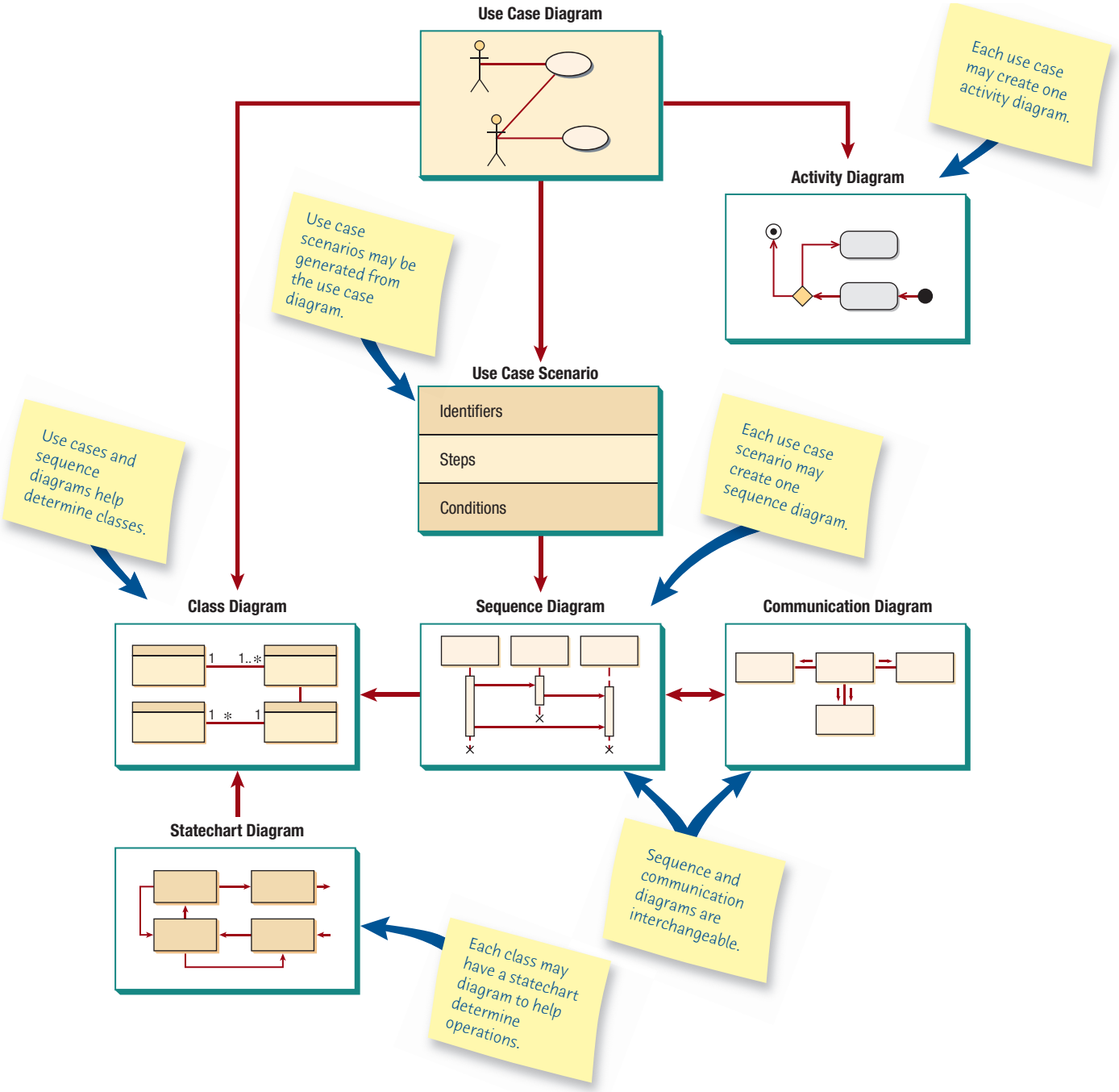


FIGURE 10.5

An overall view of UML diagrams, showing how each diagram leads to the development of other UML diagrams.

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's perspective, 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. UML techniques are used to 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, 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, or 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

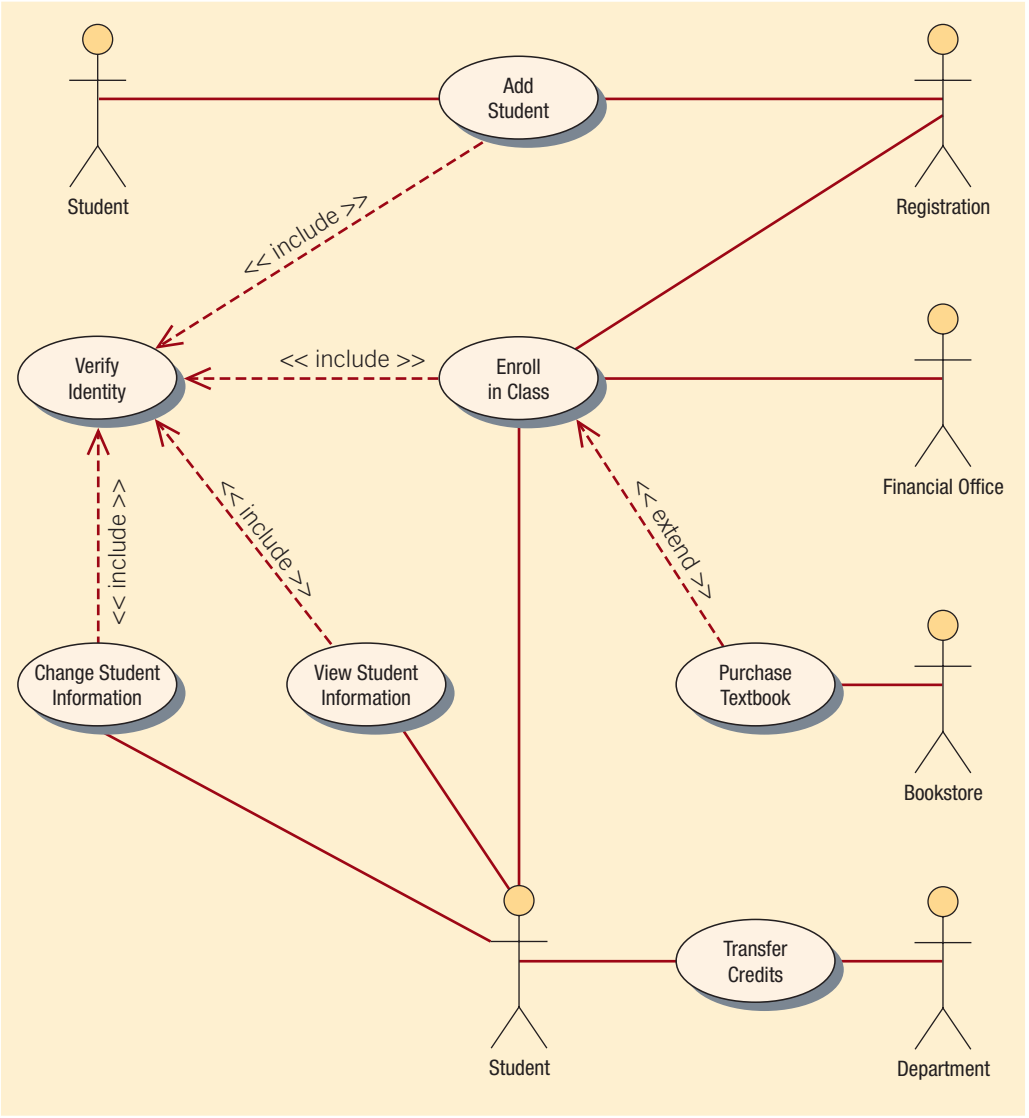


FIGURE 10.6

A use case example of student enrollment.

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 frequently, 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:

Use case name:	Change Student Information	**UniqueID:**	Student UC 005
Area:	Student System		
Actor(s):	Student		
Description:	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 website.		
Triggering Event:	Student uses Change Student Information website, enters student ID and password, and clicks the **Submit** button.		
Trigger type:	☒ External ☐ Temporal		

Steps Performed (Main Path)	**Information for Steps**
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 **Submit** 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

Preconditions:	Student is on the Change Student Information web page.
Postconditions:	Student has successfully changed personal information.
Assumptions:	Student has a browser and a valid user ID and password.
Requirements Met:	Allow students to be able to change personal information using a secure website.
Outstanding Issues:	Should the number of times a student is allowed to logon be controlled?
Priority:	Medium
Risk:	Medium

FIGURE 10.7

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

1. A header area containing case identifiers and initiators
2. Steps performed
3. A footer area that contains 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 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 logon to the system.

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

An activity diagram shows 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.

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.

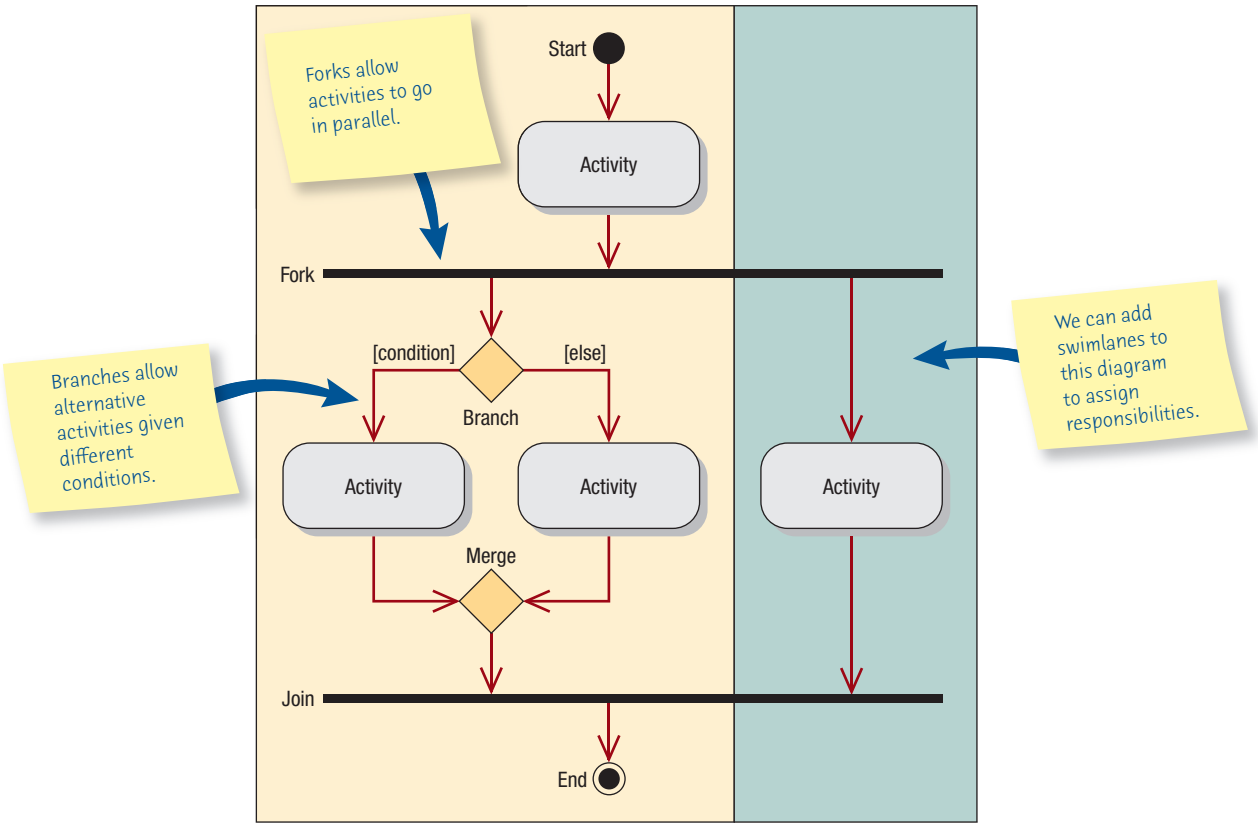


FIGURE 10.8

Specialized symbols are used to draw an activity diagram.

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,

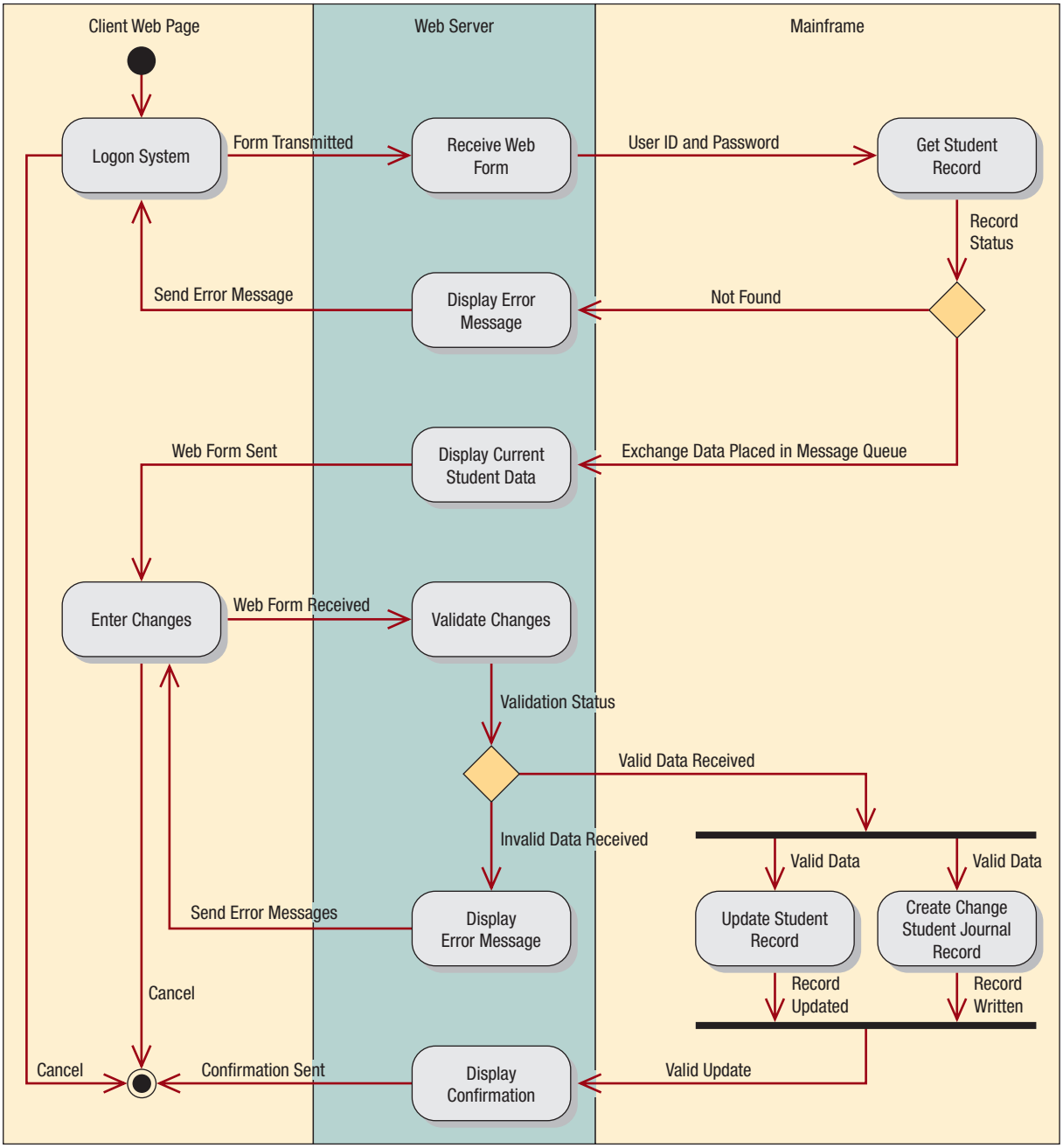


FIGURE 10.9

This activity diagram shows three swimlanes: Client Web Page, Web Server, and Mainframe.

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.

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**.

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 an enormous number of mainframe programs are 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 (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 activity diagram, 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. An analyst must

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 deal 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, has 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 automated 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 $6' \times 4'$ 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 desktop 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.

ensure that the data that the various team members need are available and correctly defined. Sometimes the data in the message queue are contained in 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 an analyst to experiment with moving portions of the design to different platforms to 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 an 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.

An 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 also may 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. We describe states with information about the state, such as the web page name, elements on the web page, and so on. We 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

A sequence diagram 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, dialogue 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.

objectName:	A name with a colon after it represents an object.
:class	A colon with a name after it represents a class.
objectName:class	A name, followed by a colon and another name, represents an object in a class.

A vertical line represents the lifeline for the class or object, which corresponds to the time it is created through to when it is destroyed. An X on the bottom of the lifeline represents when the

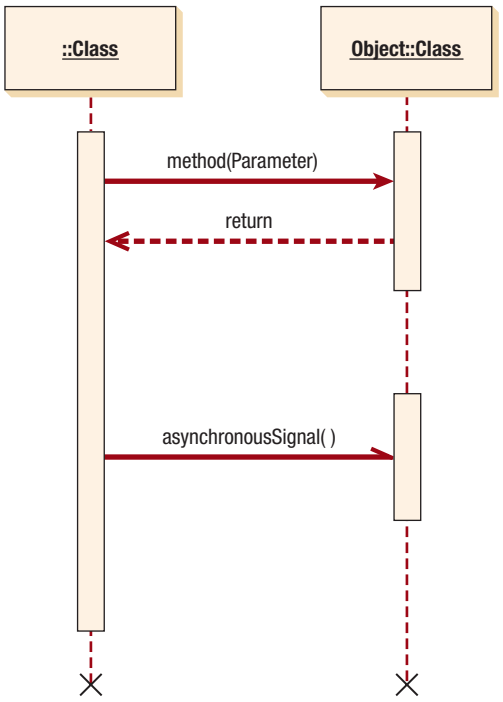


FIGURE 10.10

Specialized symbols used to draw a sequence diagram.

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 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

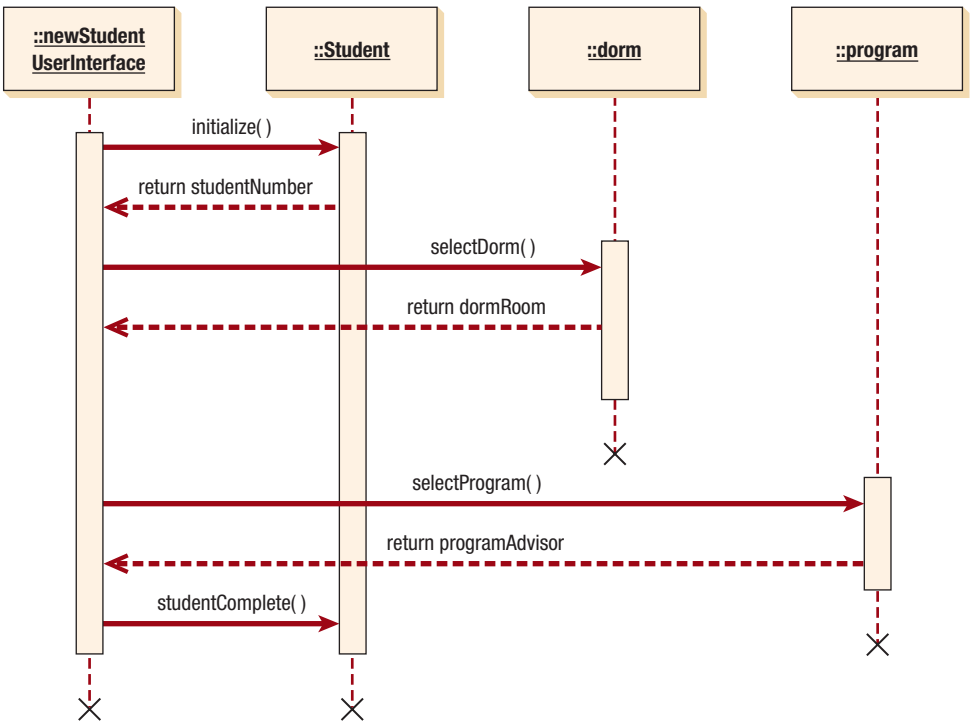


FIGURE 10.11

A sequence diagram for student admission. Sequence diagrams emphasize the time ordering of messages.

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.

A sequence diagram can be used to translate a 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, 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, and as of this writing we are on UML 2.5. Their original name in UML 1.x was collaboration diagrams. A communication diagram describes 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), communication links, and messages that can be passed along those links. Communication diagrams show the same information as a sequence diagram but may be more difficult to read. 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

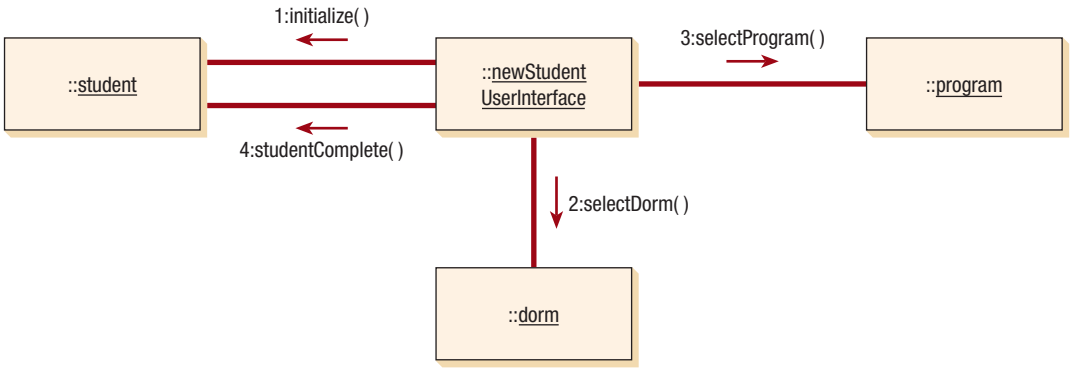


FIGURE 10.12

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.

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 also may 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.

A class is represented by a rectangle on a class diagram. In the simplest format, the rectangle may include only the class name, but it 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 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.

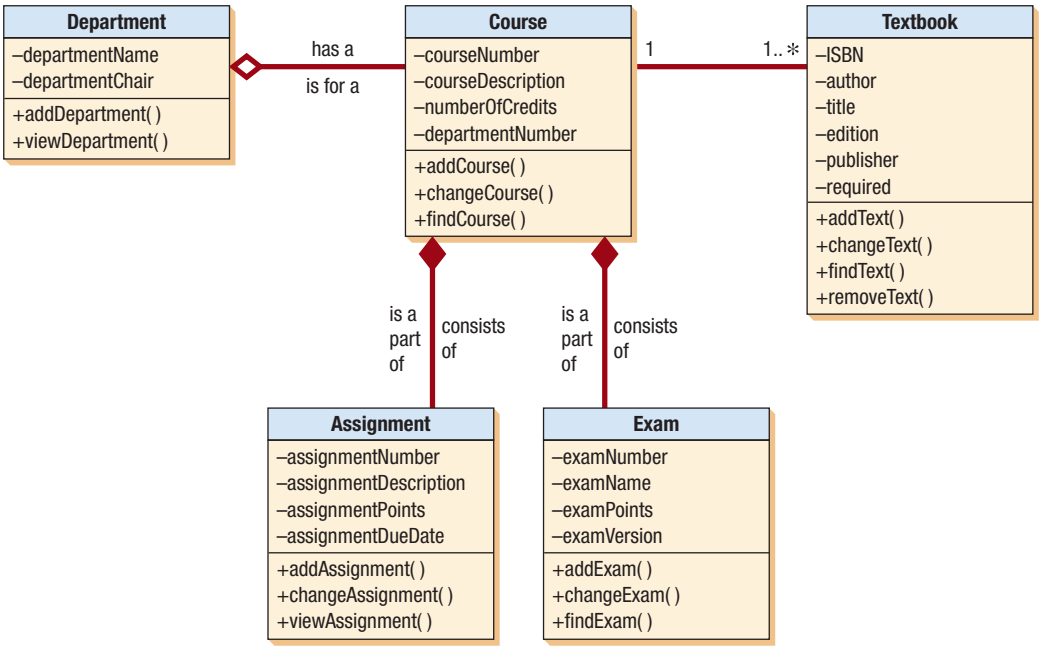


FIGURE 10.13

A class diagram for course offerings. The filled-in diamonds show aggregation, and the empty diamond shows a whole/part relationship.

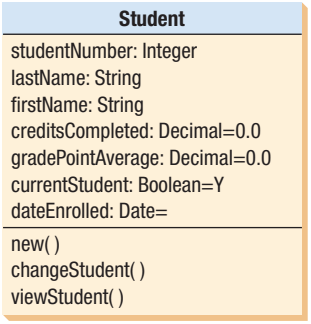


FIGURE 10.14

An extended **Student** class that shows the type of data and, in some cases, its initial value or default value.

The type of data (such as string, double, integer, or date) may be included on a 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 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.

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 (E-R) diagram. Computer-aided software engineering (CASE) tools such as Visible Analyst will allow you to create a UML entity class from an entity on an E-R diagram.

An analyst needs to determine which attributes to include in the classes. Each object has many attributes, but a 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, dialogue box, menu, list box, or other display control. It may also be a touch-tone telephone, bar code, or other ways for users to interact with the system. Human interfaces should be prototyped (as described in Chapter 6), and a storyboard is often 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 linked to concrete classes in a 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 create reusable classes, 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.

Enhancing Sequence Diagrams

Once a 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 that 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 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 give an 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 of 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 the **: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 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 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.

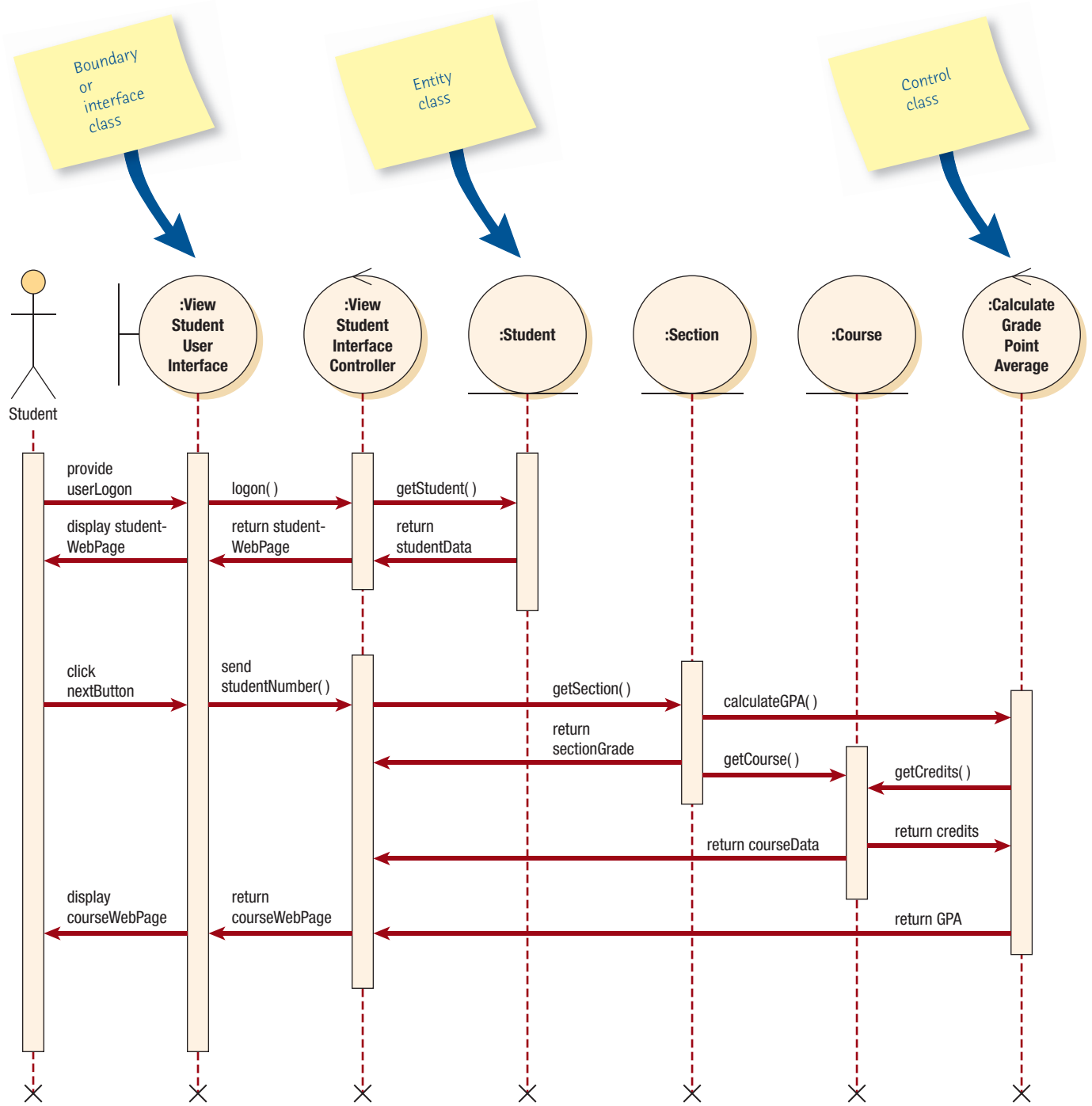


FIGURE 10.15

A sequence diagram for using two web pages: one for student information and one for course information.

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 an 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 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. Using cookies is 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.cio.com), and each cookie must be 4,000 or fewer characters.

   An 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 preceding 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 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:

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 advantage 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 website would answer some questions by entering data on a Web-based form and then wait until a new page loaded. This was necessary because the code to validate, get the data, and 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 a 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 that use this notation).

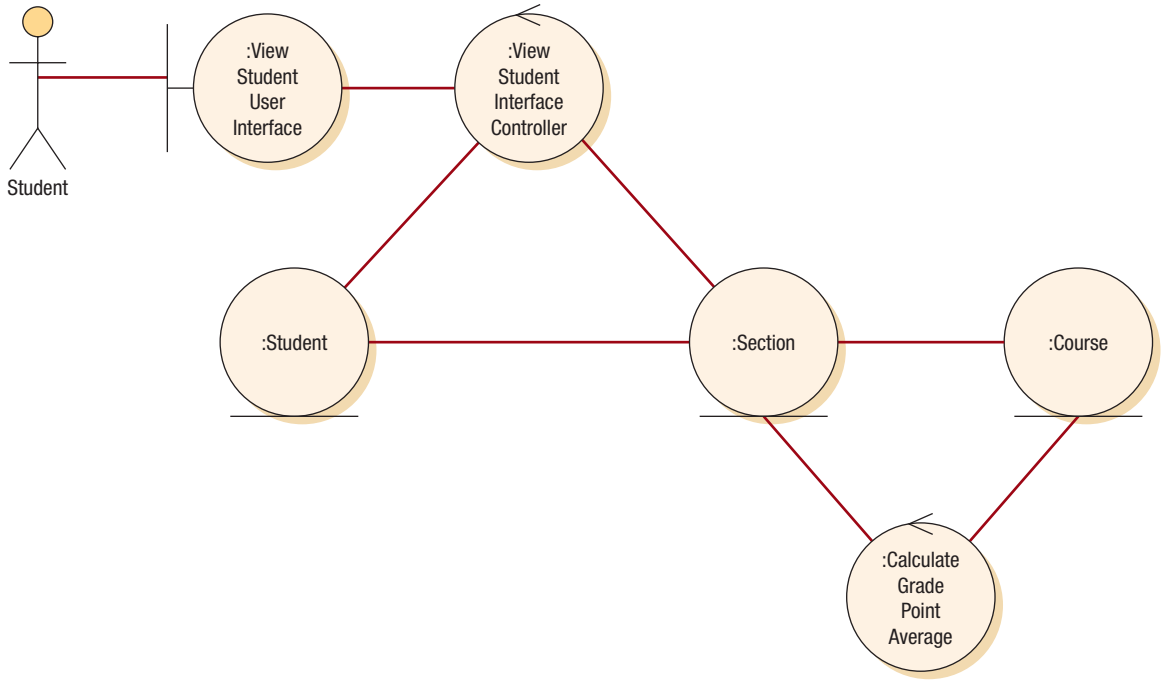


FIGURE 10.16

A class diagram for the **studentWebPage,** using special class symbols.

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.

A website may use a combination of many different classes to accomplish user objectives. For example, a website 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.

Relationships

Another way to enhance class diagrams is to show relationships. Relationships are connections between classes, similar to those found on an E-R 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 multiplicity, which is the same as cardinality on an E-R 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.

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

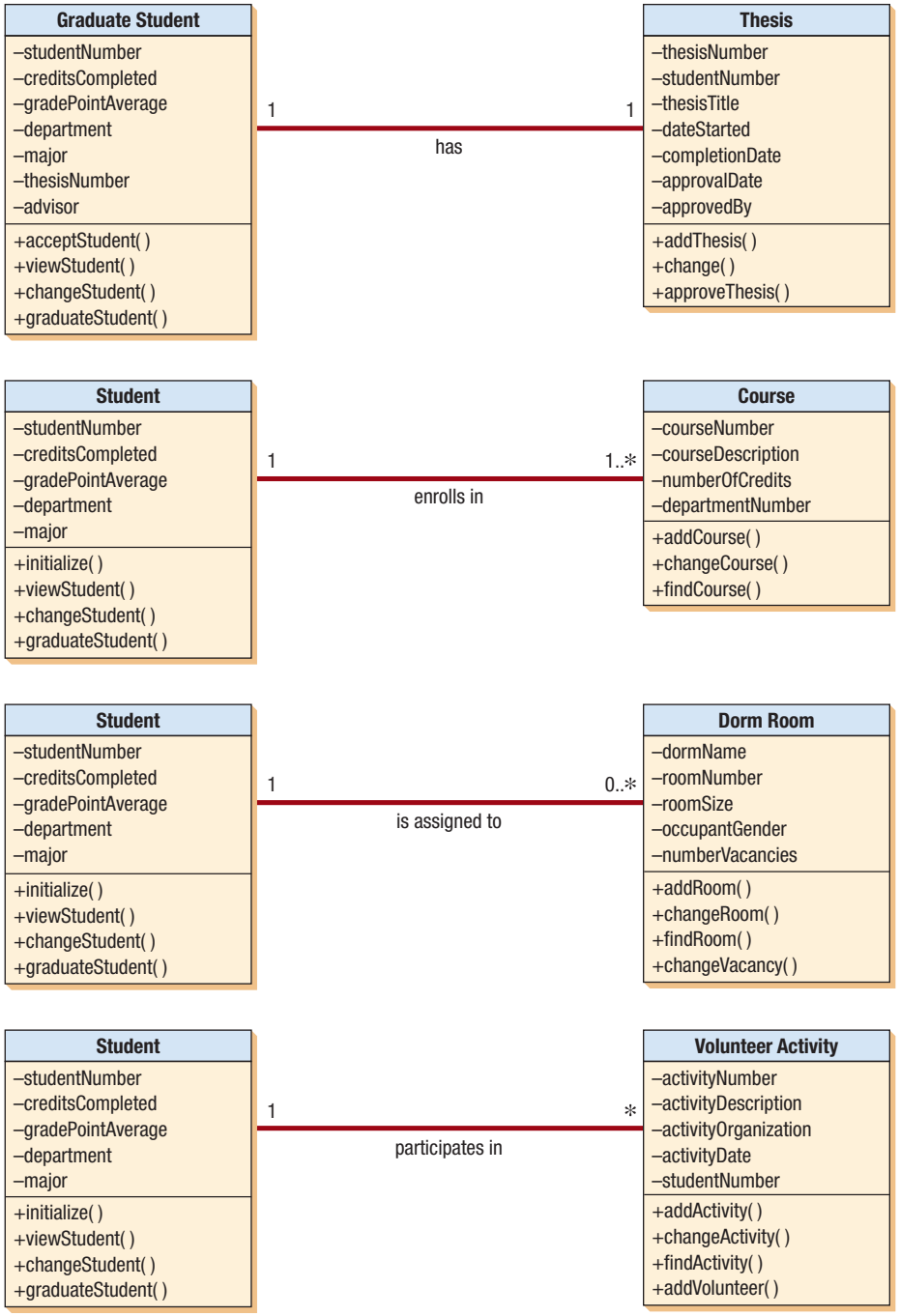


FIGURE 10.17

Types of associations that may occur in class diagrams.

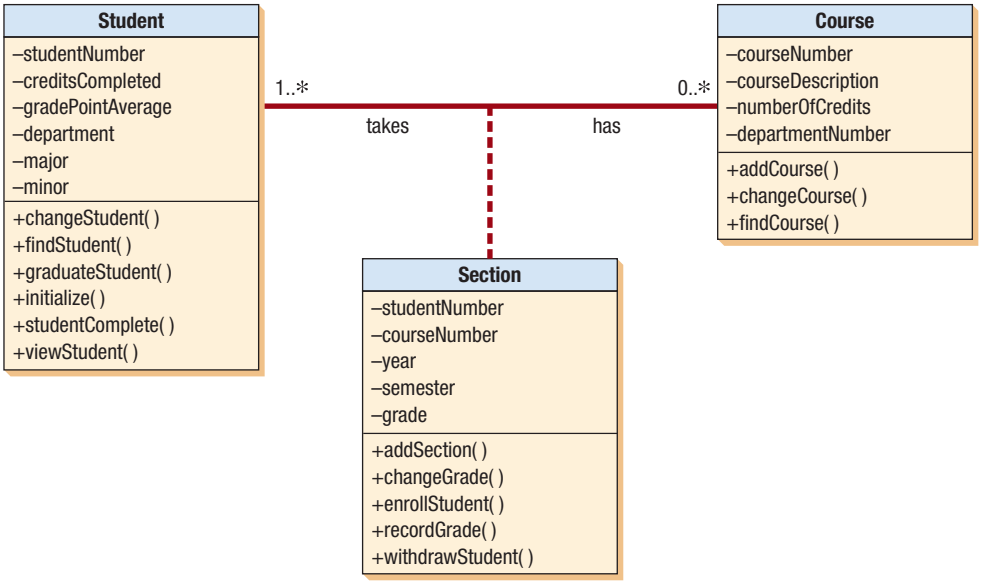
1..10, representing from 1 to 10 courses. It can also include a range of values separated by commas, such as 2, 3, 4. In the UML model, associations are usually labeled with a descriptive name.

Association classes are used to break up a many-to-many association between classes. These are similar to associative entities on an E-R 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; this is 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.

FIGURE 10.18

An example of an associative class in which a particular section defines the relationship between a student and a course.

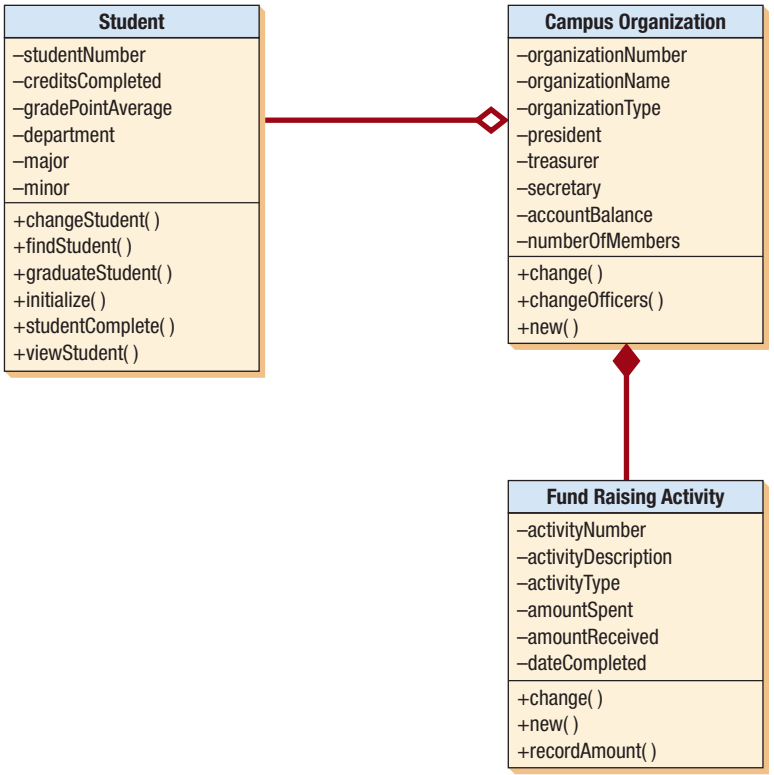


WHOLE/PART RELATIONSHIPS A whole/part relationship occurs when one class represents a whole object and other classes represent parts of that object. The whole acts as a container for the parts. These relationships are shown on a class diagram by a line with a diamond on one end. The diamond is connected 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, a brake system, a transmission, and so on. Whole/part relationships also may 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.

FIGURE 10.19

An example of whole/part and aggregation relationships.



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.

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 diagram may be considered to be an enhanced class diagram. Sometimes it is necessary to separate 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. 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.

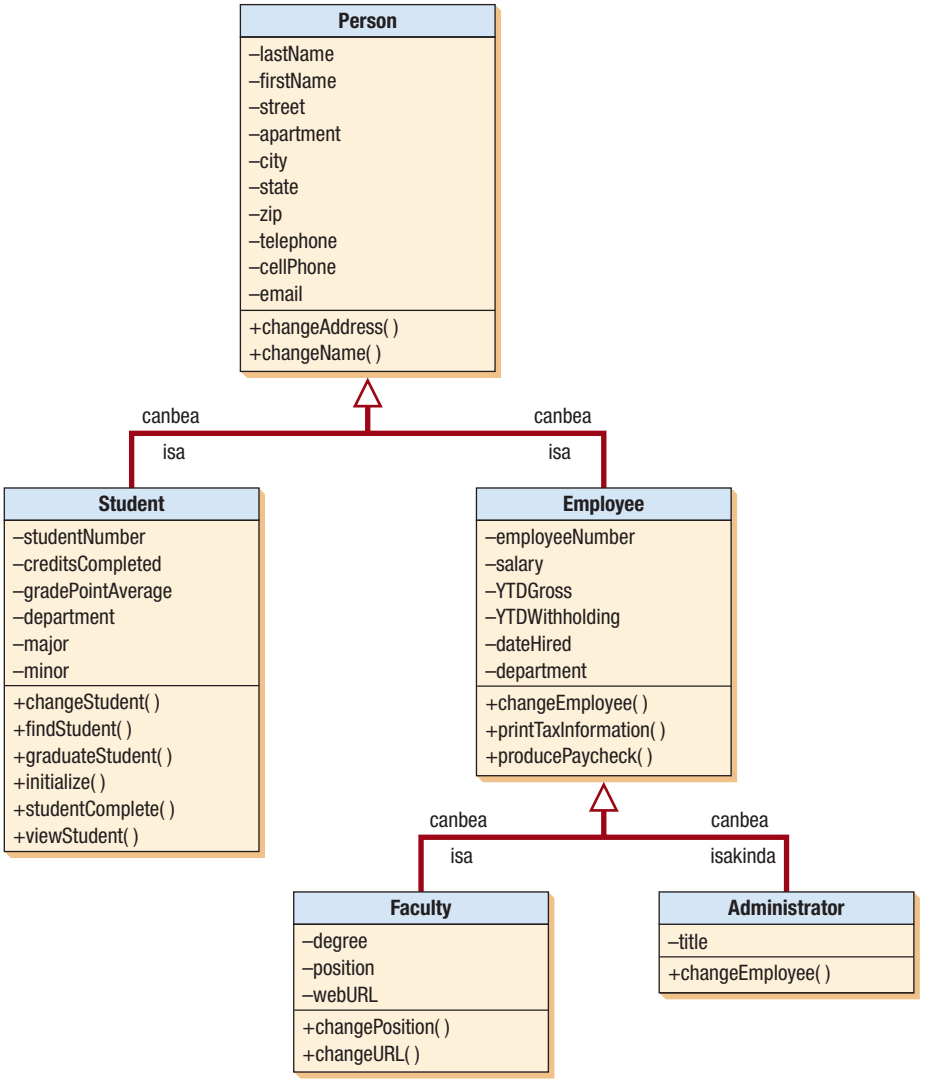
INHERITANCE Several classes may have the same attributes or methods. When this occurs, a general class is created containing the common attributes and methods. The specialized class inherits or receives the attributes and methods of the general class. In addition, the specialized class has attributes 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, a customer might receive an additional volume discount, and the method for calculating the order total will be modified. The subclass method is said to override the superclass method.

FIGURE 10.20

A gen/spec diagram is a refined form of a class diagram.



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 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 who are students and students who 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, such as *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*.

isa	Faculty *isa* Employee
isakinda	Administrator *isakinda* Employee
canbea	Employee *canbea* 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—subtracting money from the customer balance.

FINDING CLASSES There are a number of ways to determine classes. They may be discovered during interviewing or joint application design (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. An 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. An analyst should ask what the class knows (the attributes) and what the class knows how to do (the methods). The analyst should identify class relationships and the multiplicity for each end of the relationship. If the relationship is many-to-many, the analyst should create an intersection or associative class, similar to the associative entity in an E-R diagram.

DETERMINING CLASS METHODS An analyst must determine class attributes and methods. Attributes are easy to identify, but the methods that work with the attributes may be more difficult to define. Some of the methods are standard and are always associated with a class, such as the new() method or the «create» method, which is an extension to UML called a stereotype. (The «» symbols are not simply pairs of greater than and less than symbols; they are called guillemots or chevrons.)

Another useful way to determine methods is to examine a create, read, update, delete (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, you add a new() method. If there is a U for update, you add an update() or change() method. If there is a D for delete, you add a delete() or remove() method. If there is an R for read, you add methods for finding, viewing, or printing. In the example shown, the **textbook** class would need a create a method to add a textbook and a read method to initiate a course inquiry, change a textbook, or find a textbook. If a textbook were replaced, an update method would be needed, and if a textbook were removed, a delete method would be required.

MESSAGES To accomplish useful work, most classes need to communicate with one another. An object in one class can send information to an object in another class by 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.

Messages are sent from one class to another, so 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.

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.

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

Statechart Diagrams

Using a 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 in which each word is 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 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 needs a display or Web form to add or change the attributes. These become the interface objects. The display or Web form often has more controls (or fields) than just the attributes that change. It 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:

State:	Potential Student
Event:	Application Submitted
Method:	new()
Attributes changed:	Number
	Name
	Address
User interface:	Student Application Web Form
State:	Accepted Student
Event:	Requirements Met
Method:	acceptStudent()
Attributes changed:	Admission Date
	Student Status
	Return Acceptance Letter
User interface:	Accept Student Display
State:	Dorm Assigned Student
Event:	Dorm Selected
Method:	assignDorm()
Attributes changed:	Dorm Name
	Dorm Room
	Meal Plan
User interface:	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

A statechart diagram that shows how a student progresses from being a potential student to a graduated student.

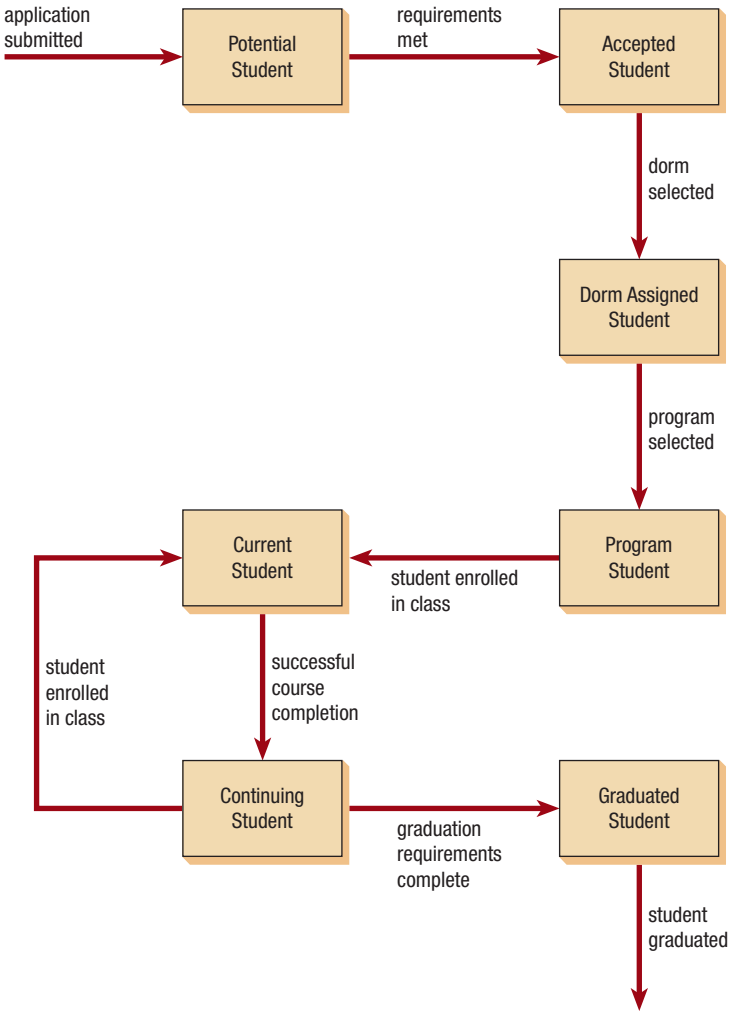


Figure 10.22. States are represented by rectangles, and events or activities are the arrows that link the states and cause one state to change to another state. Transition events are named in the past tense because they have already occurred to create the transition.

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 throughout 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 also may be component packages, which contain physical system

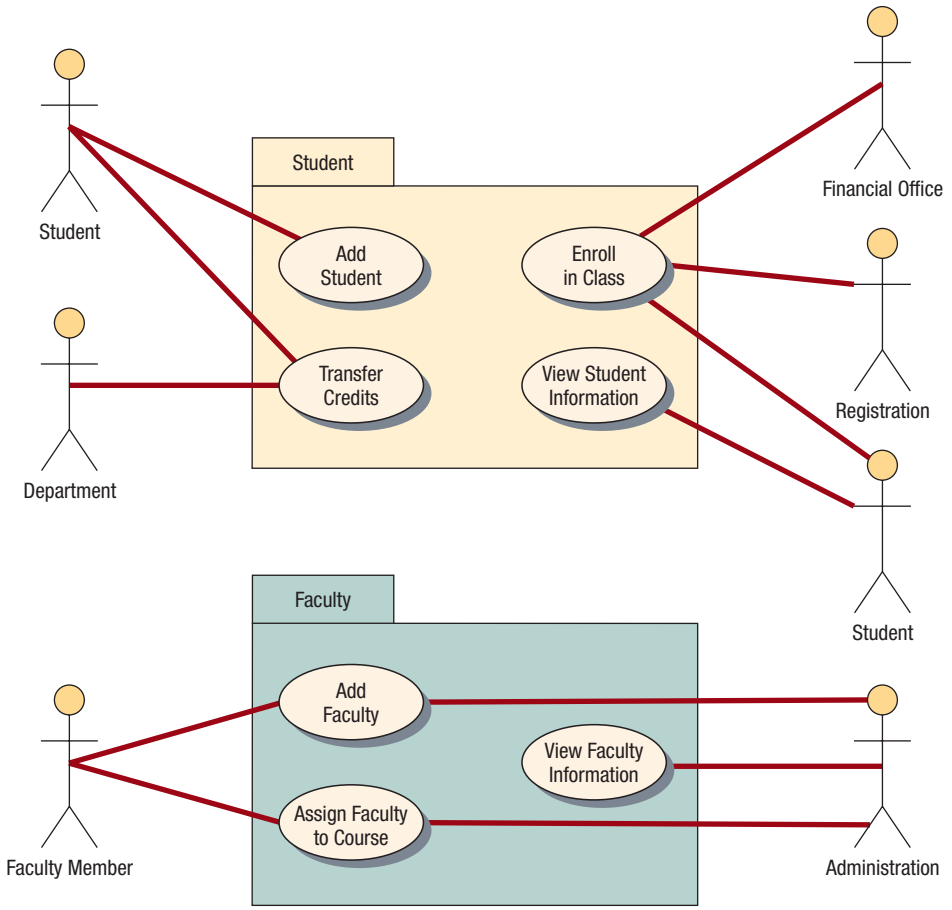


FIGURE 10.23

Use cases can be grouped into packages.

components, or 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 also may have relationships, similar to class diagrams, that 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. Three use cases, **Add Faculty**, **View Faculty Information**, and **Assign Faculty to Course**, 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.

A component diagram is similar to a class diagram, but it 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.

A 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 computer screen, 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. Even though we also have many online readers who just browse materials online. 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 notepad 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 other 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 with 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 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.
- 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. 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.

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, based in Burton, Michigan. "Only eight months ago, we completed a two-year development project of the Customer Service Representative (CSR) system. During that entire project, we endured a parade of moving requirements. Every month, Chelsea and Jonathan from Marketing 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 Salvatore, 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 people 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, Web-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?"

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? Write two paragraphs to answer these questions. Keep in mind that an important goal is to provide good support for the users' needs and the organization's business strategies.

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 the 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 using the diagrams, analysts can describe a use case by writing a use case scenario.

HYPERCASE EXPERIENCE 10

"I hope you still feel as if you're learning new things about MRE every day. I understand you've been talking to some of the systems people: Melissa, Todd, and 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, Mr. Evans 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.

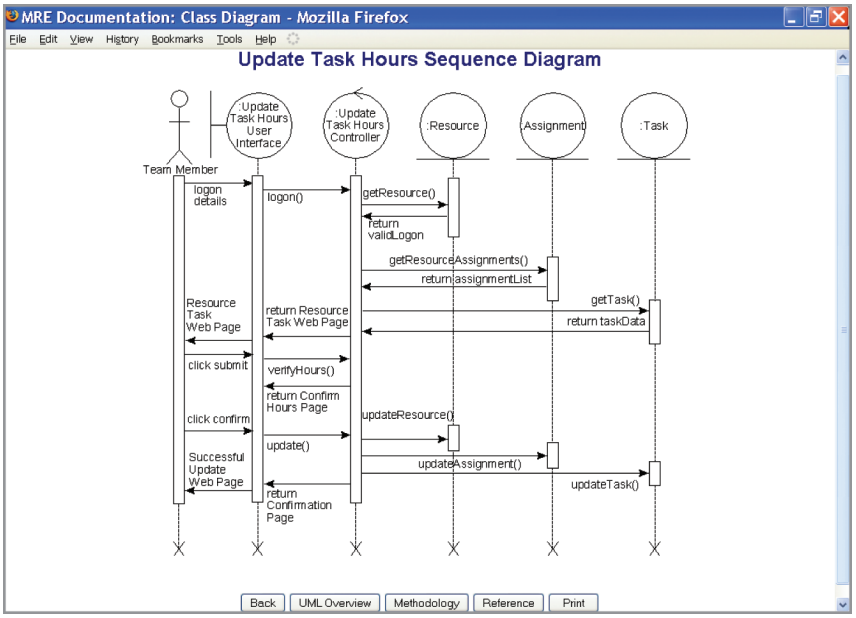


FIGURE 10.HC1

Sequence diagrams can be found in HyperCase.

Using UML iteratively in analysis and design allows for greater understanding between a business team and an IT team regarding the system requirements and the processes that need to occur in a system to meet those requirements.

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
CRC cards
dependencies
deployment diagram
entity class
event
fork
generalization/specialization (gen/spec)
inheritance
join
main path
merge
message
method overloading
method overriding
object
object-oriented
package
polymorphism
primary use case
relationship
sequence diagram
state
statechart diagram
swimlane
synchronization bar
synchronous message
temporal event
unified modeling language (UML)
unified process
use case diagram
use case scenario
whole/part relationship

Review Questions

1. List two reasons for taking an object-oriented approach to systems development.
2. Discuss attributes and methods in the context of classes.
3. Explain the relationship between a derived class and programming labor.
4. Discuss the interactive creation of CRC cards.
5. Describe what Object Think adds to the CRC card.
6. Explain the need for UML.
7. What are the three major elements of UML?
8. List the five most commonly used UML diagrams.
9. List the different things included in the UML element "thing."
10. List the different types of structural and behavioral relationships.
11. List the diagrams included in a structural diagram.
12. List the diagrams included in a behavioral diagram.
13. What does a use case model describe?
14. Would you describe a use case model as a logical or a physical model of a 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. List situations where an analyst finds activity diagrams most useful.
19. What is the role of a repository entry for an activity diagram?
20. Discuss how a communication diagram is different from a sequence diagram in UML modeling.
21. What can be shown on a class diagram?
22. Define *method overloading*.
23. Explain the use of horizontal balancing with a class method.
24. What are the steps in creating a sequence diagram?
25. How does visualizing layers in a sequence diagram help in writing system code?
26. Are statechart diagrams created for all classes?
27. What is polymorphism?
28. Discuss the role of events in statechart diagrams.
29. What is a package in the UML approach?
30. Why is using UML for modeling important?

Problems

1. Create a series of CRC cards for World's Trend Catalog Division (note that their business activities are listed in Consulting Opportunity 10.1 earlier in this chapter). 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 who is a manager or one who is a salesperson?
5. Draw a communication diagram for a bus operator handing over an end-of-shift report generated by a handheld device to an auditor.
6. Proimmune is a mobile app that allows patients to register for updates on immunization schedules on their registered mobile numbers. Draw a simple sequence diagram for the scenario, making necessary assumptions.
7. You are ready to begin UML modeling for the Aldo Sohm 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 Aldo Sohm Clinic.
9. Write a sample use case scenario for a patient who sees a physician in the Aldo Sohm Clinic.
10. Misha's Supermarket, a small chain of grocery stores, is building a website to allow customers to place online orders for groceries and other items. 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 store employees pick the goods from the shelves. The customer is then sent an email notification that his or her order is ready. When the customer picks up the order, frozen goods, chilled products, and other items are assembled. Draw an activity diagram showing the customer using the website 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 that is using Ajax on websites for customers to browse for parts. Ajax allows the website 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 vocal or instrumental sheet music to customers who like to sing or play instruments. 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 to make about the data.
    d. Create a class diagram for the entity classes used in the sequence diagram.

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11

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 for decision makers using infographics and other display features.
6. Design websites for ecommerce and corporate uses that include Web 2.0 technologies.
7. Design output and content for social media.
8. Understand the development process for apps used on smartphones and tablets.

Output is information delivered to users through an information system by way of intranets, extranets, or the Web. Some data require extensive processing before they become suitable output; other stored data are retrieved and considered output with little or no processing. Output can take many forms, including soft copy such as display screens, smartphones, tablets, video and audio output, social media output and content, as well as the traditional hard copy of printed reports. Responsive web design means designing a website that can be viewed on a desktop, tablet, or smartphone. Web design has moved away from 3-D, realistic images with shadows (skeuomorphic design) to flat Web design (two-dimensional images without shadowing). Users rely on output to accomplish their tasks, and they often judge the merit of a system solely by its output. To create the most useful output possible, a systems analyst must work closely with users through an interactive process until the result is considered to be satisfactory.

Output Design Objectives

It is essential to design useful output to ensure the use and acceptance of the information system. A systems analyst focuses on six objectives 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 phase of analysis, a systems analyst determines user and organization purposes. Output is then designed based on those purposes.

An application permits numerous opportunities to supply output, but the systems analyst focuses on features tied to the purposes defined during analysis. If the output is not functional, it should not be created because there are costs of time and materials associated with all output from a 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 most practical to create user-specific or user-customizable output when designing for a decision support system (DSS) 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 a system must provide what each person needs in order 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 provided only to flaunt the capabilities of the system. Always keep the decision makers in mind. Often the amounts of output users need is limited, 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 a systems analyst. To be used and useful, output must be presented to the right user. No matter how well designed reports are, if the pertinent decision makers do not see them, they have no value.

Providing Output on Time

One common complaint 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 the usefulness of output. 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 screens, and users have the option of printing it out with their own printer. An 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 is interrelated with the output method. When designing output, systems analysts must consider how function influences form and how the intended purpose will influence the output method chosen.

Output should be thought of in a general way so that any information generated 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.

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 websites bearing the company logo and corporate colors.

With the advent of green IT (also called green computing, or ICT sustainability), many organizations are trying to encourage customers to think about environmental savings, ease of use, and 24-hour access to accounts so that they switch from paper statements to online bills. Electronic transactions lessen the environmental impact of paper output and further computerizes the business to consumer relationship.

Internal outputs range from short summary reports to lengthy, detailed reports. 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 past six months.

Output Technologies

Producing different types of output requires different technologies. For printed output, the options include a variety of printers, including standard document printers, specialized label printers, and 3-D printers. For screen output, the options include attached or stand-alone displays as well as touch-sensitive screens found on smartphones and tablets. Audio output can be amplified over a loudspeaker or designed for individual listening on mobile devices. Electronic output includes web pages, email, RSS (Real Simple Syndication) feeds, and blogs. Figure 11.1 compares output methods.

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:

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 organization 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?

Output Method	Advantages	Disadvantages
Printer	• Affordable for most organizations • Flexible in types of output, location, and capabilities • Handles large volumes of output • Highly reliable with little down time	• Still requires some operator intervention • Compatibility problems with computer software • May require special, expensive supplies • Depending on model, may be slow • Environmentally unfriendly
Display screen	• Interactive • Online, real-time transmission • Quiet • Takes advantage of computer capabilities for movement within databases and files • Good for frequently accessed, ephemeral messages	• May require cabling and setup space • Requires system for taking "snapshots" of screen and storing them for future use
Audio output and podcasts	• Good for individual user • Good for transient messages • Good where worker needs hands free • Good if output needs to be widely distributed	• Needs earbuds where output will interfere with other tasks • Has limited application
Mobile devices	• Highly portable • Very interactive using gestures • Zoom and magnification are possible	• Screen may be too small for text • Icons and buttons may be confusing • May be lost more easily
Electronic output (email, websites, blogs, and RSS feeds)	• Reduces paper • Can be updated very easily • Can be "broadcast" • Can be made interactive	• Is not conducive to formatting (email) • Is difficult to convey context of messages (email) • Websites need diligent maintenance

FIGURE 11.1

A comparison of output methods.

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—that is, hot spots) for output technologies?

Increasingly, organizations are taking up green IT initiatives as part of sustainability efforts. These initiatives may limit the quantity of paper reports that are printed or may discourage employees from printing out copies of email messages by adding a green IT notification to the bottom of each corporate email message. By examining each output factor separately, the analyst can determine 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 websites 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 require different output. Clients, vendors, and suppliers can be part of several extranets, which are networks of computers built by the organization that provide applications, processing, and information to users on the network.

Examine the website shown in Figure 11.2 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 website is powered by a patented negotiating algorithm in which users submit

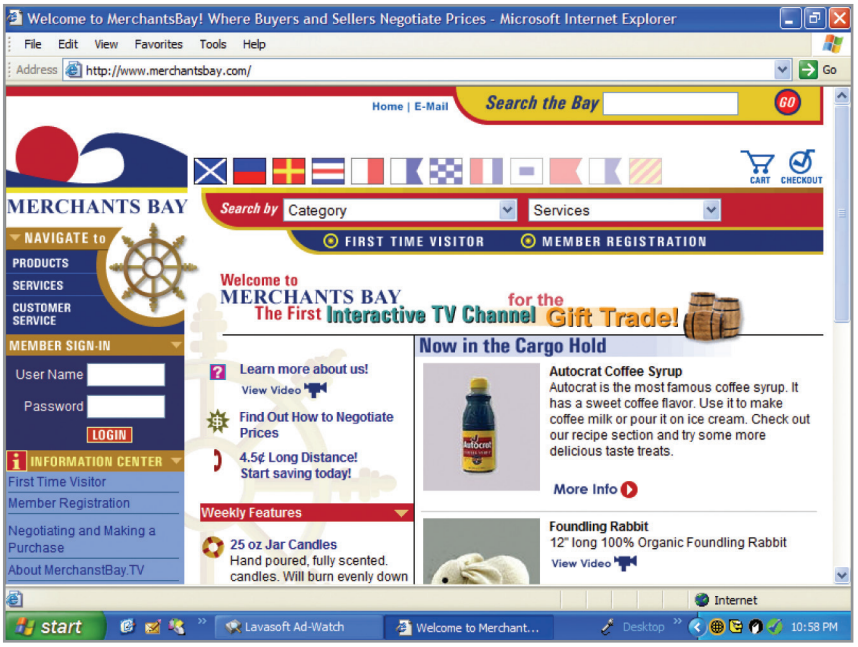


FIGURE 11.2

When designing a website, it is important to choose a metaphor that can be used throughout the site. This example from Merchants Bay (www.merchantsbay.com) employs a nautical theme. (Screenshot of Merchant Bay website. Copyright © 2000 by Merchants Bay LLC. Reprinted with permission of Troy Pappas.)

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 website 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 website has 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.

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 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.

WHERE IS THE OUTPUT NEEDED (DISTRIBUTION, LOGISTICS)? The choice of output technology is 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.

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 for over two years. 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 nonprofit 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 for breeding. 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."

"There is a special database on the Web that we subscribe to that includes selected species with 164 other zoos," says Ella as she picks up the story from Ty. "I have the password for the database stored on my computer. 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 pandas 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 access the database. 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 information you think you need to do your work as a committee. Financial data are stored on a laptop 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 Web to get the output that it needs and that it needs to share.) Analyze both internal and external output requirements.

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 organization 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. The web page shown in Figure 11.3 provides a series of six brief video clips to document 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. It serves a historic purpose.

If the purpose of output may be to provide instant updates on stock market quotes, and if the material is highly encoded and changeable, screen crawls, web pages, or audio

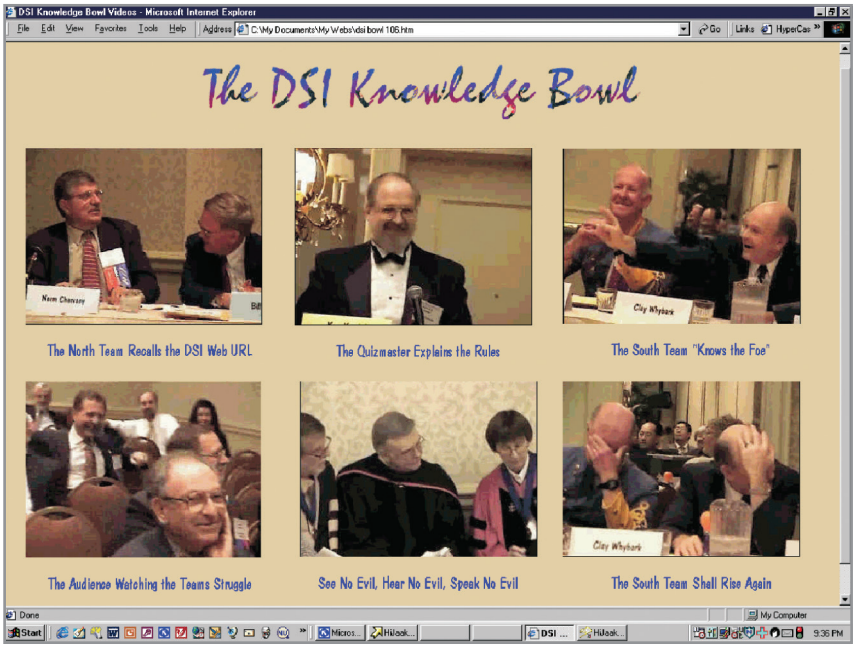


FIGURE 11.3

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.

presentations are preferable. Output must support user tasks, such as performing analysis or determining ratios, so software tools, including calculators and embedded formulas, could be part of the output. Output must also support organization 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 an organization, we find that decision makers at the lowest level of operations management need output rapidly to quickly adjust to events such as a stopped assembly line, raw materials not arriving on time, or a worker being 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 an archive, which could be cloud-based.

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 government 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 website. 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 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 printable,

CONSULTING OPPORTUNITY 11.2

A Right Way, a Wrong Way, and a Subway

"So 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 2-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 vending 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 vending 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. In a paragraph, comment on the external output that users of the automated ticket machines are apparently receiving. In a second paragraph, 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. List the 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? Reply in a paragraph.

even if it exists in an enterprise resource planning (ERP) payroll system such as Oracle. Each business in each country exists within a different complex of regulations under which it produces output. To that extent, law may dictate appropriate technology for some functions.

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 in 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 (Web 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 website 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.

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 computers are within a few hundred feet of transmitters but can be subjected to interference by other devices.

Some output technologies are prized for their unobtrusiveness. Libraries and hospitals, which emphasize silence in the workplace, make extensive use of displays for Web documents and other networked database information, but printers might be scarce. Analysts working for a company that has sustainability as part of its mission also may want to include the idea of green IT in their output decisions. This might translate into putting more transactions, reports, and documents online and discouraging printing of email messages.

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 output to avoid biasing it.

Recognizing Bias in the Way Output Is Used

It is a common error to assume that once a systems analyst has signed off on a system project, his or her impact has ended. Actually, the analyst's influence is long lasting. Much of the information on which organization 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 analysts and users make choices about how information is sorted for a report. Common sorts include alphabetical, chronological, and cost.

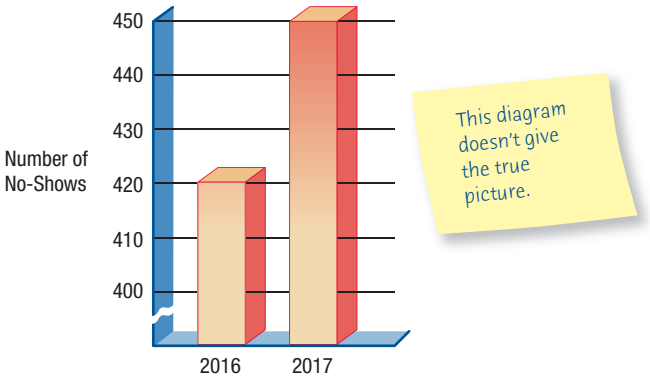
Information presented alphabetically may overemphasize the items that begin with the letters A and B because users tend to pay more attention to information presented first. For example, if past suppliers are listed alphabetically, companies such as Aardvark Printers, Advent Supplies, and Barkley Office 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

FIGURE 11.4

A misleading graph will most likely bias the user.



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 an 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 the user is not biased as to the importance of the variables that are presented. For example, Figure 11.4 shows a column chart comparing the number of no-shows for hotel bookings in 2016 with no-shows for hotel bookings in 2017. Notice that the vertical axis is broken, and it appears that the number of no-shows for 2017 is twice as much as the number of no-shows in 2016, although the number of no-shows has actually gone up only slightly.

Avoiding Bias in the Design of Output

Systems analysts 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 a systems analyst and users as it involves output. Systems analysts 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 (see Chapter 8). 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 mailings 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 operations 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.

A systems designer must understand that some website visitors might prefer to print out content. Consider inserting PDFs that can be downloaded and try printing each page in different browsers to ensure pages will have a professional look if a user prints them.

CONSULTING OPPORTUNITY 11.3

Should This Chart Be Barred?

"Gee, 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.

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 (see Consulting Opportunity 3.5, "Goal Tending").

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."

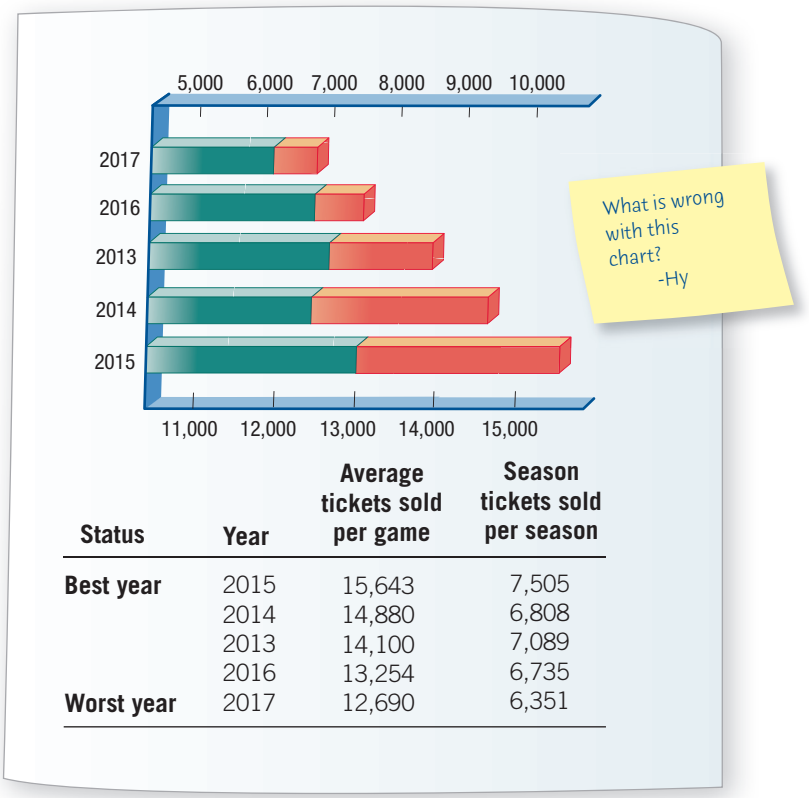
Andy hands the bar chart to Rip, who looks at it and suppresses a slight smile. "As long as we have you here, Andy, why don't you explain it to us?"

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 2015. 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 2017. 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.



Status	Year	Average tickets sold per game	Season tickets sold per season
Best year	2015	15,643	7,505
	2014	14,880	6,808
	2013	14,100	7,089
	2016	13,254	6,735
Worst year	2017	12,690	6,351

FIGURE 11.C1

An incorrectly drawn graph.

Designing Output for Displays

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. Chapter 12 covers designing displays for human or computer input, and these guidelines apply for designing output as well although the contents are different.

In addition, users must be instructed on which keys to press, which links to follow, and 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 11.5. 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 provide 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 11.6 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

New Zoo Order Status

Retailer	Order #	Order Date	Order Status
Animals Unlimited	933401	09/05/2017	Shipped On 09/29
	934567	09/11/2017	Shipped On 09/21
	934613	09/13/2017	Shipped On 09/21
	934691	09/14/2017	Shipped On 09/21
Bear Bizarre	933603	09/02/2017	Partially Shipped
	933668	09/08/2017	Scheduled For 10/03
	934552	09/18/2017	Scheduled For 10/03
	934683	09/18/2017	Shipped On 09/28
Cuddles Co.	933414	09/12/2017	Shipped On 09/18
	933422	09/14/2017	Shipped On 09/21
	934339	09/16/2017	Shipped On 09/26
	934387	09/18/2017	Shipped On 09/21
	934476	09/25/2017	Backordered
Stuffed Stuff	934341	09/14/2017	Shipped On 09/26
	934591	09/18/2017	Partially Shipped
	934633	09/26/2017	Backordered
	934664	09/29/2017	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.

FIGURE 11.5

The New Zoo output display screen is uncluttered and orients users well.

Order #	Retailer	Order Date	Order Status
933603	Bear Bizarre 1001 Karhu Lane Bern, Virginia 22024	09/02/2017	Partially Shipped

Units	Pkg	Description	Price	Amount	Detailed Status
12	Each	Floppy Bears	20.00	240.00	Backordered Due 10/15
6	Each	Growlers	25.00	150.00	Backordered Due 10/15
2	Each	Special Edition	70.00	140.00	Shipped 09/02
1	Box	Celebrity Mix	150.00	150.00	Shipped 09/02
12	Each	Santa Bears	10.00	120.00	Backordered Due 10/30
				800.00	

Contact	Account Balance	Credit Rating	Last Order	Shipped
Ms. Ursula Major 703-484-2327	0.00	Excellent	08/21/2017	On Time

Press any key to see the rest of the list; ESC to end; ? for help.

FIGURE 11.6

If users want more details regarding the shipping status, they can call up a separate screen.

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 the intended 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 they can adjust to or compensate for them.

In designing graphical output, a 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 11.7. Here, current response times, forecasted response times, and minimum requirements are graphed as differently shaded bars.

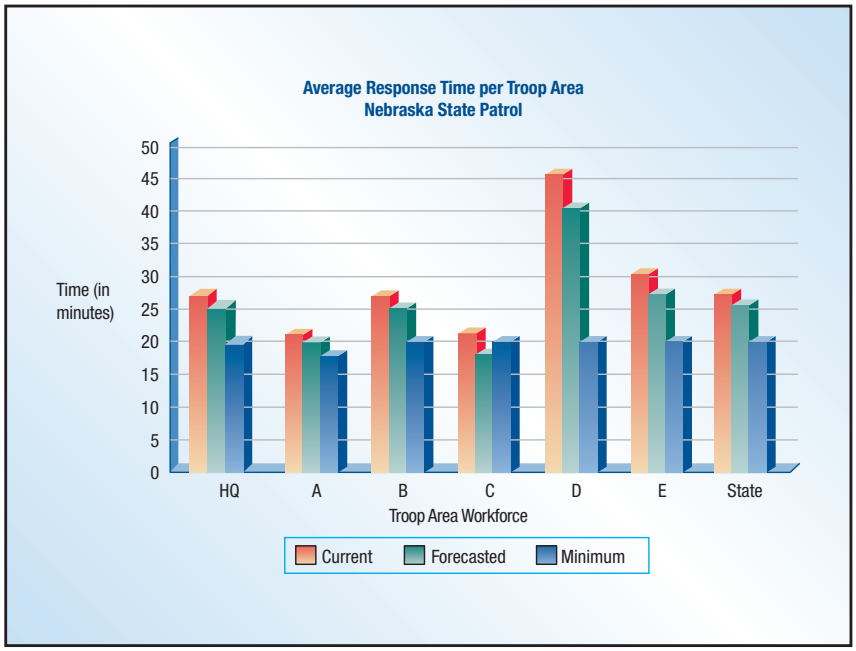
Dashboards

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

FIGURE 11.7

A bar chart display for onscreen inspection of troop time response.



to a light showing that the automatic braking system is not functioning), or even text (such as 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 11.8 shows that a considerable amount of information can be included on a single screen. Using infographics (discussed elsewhere in this chapter) can help.

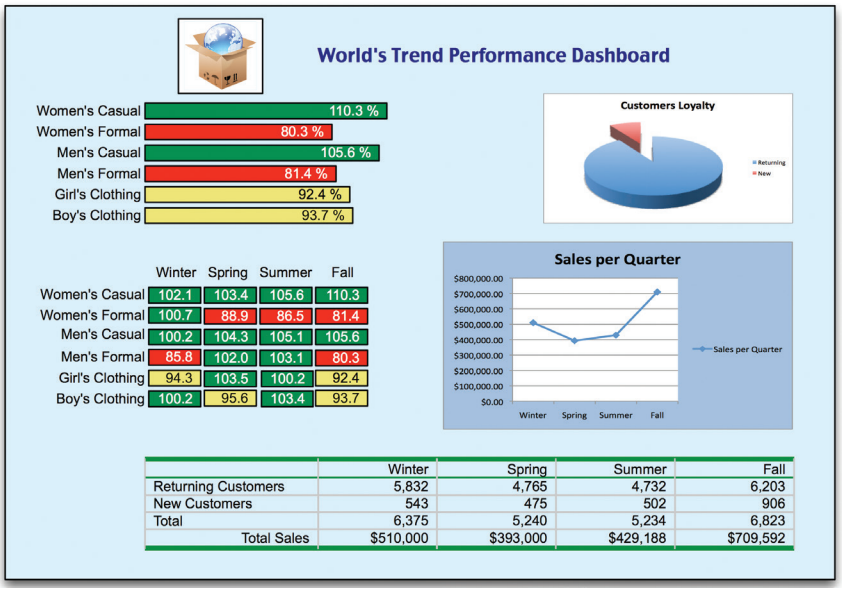
Dashboards are all about communicating measurements to the user. An executive uses a dashboard to review performance measures and to take action if the information on the screen calls for it. Here are some designing rules of thumb that make dashboards more attractive and more effective.

MAKE SURE THE DATA HAVE CONTEXT If a screen states that sales last month were $851,235, what does that mean? Are sales above or below average?

DISPLAY THE PROPER AMOUNT OF SUMMARIZATION AND PRECISION It will clutter the screen if last month's sales are displayed as $851,235.32 instead of $851,235 or even $851K.

FIGURE 11.8

This dashboard has a variety of displays depicting performance measurements to help make decisions.



	Winter	Spring	Summer	Fall
Women's Casual	102.1	103.4	105.6	110.3
Women's Formal	100.7	88.9	86.5	81.4
Men's Casual	100.2	104.3	105.1	105.6
Men's Formal	85.8	102.0	103.1	80.3
Girl's Clothing	94.3	103.5	100.2	92.4
Boy's Clothing	100.2	95.6	103.4	93.7

	Winter	Spring	Summer	Fall
Returning Customers	5,832	4,765	4,732	6,203
New Customers	543	475	502	906
Total	6,375	5,240	5,234	6,823
Total Sales	$510,000	$393,000	$429,188	$709,592

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.

PRESENT DATA FAIRLY Introducing bias into the dashboard will hinder rather than support good decisions.

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.

USE WELL-DESIGNED DISPLAY MEDIA Even the very best type of graph still needs good design to draw, size, color, and label the graph in a meaningful and pleasing way.

LIMIT THE VARIETY OF ITEM TYPES Keep the number of graph, chart, and table styles to a minimum so the information can be communicated quickly and accurately.

HIGHLIGHT IMPORTANT DATA Use bright colors and bold fonts only for important data. Highlight key performance measures or important exceptions that are occurring, but not both. Choose what to emphasize.

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.

KEEP THE SCREEN UNCLUTTERED Avoid photographs, ornate logos, or themes that can distract users from the data.

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.

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.

Infographics

Some users have a difficult time getting information from tables. Either users "get lost" in all of the numbers or they see so many tables that they get tired of looking at them. Graphs and charts are effective, but the trend is to combine numbers, charts, and different types of graphs together in one view at the same time in an ***infographic***.

The term "infographic" can mean any graph, chart, or picture that communicates the data better than words or tables. To the designer, it means visually displaying data for the user to see and choosing which type of graph, chart, or even which numbers are most appropriate.

Designers have many options for creating an infographic page either on paper or a web page. One Web-based application for making infographics is called Piktochart (https://piktochart.com). An example of an infographic developed with Picktochart software is shown in Figure 11.9. It depicts data about software adoption using many visual elements including icons, a pie graph, an area graph, text, and customer rankings from 1 to 5 as stars. Customer satisfaction is also pictured by the amount of frown or smile the character is sporting. Notice the artist has used a limited color palette of red, teal, and black against a buff-colored background. Red is a high-energy color that attracts attention to important information on the infographic.

Infographics should be newsworthy. Start the infographic with a headline, something brief but catchy. Then artfully design a small page of information and mix in visuals that together tell a story. These design elements include charts and graphs, images (mostly icons and cartoons—only rarely should photos be used), summary information in brief text, and contact information or some action the reader might want to take. The most viewed and shared content on social media is visual, so it makes sense to design infographics to convey content you want shared.

FIGURE 11.9

An infographic using a variety of design elements to visually present data about customer software adoption over time.

Designing a Website

Borrow some design principles from other displays when designing a website. Remember, though, that the keyword 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 *website* replaced *home page* in many instances, indicating that the array of pages would have to be organized, coordinated, designed, developed, and maintained in an orderly process. Sometimes the initial Web page the user lands on is referred to as a *landing page*.

Printing is a highly controlled medium, and the analyst has a very good idea of what the output will look like. Graphical user interface (GUI) and character-based user interface (CHUI) screens are also highly controlled. The Web, however, is a very uncontrolled environment for output.

Responsive Web Design

Different browsers display images differently, and screen resolution has a large influence on the look and feel of a website. There is no "standard" resolution anymore. For many years displays had a 4:3 aspect ratio and common resolutions were 1024 × 768 pixels or 1600 × 1200 pixels. Now displays are made for HD and have a 16:9 aspect ratio. The issue is further complicated by the use of handheld devices, such as smartphones and tablets, 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 website.

Responsive Web design means that a website is developed so that it can be viewed on any device: a desktop, tablet, or smartphone. This includes seeing all of the content, experiencing the same design concepts, and being able to perform all of the tasks on any device. Websites are designed in percentages rather than a fixed number of pixels.

Although a Web designer may easily implement responsive Web design for a particular company, problems may occur because advertising used on the website (banners, for example) may not be designed to be fluid. To overcome this, a Web designer might need to develop different landing pages for each type of device.

Alternatively, Ajax can recognize a device and display different sized advertising components on a page. Adaptive Web design means that a different design layout is chosen to be displayed depending on the device. Adaptive design uses a fixed grid rather than the fluid (percentage) grid in responsive Web design. Some designers think this approach is more flexible if the design and abilities of a particular device changes over time.

Cloud-based approaches to Web design such as Weebly or Wix use a drag-and-drop approach, and novice users can design a website quickly and without any knowledge of HTML code. They use a WYSIWYG (or "what you see is what you get") interface. Both of these services are currently free but limited in features because they are based or a freemium model. Users can pay to have the companies obtain a domain name for them and host a website. Although it is easy to develop a website with these cloud-based approaches, transferring a developed site to another hosting company presents an obstacle.

Stand-alone Web design development software is also available. These packages are full of features, have no advertising watermark, and are not host-specific. Working with stand-alone Web design development software makes it is easier to move a website if the customer is not pleased with the service the hosting company is providing.

Flat Web Design

Recently, Web design trends moved away from skeuomorphic design to flat Web design. In skeuomorphic design, objects were meant to look realistic and three-dimensional, with shadows added to artwork. For example, a circle and a drop shadow would represent a button. This is fake realism. In addition, note pads would have spiral bindings, an address book would have rifled pages, and a blotter would represent a desktop. These images became timeworn representations of office elements not currently in use.

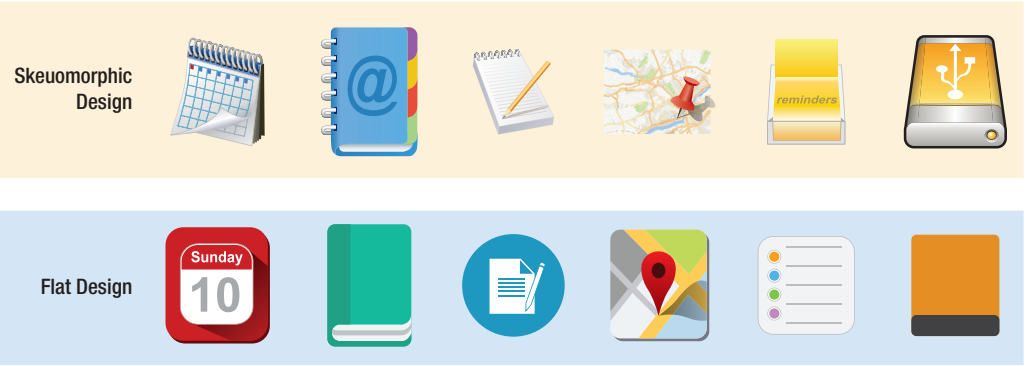
Flat Web design, however, is a minimalistic approach to design. In comparison to skeuomorphic design, flat Web design is clean, two-dimensional, and simple in many ways, including a bright color palette that is adhered to in all design. The idea behind this approach is to concentrate on only what is necessary. But it also makes it very clear that digital apps are distinct from their physical and tactile relatives.

Figure 11.10 compares the skeuomorphic icons of familiar objects, such as a calendar and a cell phone, with those same objects rendered in flat Web design, which is an abstracted image that does not depict the shadows and contours of the physical world.

Flat Web design's popularity will make way for other Web design approaches. We are beginning to see resurgence in realistic 3-D or skeuomorphic design. As you develop new apps and websites, keep searching for new design elements such as an emphasis on creative type fonts, textured backgrounds, illustrated sites, map-centered sites, and sites that have subtle motion.

FIGURE 11.10

Comparing skeuomorphic (3-D, realistic) icons with those drawn using flat Web design. (Used with permission from Piktochart Sdn Bhd.)



General Guidelines for Designing Websites

In addition to the general design elements discussed earlier in this chapter, there are specific guidelines appropriate for the design of professional-quality websites.

USE PROFESSIONAL TOOLS Consider using Web editor software such as Adobe Dreamweaver or Website X5 Evolution (for Windows) or Rapidweaver (for Mac OS). These tools are definitely worth the price. You will be more creative and you'll get the website finished much faster than if you work directly with hypertext markup language (HTML). Another option is to design a website using Weebly or Wix, but this approach might limit you from transferring the website to another hosting firm.

STUDY OTHER WEBSITES Look at websites you and other users think are engaging. Analyze what design elements are being used and see how they are functioning and 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.)

EXAMINE THE WORK 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, blogs, and so on? What about color schemes and pervasive metaphors?

USE THE TOOLS YOU'VE LEARNED Figure 11.11 shows a form Web designers have used successfully to evaluate web pages systematically. You might want to use copies of the form to help compare and contrast the many websites you will visit as you go about learning web page design.

USE STORYBOARDING, WIREFRAMING, AND MOCKUPS Designing for the Web brought back a practice known in the film industry as storyboarding. In the 1930s at Disney studios, each scene was drawn on a piece of paper and then tacked to a bulletin board in order of the episodes.

In developing a website (or any app, for that matter), a storyboard could be used to show the differences between screens. It can show how a visitor to the site would navigate the website to find the information desired. Now storyboards can be developed in Microsoft PowerPoint or Apple's Keynote by clicking on the slide organizer, and they can be drawn in Microsoft Visio or OmniGraffle.

Page design can be accomplished using a process called wireframing, which shows only the basics. There is no color, no type style. Graphics are shown as a simple box with an X drawn in it. In this way, each of the items acts as a placeholder.

Wireframing allows the designer to plan:

1. The overall design, showing what element appears at each position on the page
2. The navigational design, showing how to move from one page to the next using buttons, tabs, links, and pull-down menus
3. The interface design, showing how to interact with the website by inputting data or responding to questions

An alternative to a wireframe is a mockup. Mockups show what the output and input will look like before programming the underlying code to make the program or application functional.

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 kindergartner 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? Use a paragraph to 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 (a rule of thumb) concerning the display of report information on one report in contrast to the generation of numerous reports and write it down. Consider advocating a Web-based or dashboard solution that would permit hyperlinks to all the information Stephen desires. How feasible is that? Respond in a paragraph.

Website Critique

Analyst's Name _____

Date Visited: ___ / ___ / ___

Time Visited: _____ URL Visited _____

DESIGN	Needs Improvement				Excellent
Overall Appearance	1	2	3	4	5
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
CONTENT & INTERACTIVITY					
Content	1	2	3	4	5
Navigability	1	2	3	4	5
Site Management and Communications	1	2	3	4	5

SCORE _____ /40

COMMENTS:

FIGURE 11.11

A website evaluation form.

Software that helps a systems designer develop a mockup is abundant. Built into the software are objects that can be dragged and dropped onto the screen. Templates are available for any type of display including desktops, notebooks, smartphones, and tablets. When designing for smartphones and tablets, both screen orientations are included. Both wireframing and mockups are a form of nonoperational prototyping discussed previously in Chapter 6.

CREATE TEMPLATES OF YOUR OWN If you adopt a standard-looking page for most of the pages you create, you'll get the website up and running quickly, and it will consistently look good. Websites may be made using Cascading Style Sheets (CSS), a language that allows a 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 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 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.

Specific Guidelines for Website Design

Good websites are well thought out. Pay attention to the following:

1. Structure
2. Content
3. Text
4. Graphics
5. Presentation style
6. Navigation
7. Promotion

STRUCTURE Planning the structure of a website is one of the most important steps in developing a professional website. 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 11.12 is a screen capture from the DinoTech website. 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 website diagramming and mapping tools available. Many software packages have Web charting options built into the software. Although helpful for development, these tools become even more important when maintaining a website. 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. Look for applications that do web functionality testing or website error checking.

CONTENT Provide something important to website 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, a top ten list of tips on the page's topic, 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 website 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 post 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 website 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

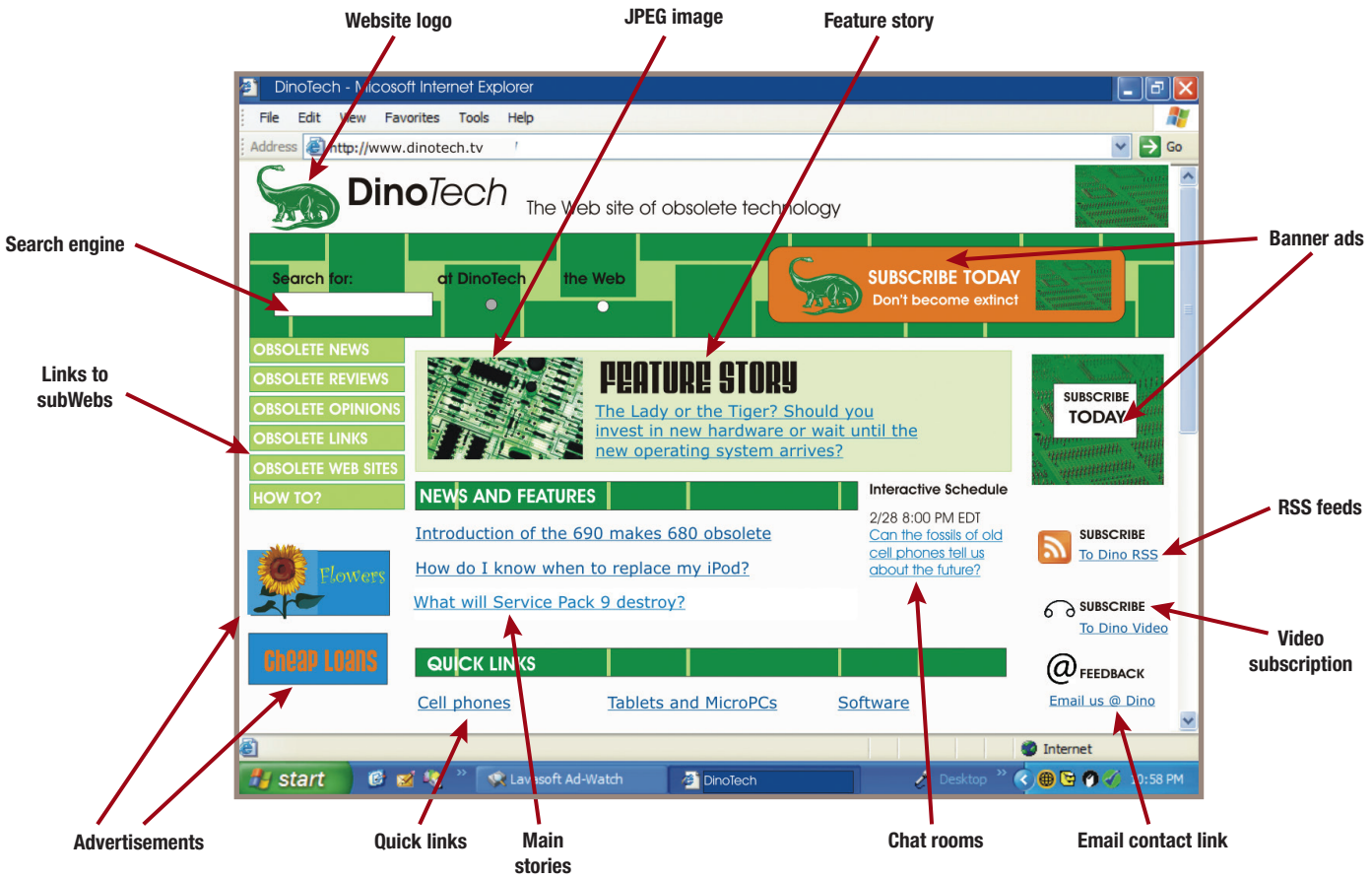


FIGURE 11.12

The DinoTech website makes the most of links, RSS feeds, video subscriptions, and banner ads.

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.

A website may take advantage of prewritten applications. Examples include search engines, mapping software, weather information, and news and stock tickers. Website designers value these packages because they can increase the functionality of the site, and the additional features encourage users to bookmark their clients' websites 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 website. Clear writing is especially important.

Content on ecommerce sites needs to be constantly updated. Content management systems (CMSs) are powerful software tools that can enable the analyst to develop and maintain websites and other online applications. An increasingly popular CMS is Joomla!, which can be found at www.joomla.org/about-joomla.html. It is based on PHP and MySQL. Unlike proprietary CMSs, which are expensive and not widely available, Joomla! is an open source solution that is made freely available to any developer under a general public license (GPL).

GRAPHICS The following list provides details about creating effective graphics for websites:

1. **Use one of the most commonly used image formats.** PNGs and 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 also may be interlaced, meaning that the Web browser will show the image in successive stages, presenting a clearer image with each stage.

MAC APPEAL

Creating Blogs

Blogs 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 these 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, which 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. Blog software features such as a calendar, search form, and other universal features.

One highly acclaimed desktop blogging editor for the Mac is MarsEdit by Red Sweater. It is compatible with WordPress, Blogger, Tumblr, and many other blog publishing platforms.

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 bullets or navigational buttons.** Commonly used 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 tooltip text in a title attribute for image hot spots.** Here is an example. If you display a map of the United States, each state could be set up as a hot spot. The name of the state would appear whenever the user moves the mouse pointer over an image of a state. Note that image spots are not as useful for mobile devices because there is no cursor that can hover over the image.
6. **Examine your website on a variety of displays and screen resolutions as well as on smartphones and tablets.** Scenes and text that look great on a high-end video display may not look good to others with other devices.

PRESENTATION STYLE The following list gives added details about how to design engaging entry displays for websites:

1. **Provide a home page or landing page that introduces the visitor to the website.** 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 website may be accessing it from home, using a slower Internet connection.) This entry display should be 100 kilobytes or less, including all graphics.

The home 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 can be linked to other pages on the same website.

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, and it contains various hot spots that act as links to other pages.
5. **Use cascading style sheets to control the formatting and layout of the web page.** CSS separates the content (the text and images) from how it looks (the presentation) and stores the information in a file external to the web page. One style sheet may control the formatting of many pages. 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.
6. **Use divisions to enhance a layout.** 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.
7. **Use the same graphics images 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.** JavaScript can be used to tell images to change when a mouse is moved and hovers over them, making menus expand and so on. JavaScript also can be used to reformat a web page based on the height and width of the screen. If the website is multinational, JavaScript can even detect the language being used (a browser setting) and redirect the viewer to a different landing page displaying text 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 is most likely that it depends. When you discover a website that loads easily, has meaningful links, and allows you to easily return to the places you want to go back to, 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 click on, 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?

Make sure you include a navigation bar and links to the home page on every page on the website. A visitor to the site may have found a particular page using a search engine, and it is important that the visitor can easily find his or her way to the home page.

Most important, 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. You can find general information about metatags at searchenginewatch.com. In addition, you can download free metatag-generating software from a variety of sources. If you try to use email to promote your site, others will consider it junk email or spam.

Encourage your readers to bookmark your website. If you link to and suggest that they go to affiliated websites that feature the "best movie review page in the world" or to the "get music for free" website, 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" in some

CONSULTING OPPORTUNITY 11.5

A Field Day

"The 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 computer 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 open an application 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 decision support system (DSS) 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 reports 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 although they wouldn't be caught without their smartphones, they don't use their desktop systems very often. 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.

browsers). You also may want to design a "favicon," or favorite icon, so users can identify your site in their lists of favorites.

Web 2.0 Technologies

Of increasing importance for an analyst working on organizational websites is the strategic inclusion of Web 2.0 technologies that focus on enabling and facilitating user-generated content and collaboration via the Web. Familiar types of technologies you should think about including on both public-facing and internal websites you design include blogs, wikis, links to social networks on which the company has a presence, and tagging (also called social bookmarking) that provides useful pointers to online resources such as websites, content on corporate intranets, corporate documents, or photos that are relevant to the organization and to users. Notice that Web 2.0 technologies can be externally faced to clients, customers, vendors, or suppliers, or internally faced to corporate intranets.

For outward-facing Web technologies, the reasons for adding these important collaborative tools to organization websites are clear. Companies use collaborative tools to communicate an integrated branding and messaging strategy across multiple platforms, to gauge consumer opinion, to gather feedback, to create a community of users, and so on. Inward-facing Web technologies can be useful in building employee relationships, maintaining trust, sharing knowledge, innovating among employees and groups of employees, locating corporate resources more readily, and nurturing corporate culture and subcultures inside the organization.

Your requirements determination phase informed you about user preferences. As you are prototyping, you might also want to add Web 2.0 technologies to internal and external web pages

Name of Icon Set	Designer or Supplier	Facebook	LinkedIn	RSS Feed	Twitter
Social Networks Pro Icons	Artbees				
Circular Social Media	BlogPerfume.com				
Free Social Media Icon Set	Elegant Themes				
Amazing 3-D Social Icons	pinkmoustache.net				
Vintage Icons for Bloggers	Nikola Lazarevic				

FIGURE 11.13

Many different Web 2.0 sets of icons. (Courtesy Facebook, LinkedIn and Twitter.)

if there is a well-thought-out, strategic reason for doing so. Part of your recommended design solutions may include adding collaborative tools. From our research and practice with for-profit and nonprofit organizations attempting to use Web 2.0 technologies, we have found that there are five aspects an analyst should consider:

1. **Realize differences between corporate objectives and objectives of key stakeholders.** There will be differences in why each group values collaborative technologies that you discover in the outlooks of both groups.
2. **Serve as the voice of the customer to your client organization.** In recommending the inclusion of Web 2.0 technologies for externally facing websites, you need to be able to articulate the needs of the customer to the organization.
3. **Recognize the importance of visual page design for effectively displaying collaborative tools.** Whenever users have an expectation of placement of Web 2.0 icons (see Figure 11.13 for an examples) on the web page (for Facebook links, Twitter icons, tagging capability, and so forth), you must observe the convention, or at least reinforce the emerging convention. Users are getting more accustomed to seeing this array of interactive options displayed in a predictable pattern on corporate websites.
4. **Revise and update the Web 2.0 technologies offered frequently.** Develop a plan (and a set of tools) for revising and updating collaborative tools offered on both internal and external websites when styles, customs, and the tools change.
5. **Work to integrate Web 2.0 technologies with the existing branding.** Ensure that messages are consistent throughout outwardly facing websites and in all public-facing communications.

Social Media Design

Designing output and content for social media has become a career in its own right, but systems analysts may be faced with those design tasks as part of their overall information systems design work for an organization. Businesses use social media for a number of reasons, including growing their audiences (by targeting users within their key demographics), increasing traffic to already well-established websites, reinforcing brand awareness, developing an online personal that can be trusted, and so on. Many fun, interactive activities can be added to social media posts such as contests, competitions, rewards, or point or badge prizes that engage, incentivize, and reward users for taking an action (going through their Pinterest account to pin a shirt purchased from Amazon to Pinterest, for example).

Your clients have numerous options to consider for posting content or advertisements that can make an impact on customers: Facebook, Instagram (via the company's Facebook Advertising), Twitter (your client will need to sign up for Twitter Advertising), Snapchat, Google+, YouTube, LinkedIn, Pinterest, and many others based in other countries. Although social platforms share some similarities, they also have some differences. On Snapchat, for instance, videos and photos disappear once they are viewed, whereas Twitter reuses the main profile picture and username every time the Twitter account is accessed. Carefully craft initial selections for these sites, and refresh with new pictures or other images as warranted.

Designing content for social media is highly visual, and visual content is 40 times more likely to be shared on social media. Sharing is at the core of what allows a designer of social media to leverage social media for its best networking aspects. Although designing for social media is built on many of the same principles as designing for intranet business pages or for corporate websites, the emphasis shifts from clarity of writing and orderly design to an emphasis on the visual. Specialized imaging tools such as *Canva* and *Pablo* are easy to use and enhance visual design of social media content.

Guidelines for Social Media Design

In the following section we consider four aspects of designing for social media: (1) emphasizing the goal of the design, (2) developing a consistent look, (3) creating appealing design flow, and (4) simplifying to use space in a positive way.

EMPHASIZING THE GOAL OF THE DESIGN Always keep in mind the most important goal of the content to be conveyed. Is it to invite participation? Is it to engage first-time customers with a new company? Is it to remind an established customer of upcoming events? Is it to underscore the presence of the corporation on social media in addition to their Web presence? Examine what is driving creation of this content. Keep focusing on what *must* be included and eliminate second and third priority social media content, which should be developed on more extended platforms such as websites or in videos.

DEVELOPING A CONSISTENT LOOK Incorporate key design elements such as corporate logos or trademarks in every posting on social media. Continue using the organization's established color palette (for example, use green, brown, and blue for an organic food company as visual cues of the freshness of organic food grown outdoors), and carefully consider the story you tell in your designs for a company that provides luxury services or goods (black and gold are traditional invocations of lavish goods and would be good color choices).

Color choice can help the audience understand the story you are trying to tell; critical elements in the story can be keyed to certain colors to increase their impact on the audience. Appropriate color choices can be found using design tools with predesigned complementary palletes or by examining a color wheel.

When beginning a new design, make sure the color choices reflect the organization's purpose and harmonize with their corporate logo. As with other types of screen and form design, limit the number of typefaces on postings to about three. Using too many typefaces risks distracting the audience with clutter and losing the story line.

CREATING APPEALING DESIGN FLOW Lay out the design in a deliberate way so that it flows well when the user views it. The upper left side of the screen and the left side are highly noticeable places for important information to appear on social media. For those familiar with the English alphabet, visualize elements for the design as being mapped out in an "E" pattern, an "F" pattern, or a "Z" pattern. In reading English text, our eyes follow those patterns, so key visual elements are best placed there. These layouts work well for social media and will garner attention for the business, keeping people on the posting or advertisement longer than will other designs.

SIMPLIFYING TO USE SPACE IN A POSITIVE WAY Understanding the concept of simplifying designs for social media is sometimes a difficult one to convey because it dwells on the idea that "less is more." Positive space is like a "rest" in a musical score. A rest is a silent pause in the

music, and the score symbolically shows how long the musician must pause before the music resumes. A rest contrasts with the sound of the note, but it is crucial to a coherent sound. A useful way to approach using positive space is to design a content posting, then ask yourself "What can be eliminated?" Oftentimes you can delete an extraneous element—an extra object, an extra color, or resize an element—and use the positive space to set off important objects in an eye-catching way.

Eventually, one goal in developing a strategy for addressing evolving user standards and conventions is to use text analytics (TA) software to interpret the qualitative data captured in customer responses to blogs, wikis, and through other social media. Indeed, this is an approach you can recommend to your client organization as you close the feedback loop created by establishing Web 2.0 technologies for consumers and employees.

Designing Apps for Smartphones and Tablets

As smartphones and tablets become more powerful and ubiquitous in organizations, systems analysts will need to conceptualize their software as apps. In the early days of computing, software was called a "program." Apple preferred the term "application." When software was designed for the iPhone and iPod, software was simply called an "app." The word *app* became mainstream with the introduction of iPhones and iPads that can run these small programs. Apple sells apps on iTunes much the same way it sells music. You can download an app and install it on your iPhone or iPad.

Creating an app for a mobile phone or a larger device such as the iPad involves brainstorming, imagining, preliminary screen design, user interface decisions, and detailed screen design. Many designers like to work in Adobe Illustrator, but others prefer Adobe Photoshop. But before attempting to use one of these packages, a large whiteboard with a marker can be the very best way to begin designing an app. Later in this chapter we examine apps that are used to create mockups, the preferred name for smartphone and tablet prototypes.

An analyst who develops apps is trying to fill or to create a user need in a unique way. The motivation for creating the app often arises from the developer, and usually not from formal requirements analysis performed for an organization. However, numerous approaches and tools used for display and Web design apply to app development as well as to larger systems projects.

In this section, we focus on designing for the small screens of smartphones and tablets. It is interesting to note, however, that Apple requires developers to send in a 512×512 pixel icon for the App Store. Requirements for the original Macintosh computer only necessitated a 512×342 pixel display, so output design for smartphones and tablets must be taken seriously.

Throughout this section, we discuss concepts useful in any operating system, whether for Apple, Android, or Microsoft. We use examples from Apple's iPad and iPhone, however, because they are currently the dominant devices of tablets and smartphones.

In designing apps for the small screens of smartphones and tablets follows these steps:

1. Set up a developer account.
2. Choose a development process.
3. Be an original.
4. Determine how you will price the app.
5. Follow the rules for output design.
6. Design your icon.
7. Choose an appropriate name for the app.
8. Design for a variety of devices.
9. Design the output for the app.
10. Design the output a second time for different orientation.
11. Share a prototype of your work.
12. Design the logic.

13. Design movement.
14. Create the user interface using gestures.
15. Protect your intellectual property.
16. Market your app.

We concentrate on the steps that are design oriented in this chapter.

Set Up a Developer Account

Apple has software developer accounts for individuals or an enterprise. Apple insists on approving every app sold in its App Store. This means there are some restrictions that frustrate software developers and, sometimes, consumers. Here's where the walled garden comes in (in this case the term refers to an array of preapproved apps that are closed to outside developers). You won't find any app with objectionable content in the App Store, and you won't find a great app that lets you reprogram the mute button on your iPhone to function as a camera shutter either. Android has a more open platform, and many developers have taken advantage of developing apps in open source communities.

Choose a Development Process

Unless you are developing a specialized app that will cost more than $19.95, prototyping is most likely the best way to develop your app. Quick releases are important, and there is a strong advantage to being the first to introduce a certain type of app. You can draw on many of the principles and values of agile development in designing an app.

Quality should not be sacrificed, but it is possible to introduce an app and then add features in subsequent releases. Numerous app developers have adopted this strategy, and it has a number of advantages. It allows you to gain an advantage by being the first to introduce a specific app. It also allows you to revise the app adding new features, and users approve wholeheartedly when improvements are made. In addition, it increases visibility because the app appears on a list of apps that have been updated.

Be an Original

Never copy other developers' software. Doing so is illegal and unethical. Make sure your app has different functionality and looks very different from other apps on the market. Observe all licensing restrictions.

This may seem obvious, but some developers don't realize that you can't use Apple trademarks in your app. You should avoid using words like iPod, iPad, and iPhone in your app, and even avoid the name Apple, for that matter.

Determine How You Will Price the App

The pricing decision you make will affect the design of the app. If your app will contain advertising, the ads will take up valuable space on your screen and may distract users. If you adopt a pricing strategy that allows upgrading of features, you need to consider the interface that asks the user to upgrade.

There are six basic options for pricing:

1. Choose a low-cost strategy.
2. Introduce an app as a "premium" app.
3. Adopt a "freemium" model.
4. Offer an app for free.
5. Promote an app by reducing its price.
6. Accept advertising.

CHOOSING A LOW-COST STRATEGY Taking into considering free and freemium apps and apps offered in the apple App Store, the average price of apps is around $1.00 and the average price of games is $0.49. A very large number of iPhone apps are $0.99. For the iPad, $1.99 rather than $0.99 is the standard. If you decide to offer a low cost app, you'll have plenty of company.

INTRODUCING AN APP AS A "PREMIUM" APP Premium apps cost $19.95 and up. These apps are intended for professionals and are often iPad versions of desktop software. Omni group offers a suite of apps that accomplish much of the functionality of Mac apps. If you price your app this way, you will have fewer users adopting the app, but they will be serious users. They will demand that you add features and functionally and provide adequate support.

The Hot Apps Factory team introduced an app for developing apps as version .983 with an introductory price of $19.95. They are planning to add six additional features and incrementally increase the price by $5.00 every time a feature is added. Version 1.0.0 will cost $49.99 when it is introduced.

ADOPTING A "FREEMIUM" MODEL Apps that are offered at no cost for basic features but allow in-app purchases for premium features and functionality are call freemium apps. In the early days of app development, there was somewhat of a backlash to this approach as many users feel they were forced to pay for each feature separately, but now it is more common. Consider all options before choosing this business model.

OFFERING AN APP FOR FREE Sometimes it is advisable to offer an app at no charge to the user. If you are the *n*th person to write an app for this situation, that may be the only way to get users to adopt your app. It may be useful if you have other apps for sale. Adopters may appreciate your work and buy something else you have developed.

PROMOTING AN APP BY REDUCING ITS PRICE A mixed strategy is sometimes best. Occasionally you can reduce the price of an app for a short period of time or even offer it for free. Apple iTunes now features a free app of the week, and other sites feature daily free offerings. Ideally you want to be on one of Apple's top lists, and offering an app for free might accomplish this.

ACCEPTING ADVERTISING If you have a very useful app that is open much of the time (a weather app, a stock market app, or even a popular game, for example), it might be advantageous to have a free app with advertising. If you read the comments of users about a certain weather app on the App Store pages, you will notice that customers keep asking for an ad-free option. Use advertising cautiously.

Follow the Rules

Follow the design rules set forth by the developer of the operating system. Apple rejects many apps designed for Apple's iOS because they violate the Human Interface Guidelines (HIG). Interfaces are discussed in detail in Chapter 14.

Design Your Icon

On a smartphone or tablet, the icon is just as import as the app name. Try to design a simple, easily identifiable, and easy-to-remember icon. Figure 11.14 shows an example from App Cooker, developed by Hot Apps Factory. It allows you to see how your icon will look in various different formats.

Choose an Appropriate Name for the App

Keep your app name to 12 or fewer characters. It will appear under the icon on the home screen, and if it is longer than 12 letters, some letters will be dropped when the icon is displayed on a screen.

Design for a Variety of Devices

Even staying within Apple's set of iPads and iPhones, may mean that you need to design apps that are flexible. Some of the differences among displays are shown in Figure 11.15. You need to supply Apple with a number of different icon sizes, so take that into consideration when you are developing an icon. Icons will look different from one device to another if they are too complex. Simplicity is a virtue when designing icons.

You should create icons in a vector-based graphic application such as Adobe Illustrator. If you use vector-based graphics, you can scale your icons rather than create bitmap images in

FIGURE 11.14

App Cooker (by Hot Apps Factory) allows a designer to see how an app icon will appear in its many forms. (Screenshot from App Cooker application. Copyright © 2011 by Hot Apps Factory SARL. Reprinted with permission.)

many different sizes. Start with a 1024 × 1024 design, and you can shrink the graphic to smaller sizes. If you create a 1024 × 1024 design, it will print as a 3.5 × 3.5-inch item at the 300 dots per inch resolution needed for magazines.

Design the Output for the App

Although it is possible to use Adobe Illustrator, Visio (on the PC), or OmniGraffle (on a Mac), you might consider using one of the many apps designed specifically for creating apps on handheld devices. Some apps especially useful for designing for Apple iPhones and iPads are AppCraftHD, iMockups, and App Cooker.

FIGURE 11.15

Apple smartphones and tablets come in different sizes.

Icon Required	Size for Older iPhones in (pixels)	Size for High-Resolution iPhone (pixels)	Size for Older iPad (pixels)	Size for High-Resolution iPad (pixels)
Display size	320 × 480	640 × 1136	1024 × 768	2048 × 1536
Application icon (Home screen icon)	57 × 57	114 × 114	72 × 72	144 × 144
App icon for the app store	512 × 512	1024 × 1024 recommended	512 × 512	1024 × 1024 recommended
Launch image	320 × 480	640 × 960	768 × 1004 and 1024 × 748	1536 × 2008 and 2048 × 1496
Spotlight search icon	29 × 29	58 × 58	50 × 50	100 × 100
Settings icon	29 × 29	58 × 58	29 × 29	58 × 58
Documents icon	22 × 29	44 × 58	64 × 64 and 320 × 320	128 × 128 and 640 × 640

FIGURE 11.16

The mockup app App Cooker has a toolbox of widgets you can use to design a screen. (Three screenshots from App Cooker application. Copyright © 2011 by Hot Apps Factory SARL. Reprinted with permission.)

Figure 11.16 shows how the App Cooker app allows a designer to pick from a series of widgets. This app, as well as many others, provides templates for iPhones and iPads so a designer can plan precisely what will appear on the screen when the app is running. The principles for designing smartphone and tablet screens are similar to the ones mentioned earlier in the chapter.

Design the Output a Second Time for a Different Orientation

Once you have designed all the screens for an app, you should do it again, but this time turn the devices 90 degrees. If you designed the app in landscape mode, turn the device and design it in portrait mode.

Let's face it. Some apps look better in one mode than another. If you read a full page of text on a smartphone in a browser such as Safari, you may be familiar with looking at it in portrait mode. On a tablet, however, the text may appear to look better in landscape mode, even if the number of words is exactly the same.

When text is justified, the gaps between words seem to be larger in portrait mode, making it more difficult to read. On a device such as Kindle, changing the orientation changes the number of words on a page and also changes the column structure. Users like to choose their screen orientation.

Developers can use different orientations to their advantage. In portrait mode, a calculator app can present a very simple calculator, but putting it in landscape mode may transform it into a powerful scientific calculator. Giving this easy option to a customer is usually welcomed.

Share a Prototype of Your Work

Before you begin coding, take the opportunity to get valuable feedback from friends, potential users, and even fellow developers. Apps such as AppTaster allow you to test your app designs by sharing your prototypes created in App Cooker.

Design the App's Logic

Tablets and smartphones fit in well with the prototyping method of development, but sometimes the best way to approach an app is to sketch out the logic using some of the principles used in creating process specifications and diagramming structured decisions (discussed in Chapter 9).

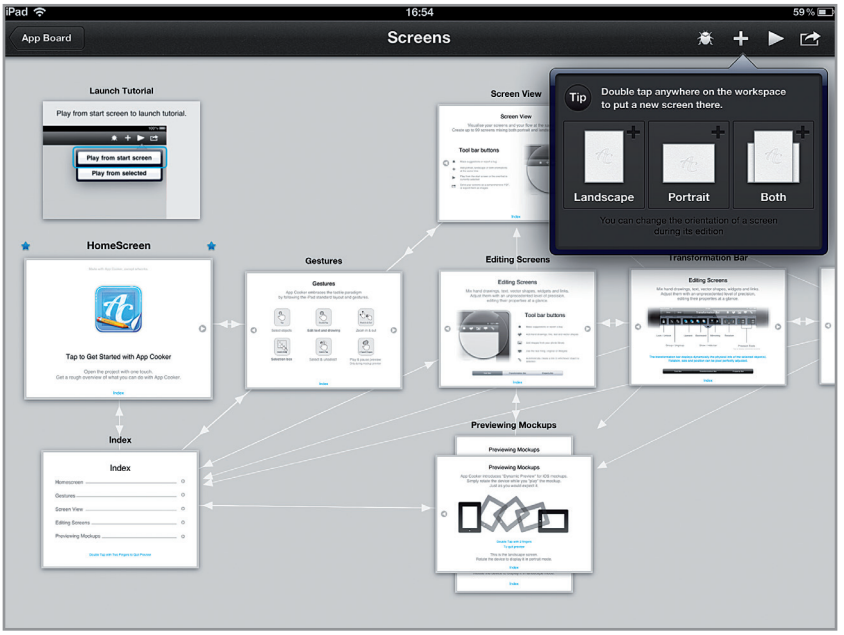


FIGURE 11.17

App Cooker allows you to plan how an app goes from one screen to the next. (Three screenshots from App Cooker application. Copyright © 2011 by Hot Apps Factory SARL. Reprinted with permission.)

Design Movement

How you move from screen to screen may make a big difference in a user's experience. Don't leave movement to chance. Plan movement carefully, and use storyboards or an app such as App Cooker to plan how an app navigates from one screen to another as shown in Figure 11.17.

Create the User Interface Using Gestures

Smartphones and tablets have innovative user interfaces (technically called touchscreen capacitive sensing), and you need to design your apps assuming that users will demand touch-sensitive interfaces that use gestures such as swipes, pinches, tugs, and shakes. Users will expect different types of feedback and will demand the ability to opt out of some of the features.

Gestures and feedback for tablets and smartphones are discussed in greater detail in Chapter 14, in the context of human–computer interaction (HCI), providing user feedback, and usability.

Protect Your Intellectual Property

If you put the effort into design, you need to protect it. Trademark your icons and logos. Recently competitors have introduced apps with one-off logos or icons very similar to already popular ones. You might also want to copyright your app. Doing so is not very expensive.

You are also advised to create your own end user license agreement (EULA). Your end user license agreement gives others the right to use your app and limits what a user can do with the app.

When you write a EULA, consider including a warranty disclaimer. Some users will not like an app and will want a refund. This is often unreasonable, especially when a user may have paid only 99 cents to buy the app. Still, users' expectations are not always aligned with yours, so protect yourself. Apple has a default EULA, but our advice is to consider a custom EULA.

The smartphone market and tablet markets are constantly evolving. New operating systems will change the way apps are designed in the future.

Market Your App

If you are fortunate enough to get a potential user to visit your app's product page, you need to convince the person to pay for and download your app. Pay attention to the content on Apple's App Store, which is divided into many sections. To market your app, you will need a large icon, a description, a section explaining what is new in the current version, and a sample set of screen shots. The screen shots selected are very important. All this is mentioned here because good app design is essential to putting your best face forward.

There are many other ways to market your app, but that discussion is beyond the scope of this book. There are many books and websites devoted to marketing apps.

Output Production and XML

Output production varies depending on the platform used. There are many different ways to create output, ranging from database software such as Microsoft Access and FileMaker Pro, to statistical packages such as SAS, to document creators such as Adobe Acrobat. Figure 11.18 illustrates the transformation process.

One of the advantages of using XML (see Chapter 8) is that an XML document can be transformed into different output media types. This is done using cascading style sheets (CSSs) or extensible stylesheet language transformations (XSLT). These methods reinforce the idea that data can be defined once and used many times in different formats.

Using CSSs is an easy way to transform an XML document. A 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.

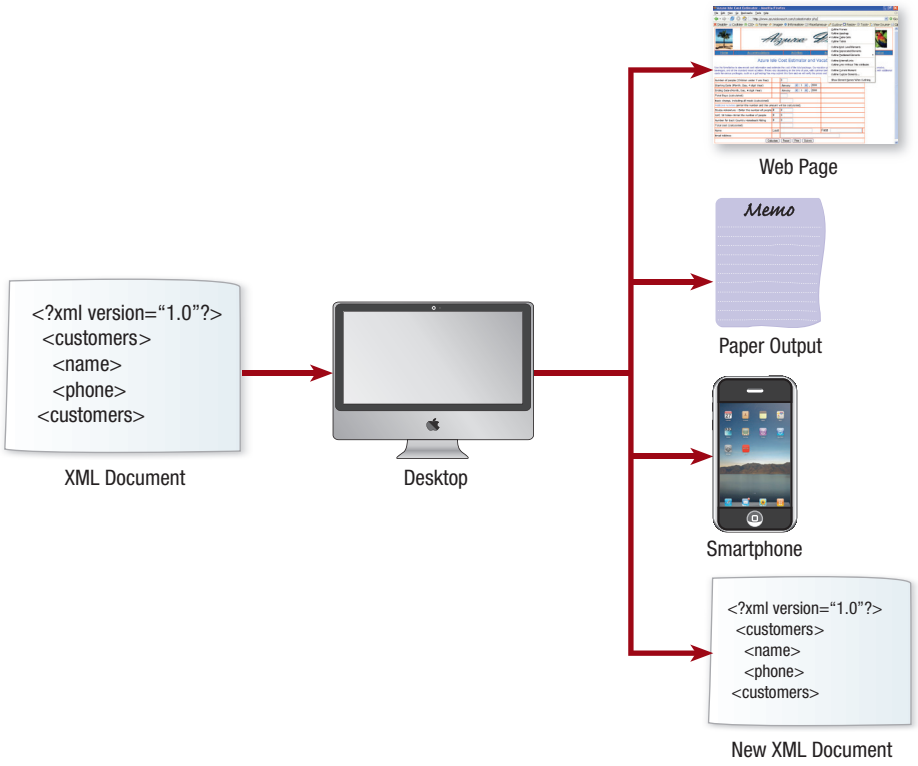


FIGURE 11.18

Extensible Stylesheet Language Transformations (XSLT) software can be used to make XML documents and transform them into many different formats for a variety of platforms.

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 CSSs is that it does not allow an 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. CSS is basically used for formatting.

Extensible stylesheet language transformations is a more powerful means of transforming an XML document. XSLT allows an analyst to select the elements and insert them into a web page or another output medium. XSLT is not a programming language but uses a series of statements to define which elements should be output, the sort sequence, the selection of data, and so on. An example of an XML transformation is illustrated in Figure 11.19. 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 (contained in less than [<] and greater than [>] symbols) are included in the output.

FIGURE 11.19

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.

```
<?xml version="1.0" standalone="no"?>
<?xml–stylesheet type="text/xsl" href="cust02.xsl" ?>
<customers>
  <title>Customer Information</title>
  <customer>
    <number>09288</number>
    <name>
      <lastname>Green</lastname>
      <firstname>George</firstname>
      <middle_initial>L</middle_initial>
    </name>
    <address>
      <street>123 Oak Street</street>
      <apartment>Suite 16</apartment>
      <city>Madison</city>
      <state>WI</state>
      <zip>53704</zip>
      <country>United States</country>
    </address>
    <current_balance>123.45</current_balance>
  </customer>
  <customer>
    <number>15008</number>
    <name>
      <lastname>Brown</lastname>
      <firstname>Sally</firstname>
      <middle_initial>S</middle_initial>
    </name>
    <address>
      <street>123 Elm Street</street>
      <apartment>Apt. 1</apartment>
      <city>Camden</city>
      <state>NJ</state>
      <zip>08102</zip>
      <country>United States</country>
    </address>
    <current_balance>9,876.54</current_balance>
  </customer>
</customers>
```

Customer Information

Number:	09288
First Name:	George
Last Name:	Green
Street:	123 Oak Street
Apartment:	Suite 16
City:	Madison
State:	WI
Zip:	53704
Country:	United States
Current Balance:	123.45

Number:	15008
First Name:	Sally
Last Name:	Brown
Street:	123 Elm Street
Apartment:	Apt. 1
City:	Camden
State:	NJ
Zip:	08102
Country:	United States
Current Balance:	9,876.54

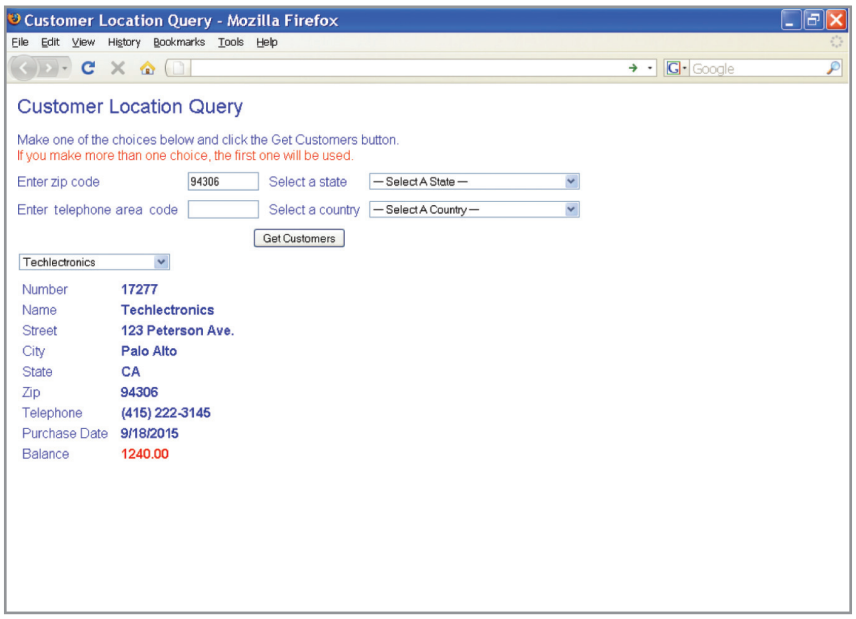


FIGURE 11.20

A web page using Ajax makes it possible to display much less data on a page, allowing an uncluttered display.

Ajax

Ajax is a technique that 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. 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 analysts and designers 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 11.20, 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 that 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, a systems analyst has many different options regarding how to display 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.

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 a question by making a choice, a new question may be generated.

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 Mr. Evans 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 Mr. Evan's complaints about these reports? Explain in a paragraph.
2. Using 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 Mr. Evans:

   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 Mr. Evans 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.

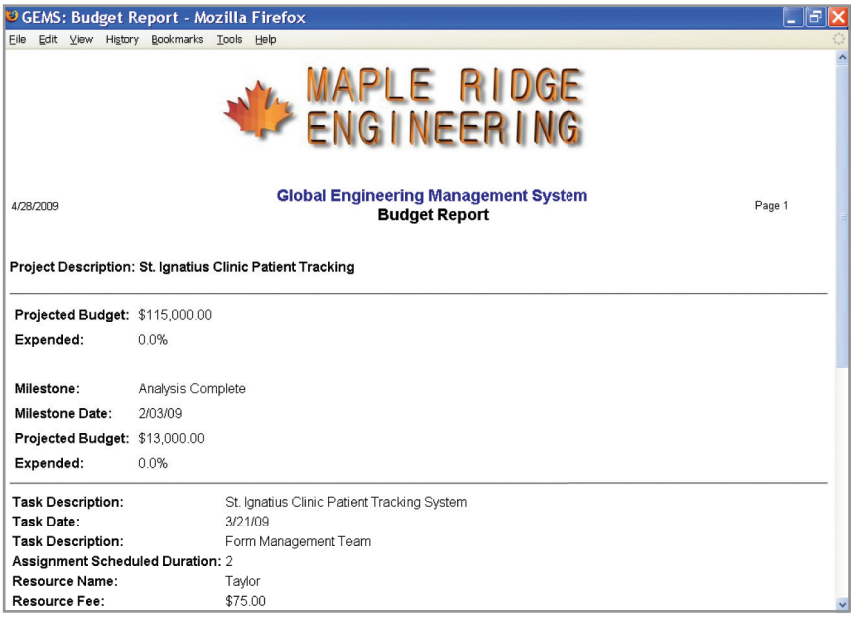


FIGURE 11.HC1

You have the ability to view and critique output screens in HyperCase.

Summary

Output is any useful information or data delivered to the user by the information system, decision support system, the Web, or smartphones or tablets. Output can take virtually any form, including print, computer, smartphone, and tablet displays, audio, microforms, social media posts and content, and Web-based documents.

A systems analyst has six main objectives in designing output: to serve the intended human and organization 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.

Analysts should recognize 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, storage, and retrieval possibilities. All these factors must be considered when deciding among output options.

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.

Designing output for user displays is important, especially for dashboards, decision support systems, the Web, and smartphones and tablets. Responsive Web design means that a website is developed so that it can be viewed on any device: a desktop, tablet, or smartphone. Recently designers have moved away from 3-D, realistic designs (skeuomorphic design) to flat Web design which is a clean, two-dimensional design using bright colors.

Web 2.0 technologies (including social media) should be incorporated in both public-facing and internal web pages to permit user communication and collaboration. The analyst has several goals in designing social media output and content. They include emphasizing the goal of the design, developing a consistent look, creating appealing design flow, and simplifying design to use space in a positive way.

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.

Developing applications, or "apps," that are fun or useful apps for smartphones and tablets has its own distinct development process, but many aspects of agile development, such as quick releases or limited features, as well as prototyping, can be extended to app development. App designers who design apps for market-dominant Apple smartphones and tablets should consider pricing options for apps, developing apps for specific user gestures, designing for different screen orientations on different devices, and legally protecting the intellectual property they create.

Keywords and Phrases

app
Ajax
audio output
blog
bookmark
browser
cascading style sheets (CSS)
collaborative technologies
content management system (CMS)
dashboard
display screen
electronic output
email
end user license agreement (EULA)
extensible stylesheet language transformations (XSLT)
flat Web design
frequently asked questions (FAQ)
general public license (GPL)
gestures
green IT
infographics
Java
mockups
orientation
output bias
output design
plug-in
podcasting
responsive Web design
RSS feeds
skeuomorphic design
social media
stickiness
storyboarding
walled garden
Web 2.0 technologies
Webmaster
web page
wiki
wireframing

Review Questions

1. List six objectives an analyst pursues in designing system output.
2. Contrast external outputs with internal outputs produced by a system. Remember to consider differences in external and internal users.
3. List potential electronic output methods for users.
4. What are the drawbacks of electronic and Web-based output?
5. List 10 factors that must be considered when choosing output technology.
6. Compare a display screen and a mobile device as output methods.

7. What kind of output is desirable to decision makers in a firm at the lowest level of operations management?
8. How do special regulations affect output type?
9. List three main ways in which presentations of output are unintentionally biased.
10. What are five ways an analyst can avoid biasing output?
11. Why is it important to show users a prototype output report or display?
12. How is display output different from printed output?
13. Give one difference between exception and summary reports.
14. How could the relationship between a systems analyst and a user help to avoid bias in output design?
15. List four guidelines to facilitate the design of good display output.
16. What differentiates output for a decision support system from that of a more traditional management information system that sends predetermined reports to decision makers?
17. What are the four primary considerations of an analyst in designing graphical output for a DSS?
18. Define *stickiness*.
19. List seven guidelines for creating good websites.
20. List the rules that make dashboards more effective.
21. Compare the difference between skeuomorphic design and flat Web design.
22. List five guidelines for using graphics in designing websites.
23. List seven ideas for improving the presentation of corporate websites that you design.
24. What is the "three-clicks" rule?
25. In what ways can you encourage companies to promote their websites that you have developed?
26. Discuss alternative approaches to overcoming limitations of responsive web design.
27. List the five factors analysts should consider when including Web 2.0 technologies in organization Web pages.
28. List the four guidelines for designing output and content for social media.
29. What is another word for *app*?
30. List 8 of the 16 app development steps that deal with design.
31. Which approach should a firm apply to address evolving user conventions in social media design?
32. What principles of agile development apply to developing an app?
33. Why is it important to design an app for different orientations (portrait and landscape)?
34. List the six basic options for pricing an app you develop.
35. What are *gestures* in designing smartphones and tablets?
36. What are three ways to protect your app as intellectual property?
37. How can a developer ensure that their app design is flexible?
38. What are the advantages of using XSLT instead of CSSs?
39. What are RSS feeds?
40. What are the main uses for dashboards?
41. What are infographics?
42. How do CSSs allow an analyst to produce output?
43. What are the advantages of using XSLT instead of CSSs?
44. 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, provide the appropriate decision.
   a. A territory manager reviewing regional sales needs access to the entire sales data arranged by regions and specific sales managers over a given period of time.
   b. A notice is circulated in the entire organization regarding change in office hours.
   c. A survey report containing feedback from all employees working in a firm is submitted to the head of HR for review.
   d. Payroll information containing subtotals under different headings is distributed to employees every month.
   e. Point of sale systems access different pricing options to charge the lowest possible price applicable in their region every day.
   f. The head of sales reviews the past pricing information of a product and then prices it in a new market on an international scale.
   g. The head of sales revises the price of a product locally based on its past pricing information.
   h. The company invites internal applicants to work on a new project at a distant location.
   i. The company announces new policies with combinations of welfare practices, bonuses, and changes in work culture.
   j. The store manager decides on the quantity of raw foods to be ordered at the end of his shift for the next day's sales.
   k. Employees in sales sell concert tickets sponsored by their firm at three different store offices.
   l. The government plans to spread awareness about prevalent diseases and newly launched healthcare plans at hospitals.
   m. A user receives potential natural disaster alerts such as heavy rainfalls, landslides, cyclones, etc. through social media tracking.
   n. The top executives meet twice a year to discuss pitfalls in the firm's past performance and formulate future strategies.
   o. All sorts of information about a newly launched service by a firm is to be provided.
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 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 observe all the conventions for good report design. These reports will be used to determine staffing patterns and future activities offerings.

Date	Patient	Visitors	Relationship	Activities
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, used email on one of the home's computers
	Goldstein	2	Sister, brother	Conversation, games out of room, whirlpool, used email on one of the home's computers

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 this problem and Problem 5. 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.
   c. Several family members are on social media and would like a quick way to use Facebook to check on the daily activities participated in by their relatives. Design an infographic that could be shared on Facebook or other social media that captures key information about the patient for the family by the convalescent home staff.
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 dashboard for Clancy Corporation's decision makers, 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.

Style Name	Example of Buyer	Designers
Full military	NYPD	Claudio, Rialtto, Melvin Mine
Half military	LAPD	Rialtto, 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.
   a. Choose an appropriate graph style and design an infographic that incorporates the following data:

	Full Military (percent of total)	Half Military	Formal Dress	Casual Dress
2013	50	20	20	10
2014	55	15	20	10
2015	60	15	15	10
2016	62	15	15	8
2017	65	10	15	10

   Be sure to follow proper design conventions for displays. Use codes and a key, if necessary.
   b. 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 executive dashboard. Be sure to follow proper design conventions for displays. Use codes and a key, if necessary.
   c. 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 dashboard for Michael from Problem 9. Use appropriate types of charts and graphs to illustrate performance.
11. Design a dashboard for a stock clearance sale on a website. Incorporate elements like sales by product categories, offers availed, items in stock, trends in purchases, and new customers who registered during the sale. Include your own assumptions into the dashboard, such as the website operating in an international market.
12. A city in your country is hosting a grand musical event for a week in June where artists from around the world will be performing. The city already attracts a lot of tourists and the authorities are concerned about transportation, traffic management, and accommodation issues in the city. Two concerts each in seven different locations in the city are scheduled every day. Design a dashboard for the city authorities so that they can visualize these issues and improve their decision-making process.

13. Browse the Web to view well-designed and poorly designed websites. Choose three examples of each and list their Web addresses. Comment on what makes each of the sites excellent or poor, using the critique form presented earlier in the chapter to compare and contrast them.
14. Propose a website 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 website are and state why it makes sense for Clancy's to have a Web presence. Specify whether you will be using flat Web design or skeuomorphic design to create your icons and graphics, and add a paragraph to justify your decision.
15. 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 put its gift registry online to allow wedding and other event guests to be able to browse for items that were selected by the wedding couple or others.
    a. Design a Web page that would allow customers to enter a postal code and find the nearest Elonzo's store.
    b. Design a Web page for customers to browse wedding 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. Your design should include the quantity of an item a wedding couple would like (for example, 1 pair of crystal candle holders, 1 fully equipped picnic basket, 8 formal place settings including dinner plates, salad plates, soup plates, and dessert plates). Also include an icon or text that shows how many items have been purchased and whether the maximum requested has been reached.
    c. Design an ordering option that allows customers to click on an item they would like to purchase that puts them into the checkout page. Be sure to include an option where gifts can be wrapped and sent directly to the wedding couple from Elonzo's.
    d. 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.)
16. Design an outline of a podcast for someone touring your university, college, or business. In what sequence would you place the topics? How much time would you allow for each campus or building location? Assume that the visitor will arrive in the morning and remember to sequence a lunch break into the podcast.
17. Draw a diagram that compares the flow of app development through the 14 steps with the seven phases of the systems development life cycle which is composed of: (1) identifying problems, opportunities, and objectives (2) determining human information requirements (3) analyzing system needs (4) designing the recommended system (5) developing and documenting software (6) testing and maintaining the system and (7) implementing and evaluating the system.
18. Write two paragraphs that compare and contrast the process of app development and the seven phases of the systems development life cycle as you diagrammed it in Problem 17.
19. Create a blog entry for your university that is attractive and reliable.
20. Using the portrait orientation, design a fee payment reminder screen for a smartphone.
21. Design an Ajax-style 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 executives and staff of Edwards Recruiting Agency, which conducts recruitment drives on behalf of its partner recruiting firms. 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 a paper layout form to complete each display or form.)
3. Create a dashboard for Edwards Recruiting Agency's executives in Group Project 1.

4. Together with your team, design a poster-size infographic to post near the desktop computers of corporate users that reminds them to backup their data on a regular basis. Remember to use a catchy title, a limited color pallete, icons, and summary statistics or ratings to convey a strong, straightforward message.
5. Design a website, either on paper or using software with which you are familiar, for Edwards Recruiting Agency in Group Project 1.
   a. Which web design approach will you utilize and why? Also discuss the features and content you will incorporate into the website design. How will you enhance its style of presentation?
   b. Assess the design that you have proposed in terms of structure, content, text, graphics, presentation style, navigation, and promotion. Let other team members provide feedback on your design and summarize how the feedback addresses some of the issues found in it.
6. Design sample pages for the following smartphone applications. You do not need to use a mockup app for this assignment. Just draw them on paper. (Each group can pick a different app to work on.)
   a. A water-intake tracker
   b. A cab locator
   c. An app to help you relax and meditate
   d. An app to track daily expenses
   e. A medicine tracker
   f. A sale alert app
7. Explore the Joomla! website at www.joomla.org. How could this open source application be helpful in implementing your designs from Group Project 4? Summarize your findings in a paragraph. Find another content management system on the Web and write a paragraph comparing it to Joomla! Be sure to address cost, ease of use, support, and availability in your comparison.

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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. Use pervasive navigational elements and icons to give Web designs a professional look.
4. Design useful input forms for people interacting on the Web.
5. Design useful input pages for users of intranets, the Web, smartphones, and tablets.

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, 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, and 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. Analysts can use standard navigational elements and icons such as a hamburger icon or menu, context-sensitive help, input validation, a breadcrumb trail, and fat footers to give their Web designs a professional look that users can readily understand and use.

Good Form Design

Whether designing paper of Web-based forms, a 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 organization 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 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 websites set up for information or ecommerce transactions.

FORM FLOW Designing a form with proper flow can minimize the time and effort employees expend 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 has 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.

Bakerloo Brothers

EMPLOYEE EXPENSE VOUCHER
Claimant: Make No Entries
in Shaded Areas

Full Name of Employee _____

Department _____ Room Number _____

Employee ID Number

Voucher 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	Meal	Lodging	Automobile		Miscellaneous		Taxi	Total
/ /	City, State	Expenses	Expenses	Miles	Cost	Description	Cost	Cost	Cost
	Totals								

I certify that all the above information is correct

Signature of Claimant Date

Approved by Date

Form BB-104 01/2017

FIGURE 12.1

Seven sections found in a well-designed form help encourage completion.

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 the suitable form design.

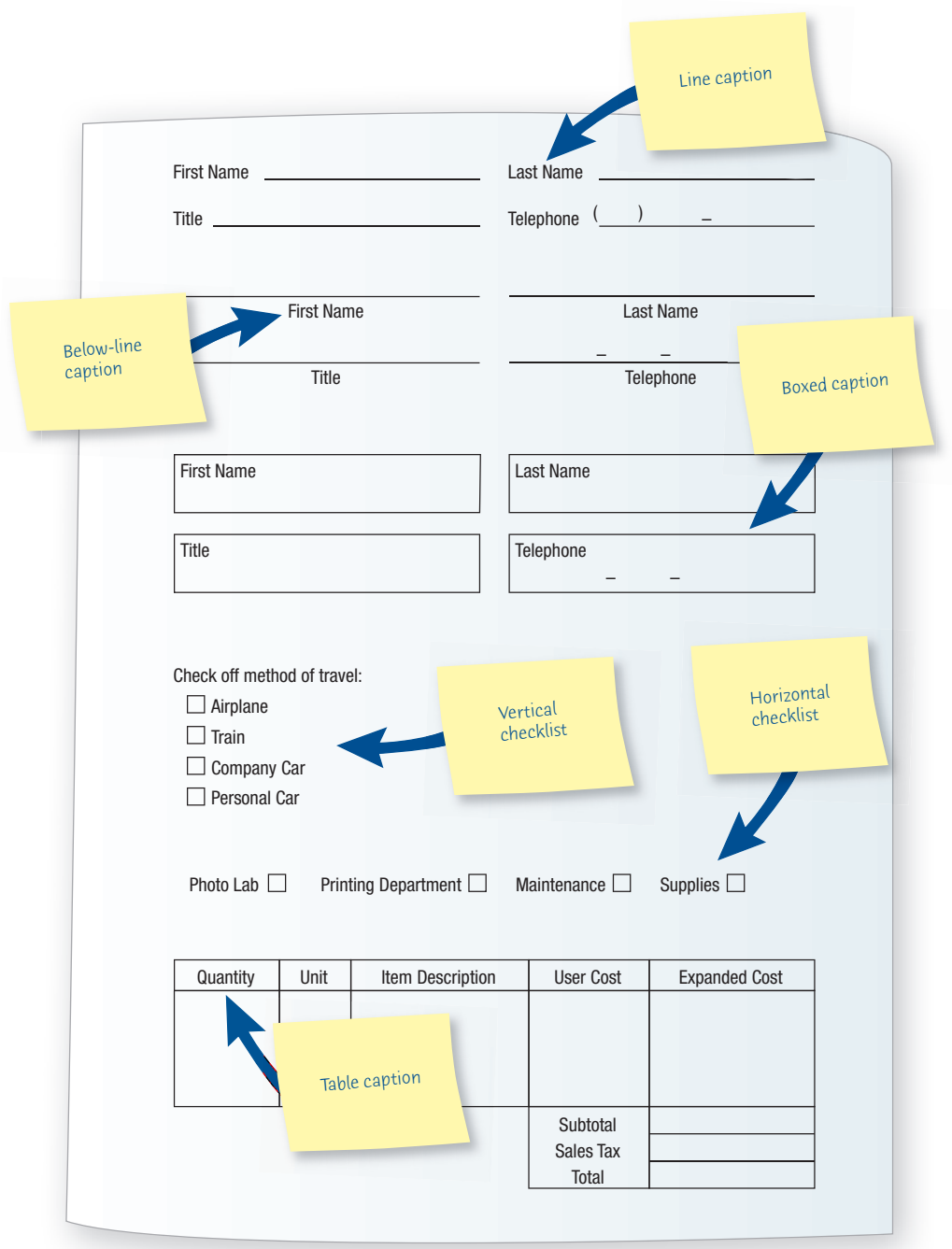
CAPTIONING Clear captioning is another technique that can make easy work of filling out a form. Captions tell the person completing the form what to put in a blank line, space, or box. Several options for captioning are shown in Figure 12.2. Two types of line captions, two types of check-off captions, 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

FIGURE 12.2

Major captioning alternatives that can be used on paper, online, or computer displays.



they also make reading the form easier for the form's recipient. The caption should use a small 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 Figure 12.2. If employee expenses for business travel are reimbursed only for the 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 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 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 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 we deal with attractiveness of forms 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 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 also may 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.

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 a 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 websites, Web pages, smartphones, and tablets. Once again, the users must remain foremost in an 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 following four guidelines for display design are important but not exhaustive (refer to Chapter 11):

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 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 over 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 be made available by having the user click the right mouse button in the body section of the display.

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 are to use context-sensitive help, rollover buttons that reveal more information, and other pop-up windows. Also, keep in mind that users can minimize or maximize 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 postal 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 postal 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 clicks or keyboard strokes. 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 using scrolling arrows, context-sensitive pop-up windows, or onscreen dialogue.

Designing an Attractive and Pleasing Display

The fourth guideline for good display design is to create an attractive display. 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. Never crowd a form; similarly, 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 graphical user interfaces (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.

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 businesses and other users.

There are some guidelines for the design of effective icons. Shapes should be readily recognizable so users are 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 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.

CONSULTING OPPORTUNITY 12.1

This Form May Be Hazardous to Your Health

Figure 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 unique seven-digit account ID number. Recently all of the doctors associated with Mike Robe's practice decided to experiment with patients filling out this form using an iPad issued by the office. Redesign the form for both landscape and portrait orientation for an iPad. Which office procedures would you have to change to accommodate patient data entry with an iPad? Provide your answer in a paragraph, including manual and computerized procedures and processes.

Medical History Form

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.

	I have had	Family history
Diabetes	☐	☐
Heart trouble	☐	☐
Cancer	☐	☐
Seizure	☐	☐
Fainting	☐	☐

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.

CONSULTING OPPORTUNITY 12.2

Squeezin' Isn't Pleasin'

The Audiology Department in a large veteran's hospital is using a PC and monitor so 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 didn'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 First Middle Initial
Examining Station Date of Exam
Patient Number Social Security Number
First Exam Claim Number

AIR CONDUCTION

Right ear					Left ear				
500	1000	2000	4000	6000	500	1000	2000	4000	6000
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

BONE CONDUCTION

Right ear					Left ear				
500	1000	2000	4000	6000	500	1000	2000	4000	6000
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

SPEECH AUDIOMETRY SECT. Comments [
SPEECH RECEP. THRESHOLD
Right Ear [ ]
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.

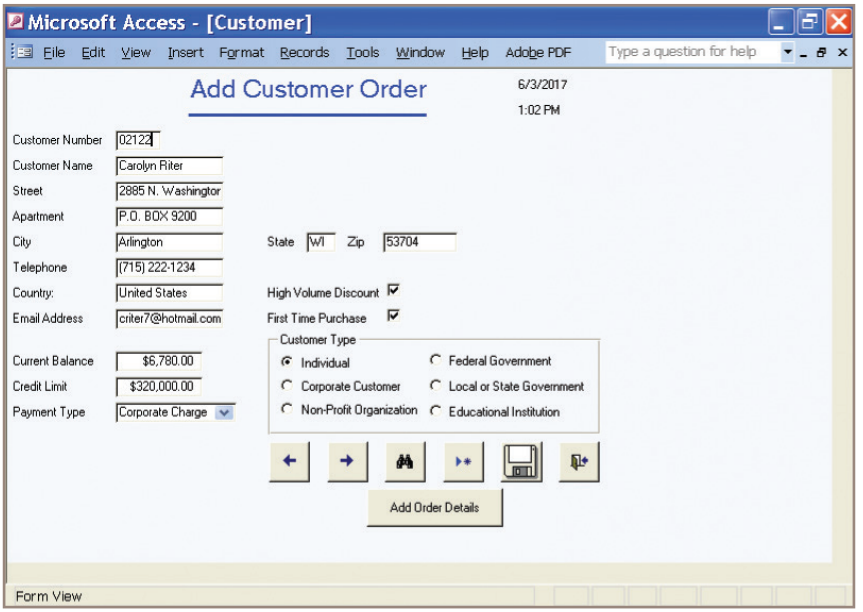
Icons for a particular application should be limited to approximately 20 recognizable shapes so the icon vocabulary is not overwhelming and a worthwhile coding scheme can still be realized. Use icons consistently throughout applications where they will appear together to ensure continuity and understandability. Generally, icons are worthwhile for users if they are meaningful.

Graphical User Interface Design

Users interface with an operating system (OS), such as Windows or the Mac OS, through a graphical user interface (GUI, pronounced "GOO-ey"), 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 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 dialogue boxes, and image maps. Figure 12.3 is a Microsoft Access input display showing a variety of GUI controls.

FIGURE 12.3

The many available GUI components allow flexibility in designing input screens for the Web or other software packages. This example is from Microsoft Access.



TEXT BOXES A rectangle represents a text box and is used to outline data entry and display fields. Care must be taken to ensure that a 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 left-aligned, and numeric data are right-aligned.

Starting with HTML5 browsers, a feature called a *placeholder* allows a designer to put a small amount of text into a text box, which will display in a lighter color, informing the viewer what to key into the text box. When the cursor is placed in the field (clicking or tabbing into it), the text vanishes.

Several new types of text boxes are available with HTML5. These are email, telephone, and URL (a Web address). These appear as normal text boxes on a computer, but when used on a tablet or smartphone, they can be used to customize the pop-up keyboard. For example, if the text box is used for a telephone number, the virtual keyboard layout changes to a number pad. If the text box is used to enter a URL, the virtual keyboard includes a *.com* button. Finally, if the text box is used to enter an email address, the virtual keyboard includes an @ symbol. This customization helps the user enter data quickly and accurately.

A datalist is a new feature included in HTML5 that displays a drop-down list of predefined suggestions to make entry easier for the user. As the user begins to type the first few letters, the datalist is displayed. The user can choose one of the items in the list to make a selection. This is used in the autocomplete function.

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, depending on whether 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 a 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, you can group them together in a bordered box.

OPTION BUTTONS An option button, also called a radio button, is used to select exclusive choices. Only one of several options can be chosen. By using option buttons, 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, you should 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. An elegant way to handle making a selection from a predetermined list is available when developing drop down lists for Apple products. You can insert a *picker*, which includes "one or more scrollable list of distinct values, each of which has a single selected value—appearing in darker text in the center of the view." Pickers can be placed at the bottom of the screen or used as a popover overlaying the app if the user is tapping on a menu. (Apple Developer Human interface Guidelines, 2017). An example of a picker would be allowing the user to pick a destination city from a list of cities an airline stops in, when the user is in an airline app. Another example is choosing a date when making an addition to one's calendar.

TAB CONTROL DIALOGUE BOXES Tab control dialogue 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.

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.

CALENDAR CONTROL Starting with HTML5, a designer may include a calendar control to select a date, a date and time, or a local date and time. A calendar is displayed, and the user either selects the default date or may change it by clicking on a date or scrolling through the calendar. This is common on hotel reservation sites. The default date may be today, but the user will change it to the actual arrival day. Once the user locates the arrival date on the calendar, a second calendar pops up with the next day as the default departure date. The user again changes this to the correct departure date, but the process of selecting dates from a pop-up calendar is still easier and less error-prone than entering text.

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 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 dialogue box, often overlapping the display. 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 also may 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 value pair that is transmitted to the server or in an email sent along with the form (such as the name city and the value 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 and, when an option is chosen, the selected value is sent with the form. Form values may be used in calculations performed using JavaScript on the browser to multiply, add, and make decisions.

Figure 12.4 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

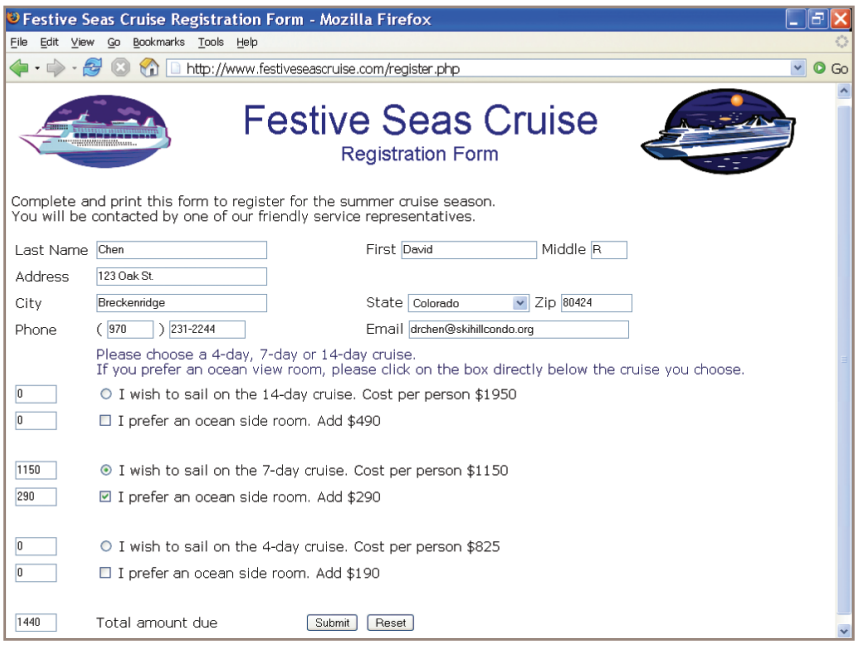


FIGURE 12.4

A Web-based input form for users to register for a cruise.

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 contains 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 (see 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 12.5 is a website 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 12.6. Notice that there may be a number of events for each Web form control. The user may do any number of actions in any order, so 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 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 because 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 7 days. When the starting month or day changes, the ending date could be set for 7 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.

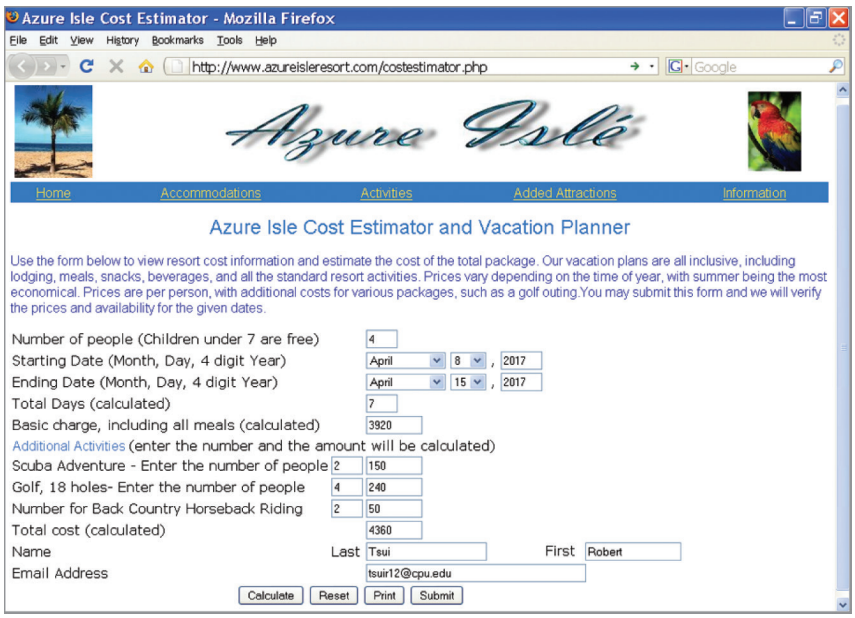


FIGURE 12.5

A website that permits users to estimate the cost of staying at Azure Islé Resort. The cost depends on the number of people included, length of stay, and extra activities added.

Form Control	Event	Response
Web Page	Page loads	Place the current year in the **Starting Year** and **Ending Year** fields. Place the cursor in the **Number of People** field.
Number of People	Value changes	Verify that **Number of People** contains a number greater than zero.
Starting Month	Selection changes	Set the **Ending Month** in the drop-down list to the **Starting Month**. If the month is less than the current month, change the **Starting Year** and **Ending Year** values to the next year.
Starting Day	Selection changes	Set the **Ending Day** in the drop-down list to the **Starting Day**. Use the **Starting Month** value to set the **Starting Year** and **Ending Year** values.
Starting Year	Receives focus	Use the **Starting Month** value to calculate the **Starting Year** and **Ending Year** values.
Number of Days	Receives focus; value changes	Calculate the **Number of Days** 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 **Basic Charge** and put the cursor in the **Scuba Adventure Number of People** 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 **Scuba Cost** based on the value of **Scuba Adventure Number of People** and put the cursor in the **Golf Number of People** field.
Scuba Cost	Value changes	Recalculate the **Scuba Cost** and put the cursor in the **Golf Number of People** 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 **Golf Cost** and put the cursor in the **Horseback Riding Number of People** field.
Golf Cost	Value changes	Recalculate the **Golf Cost** and put the cursor in the **Horseback Riding Number of People** 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 **Horseback Riding Cost** based on the value of **Horseback Riding Number of People** and put the cursor in the **Last Name** field.
Horseback Riding Cost	Value changes	Recalculate the **Horseback Riding Cost** and put the cursor in the **Last Name** field.
Total Cost	Value changes	Calculate the total cost and put the cursor in the **Last Name** field.
Calculate Button	Button clicked	Validate the form data and display an error message if any errors occur. Calculate the **Total Cost** if there are no errors.
Reset Button	Button clicked	Clear the form and place the current year in the **Starting Year** and **Ending Year** fields. Place the cursor in the **Number of People** field.
Print Button	Button clicked	Validate the form data and display an error message if any errors occur. Calculate **Total Cost** 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.
Submit Button	Button clicked	Validate the form data and display an error message if any errors occur. Calculate **Total Cost** if there are no errors. Send the form to the server and send confirmation to the user.

FIGURE 12.6

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.

Events are not limited to working within a single Web page. They may be used to control navigation among Web pages as well. This can happen when changing a selection in a drop-down list or clicking a radio button. Events may 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 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.

An analyst should think about the information that would make sense to the website 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 were Canada, the captions would say Province and Postal Code. If the country were Japan, the captions would say Prefecture and Mail Code.

Three-Dimensional Web Pages

Dynamic Web pages can 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; other layers 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. An analyst must determine when it makes sense to include a layer, often examining each field on a Web page to determine whether 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 websites because it does not require any pop-up pages (which may be blocked by Internet security software). In addition, 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 12.7 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 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

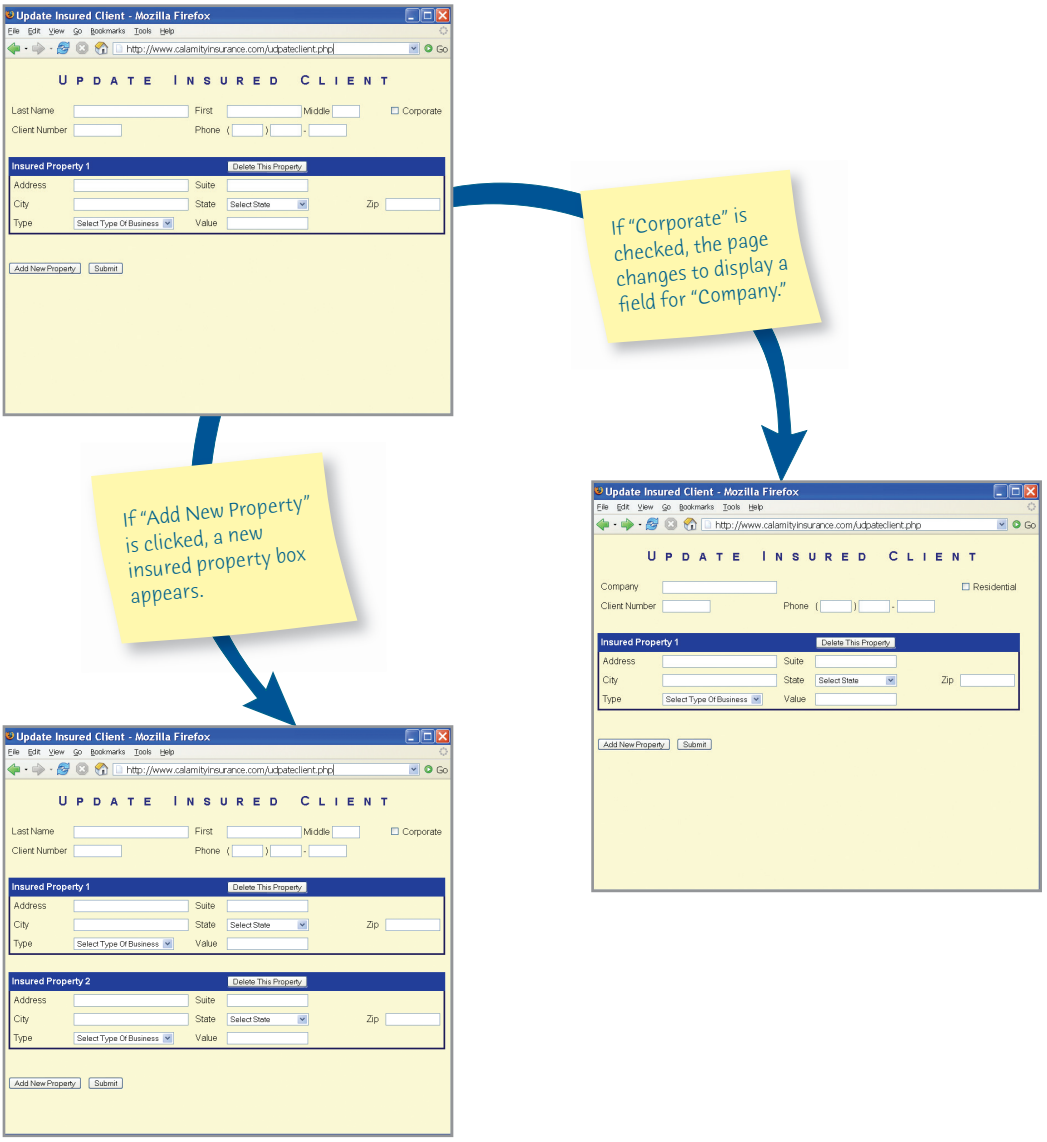


FIGURE 12.7

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.

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). 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. An analyst must decide what to do in this situation.

If a person must use a website (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 websites do not require JavaScript to be turned on and have an alternate website for customers.

A second disadvantage when using dynamic Web pages is that they may not be compliant with the Americans with Disabilities Act. (For more on Web accessibility for all users, see Chapter 14 on designing for human–computer interaction.)

Ajax (Asynchronous JavaScript and XML)

Ajax is a technique that works in 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 that contains 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 is designing a traditional website, without Ajax, for making a reservation for a European ferry. The resultant website 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. The number and ages of the passengers determine pricing, so 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 by using Ajax techniques, as illustrated in Figure 12.8. 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.

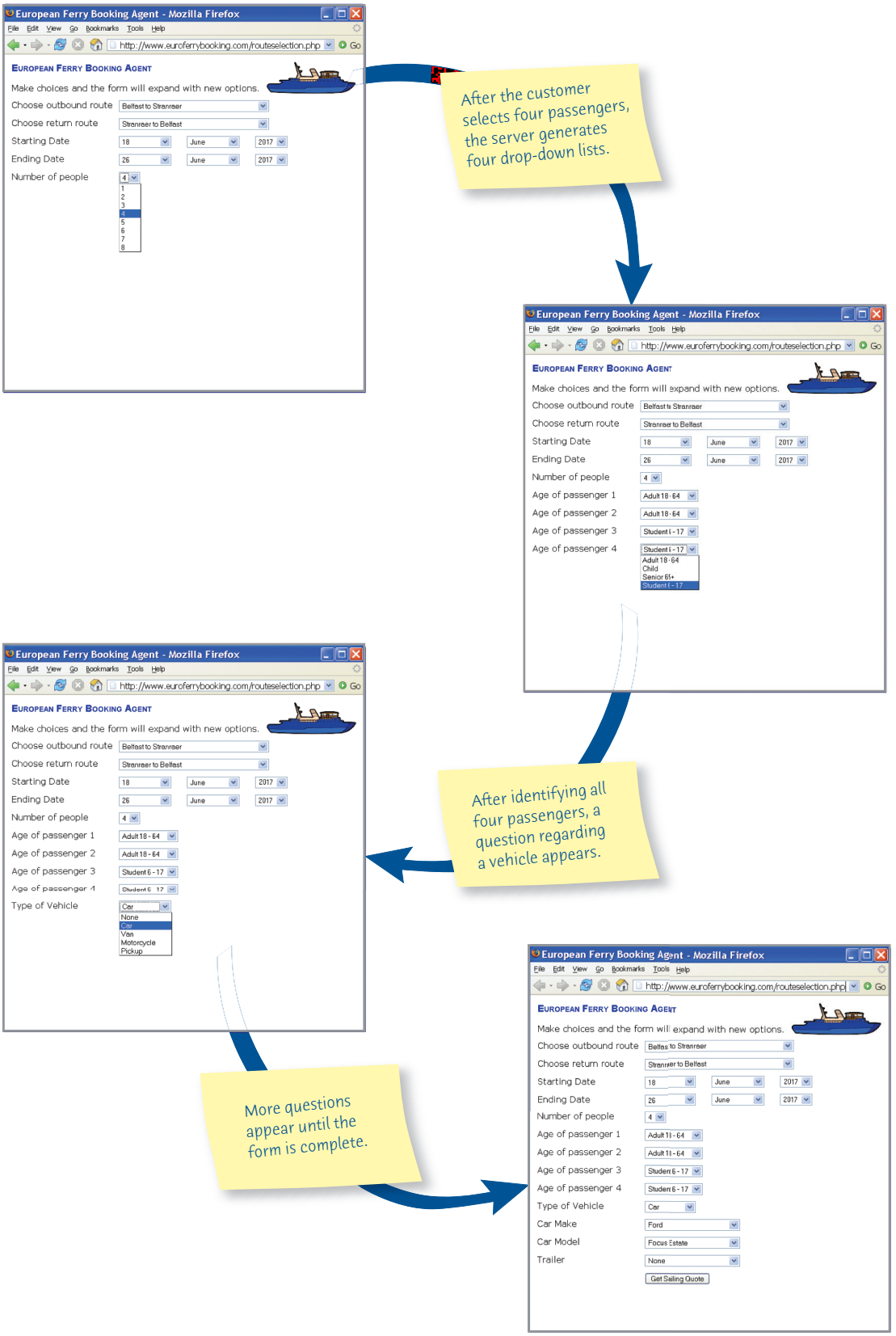


FIGURE 12.8

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.

MAC APPEAL

Ecommerce has changed the world by asking users to enter their own information directly on Web-based input forms; in doing so, ecommerce has increased the accuracy of data entry. Although 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 the process so users can 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 SiberSystems is a good alternative. On the Mac, 1Password by AgileBits appears to be the current leader.

1Password allows a user to automate logins, complete credit card information, and fill in an identity complete with street and email addresses. It has separate categories for saving bank accounts, membership, drivers' licenses, and wireless router setups. Like every other good password program, 1Password includes important features such as strong password generators, antiphishing technology, and built-in protection from keyloggers. It also offers a security audit called Watchtower that informs you if your passwords have become vulnerable. 1Password is also an app for iPhone and Android devices, so users can take their passwords with them.

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 using Ajax may be the best approach. At times it is better to use several pages, as when a user makes an airline reservation. One Web form can obtain all the flight information, and another page can 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 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 websites. Some notable ones are Google Earth (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.ajax-launch.com/ajaxwrite) is a Web-based word processor. There is also an Ajax spreadsheet and a sketching tool.

Using Color in Display Design

Using color is an appealing and proven way to facilitate 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, and "in the red" also means a company is losing money. Green means "go" and is a safe color in Western countries.

When observing Web accessibility guidelines, 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 other enhancement, designers need to question the 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.

Website Design

Some icons and navigational elements are so pervasive in website design that you may not be aware of them on a conscious level any longer. However, using these readily identifiable elements can help you give your Web designs a professional look as well as communicate effectively and efficiently with users. We examine the hamburger icon, context-sensitive help, input validation, using a breadcrumb trail, and the concept of the fat footer to aid in the efficient and effective design of websites.

The hamburger icon or hamburger menu ☰ is depicted with three stacked bars that minimalistically resemble a hamburger patty placed inside a bun. The three bars are stacked together in a parallel position within a square, as part of a GUI. Place this icon at the top of a graphical display to alert the user that they can click on the hamburger icon to display a menu of the website. Using the hamburger icon can save space on the website, which is especially helpful for designing for smaller mobile devices such as cell phones.

Context-sensitive help for GUI design is a good way to help users as they progress through an application or a website. The cursor changes to a question mark as the user hovers over a word that is part of the context-sensitive help feature. Clicking on the question mark will bring up a specific comment designed to help the user with the feature they are currently trying to use. Users do not need to be connected to the Internet to receive this help. Context-sensitive help differs from online help that users access by getting on the Internet for in-depth help on multiple features in the software or to access Read Me documents that supply software details and troubleshooting on a variety of topics.

Input validation (displaying the item the user just typed in) is a way to prevent the user from entering the wrong type of data or incorrectly formatted data into the file or database. The design is such that the user is not permitted to advance to the next input field until the problem is corrected. At this point, the designer can add a message showing that the input data typed are not correct such as the messages a user receives in a Microsoft Excel UserForm "Amount box must contain a number," or "Date box must contain a date." Consequently, the user is able to correct an error in real time, and incorrect data will not be erroneously stored in the database or file.

A breadcrumb trail is a colorful term for a navigational element developers can use to let the user know where they are on a large website, in a program, or in a complex document. (The phrase *breadcrumb trail* refers to the breadcrumbs dropped by Hansel and Gretel, in the fairytale of the same name, in which they dropped a trail of breadcrumbs entering the forest in hopes that

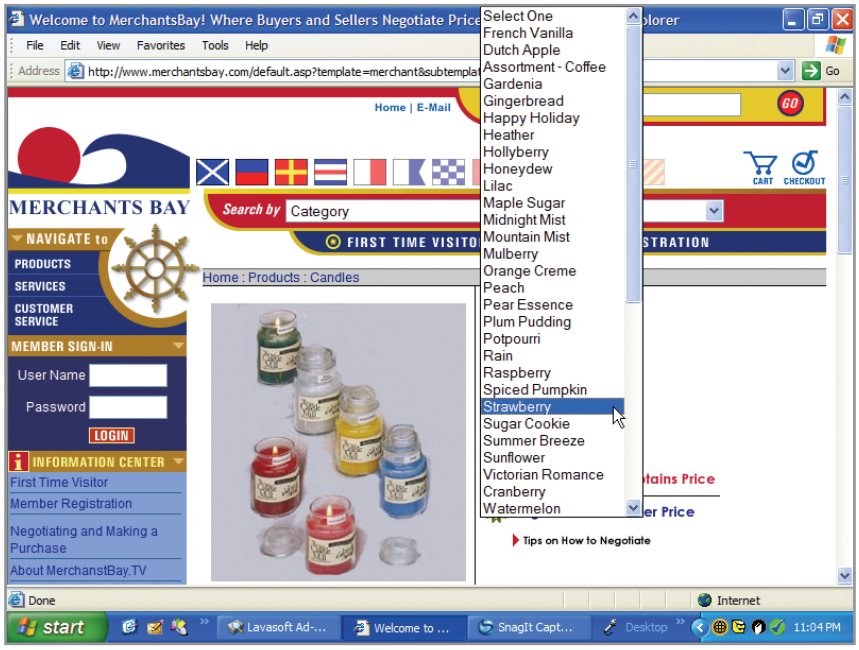


FIGURE 12.9

The order screen from the Merchants Bay website (www.merchantsbay.com) is a good example of how to design an input form that is clear, easy to use, and functional. (Screenshot of Merchants Bay website. Copyright © 2000 by Merchants Bay LLC. Reprinted with permission of Troy Pappas.)

retracing the trail would help them find their way out of the forest to get back home.) You can enhance the user experience and improve the user's perception of control if you include a breadcrumb trail to help the user navigate, especially on large, hierarchically arranged websites, such as retail sites. A breadcrumb trail on a subpage of a website can be displayed in a shaded bar at the top of the screen showing the path the user has used to arrive at that page, or it can be something simple such as a path—*Home>Help>Contact Us>Email>Live Chat*—to indicate where navigationally one is on a website when a user is searching for help with a purchase.

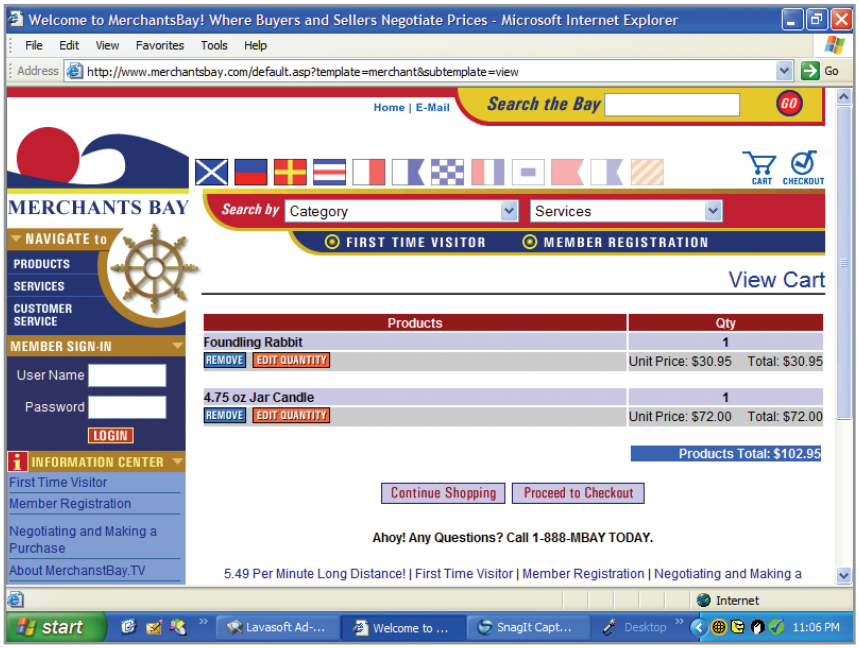
The bottom of a Web page is called the footer. A footer often give basics of contact information for the company, a copyright notice, or information about who to contact about the content of the website. Footers are often seen as throwaway designs of little importance. Their design should not be ignored, however. One current perspective is that by designing *fat footers* an entire section of the website can feature social media links, recommend what visitors should check out next on the website, add keywords and tags to improve search engine optimization (SEO), and develop a lasting impression with users based on an excerpt from the organization's mission statement, show a corporate slogan, display a key value, or even add humorous art or icons to reveal a more human dimension to the business.

Designing websites or designing for smartphones and tablets (see Chapter 11) share some guidelines with designing a good Internet or intranet fill-in form. Now that you have learned some of the elementary aspects of input form and display design, examine Figure 12.9, which shows a fill-in form order page containing 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 users must scroll excessively, divide the form into several simpler forms on separate pages.

FIGURE 12.10

The Merchants Bay website (www.merchantsbay.com) is a good example of a shopping cart. (Screenshot of Merchants Bay website. Copyright © 2000 by Merchants Bay LLC. Reprinted with permission of Troy Pappas.)



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.

Ecommerce applications involve more than just good design of websites. 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 12.10 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 an analyst who must design websites 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.

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 may 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, context-sensitive help functions, and feedback forms, to correct input before final submission.

HYPERCASE EXPERIENCE 12

"Isn'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 Mr. Evans 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 Mr. Evans 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.

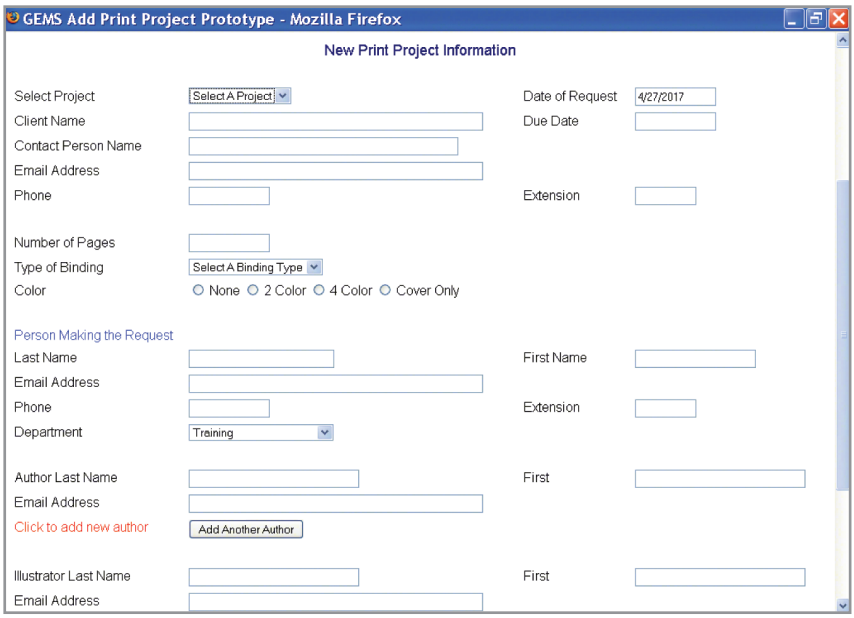


FIGURE 12.HC1

Take a look at some of the input screens in HyperCase. You may want to redesign some of the electronic forms.

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 help the systems analyst 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, dialogue 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.

Several pervasive navigational elements can be use by analysts to give their Web pages a professional look. These include the hamburger icon or menu; context-sensitive help for GUI design; input validation for input forms; a breadcrumb trail to let users know where they are within a large website, program, or complex document; and including fat footers.

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 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
base plane
box caption
breadcrumb trail
check box
command button
context-sensitive help
control of business forms
cursor
display color combinations
drop-down list box
dynamic Web pages
event-response chart
facilitating movement on pages
fat footer
form flow
form values
hamburger icon
hamburger menu
hidden field
horizontal check-off caption
image map
input validation
Internet/intranet fill-in form
layer
line caption
list box
message box
onscreen color
onscreen dialogue
onscreen icon
option button
picker
prompt
radio button
response time
seven sections of a form
slider
specialty form
spin button
table caption
text box
three sections of a display
vertical check-off caption
website design

Review Questions

1. What are the design objectives for paper input forms, input screens, and 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. Why is controlling business forms important? What are the duties for controlling 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. List the guidelines for the design of effective icons in display design.
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. List 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 it in a display design or on a Web-based fill-in form.
14. When should calendar control be used?
15. Why are message boxes used?
16. What is a "picker" in app development?
17. What are two different ways that form values are used?
18. What are hidden fields used for on a Web form?
19. List four different types of events.
20. What are dynamic Web pages?
21. List the advantages and limitations of dynamic webpages.
22. How does an analyst determine when to include layers in Web page design?
23. How can colors be used to enhance input display design?
24. Describe how a hamburger menu or icon functions on a Web page.
25. How does context-sensitive help differ from online help?
26. In what ways does input validation improve the quality of data stored in a database?
27. What is a breadcrumb trail in Web design?
28. List five of the many items an analyst can include in the design of a fat footer for a Web page.
29. List the additional demands that may be placed on an analyst who designs a website for an e-commerce application.
30. 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 website. What changes were necessary in moving from a paper form to one that will be submitted electronically?
2. A multispecialty hospital requires patients to register at the OPD either physically or through the hospital's website, where they are given unique registration numbers valid for all their future transactions at the hospital.
   a. Design and draw a representation of a display screen for registration on the hospital website on a given date. Label the three sections of the screen that you included.
   b. Many patients are recommended tests at specialized labs in the hospital. The labs rarely schedule a test on the same day the patient has requested it unless there is an emergency; instead, the next vacant slot found by the system is generally allotted to the patient. Design a form that takes these parameters as input and generates pricing information for the tests. Label the seven sections of the form that you included.
   c. The hospital has set up kiosks with display screens on the premises where patients can log in to view their reports. Discuss the usability of this approach in terms of possible security risks and how it is different from logging in from a personal device.

3. A new initiative lets citizens access information on a variety of government-related activities through helpdesks at a citizen service center. The administration wants to benchmark the process and is looking for ways to reduce the waiting time to less than five minutes at any desk. The desk operators believe that they could reduce the service time drastically for each service if they received a form containing all the necessary details. For example, a person who wants to know the status of their driving license application would receive the information in a minute if their name, date of birth, tracking number, and other relevant details were recorded properly. It becomes easier and faster to fetch the information from the system.
   a. Design and draw a form that people can fill in to help the desk operators serve them better. Make your own assumptions.
   b. Design and draw a representation of a display screen that can be used by the citizens and the desk operators to fill in the information captured on the form.
   c. Design a display screen for the desk operator based on the display you designed in part b that allows them to add another functionality. For example, when they view the status of a driving license, the screen allows them to schedule a driving test for the applicant. Suggest how the changes can be made to include this step in the existing display.
4. Sherry's Meat Products, 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 (31/2" × 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 part b 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.
   i. Design a fat footer for the Web page you designed in part f. It should include social media links, keywords, references to additional Web pages of interest, and a statement of a key value Sherry's has, such as "Fresh is the key to our customers hearts."
5. R. George's, a fashionable clothing store that also has an online store business, would like to keep track of the customers coming into the store to expand its mailing list.
   a. Design and draw a simple form that can be printed on 3" × 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 part a.
   c. Design and draw a second onscreen tab control dialogue 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 website. In a paragraph, explain how it will differ from the printed form.
   e. Design a social media post that depicts a customer's positive experience shopping at R. George that advertises the brand in a subtle way. Use visuals.

6. A bank has launched a smartphone app that determines a client's loan eligibility and expected monthly installment. Clients can download the app on their smartphones and register with their details. Once they provide the necessary information, like their age, monthly income, the loan amount, and the duration of the loan, the app determines their loan eligibility. The app also computes the approximate monthly installment they are to pay based on the duration of the loan they enter.
   a. Design an input display for the app using the guidelines in the text. Write a paragraph on how you included each guideline in your design.
   b. Generate an event-response chart for this situation listing form controls, events, and consequent responses based on your assumptions.
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 and 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 part a 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 part a 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.
   d. Design a breadcrumb trail for the My Belle website. Make sure to include the names of key pages and show how a user could navigate between pages. Use shaded boxes at the top of the page to indicate the breadcrumb trail.
8. The Carol, Tracy, & Leslie 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 (not in any particular order) 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 landing page for the Carol, Tracy, & Leslie Realty Corporation display screen created in Problem 8.
10. 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 website 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.
    a. Add a fat footer for the Sludge's website landing page. It should include social media links, keywords, references to additional Web pages of interest, and a statement of a key belief Sludge's has, such as "The cars we drive say a lot about us."
11. Design the Add Customer Web page for Sludge's Auto (see Problem 10). Include a profile that would allow Sludge's to send the customer an email if a requested part becomes available.
12. Design the Purchase Web page for Sludge's Auto (see Problem 10). 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.
13. 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 a 15-year-old national U.S. trucking firm. 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. 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 for Maverick Transport using either a CASE tool, a drawing tool such as Microsoft Visio, or paper and pencil. Share your results with your team members. Include small pop-up notifications for input validation that notifies users that the data they are entering is invalid or that they have missed a field that requires data.
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? Respond in a few sentences.

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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.
6. Understand the relationship of business intelligence to data warehouses, big data, and data analytics in helping systems and people make decisions.

Some consider data storage to be the heart of an information system. The data have to be available when the user wants to use them. In addition, the data must be accurate and consistent (they must possess integrity). 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 stored data must be in a form that is useful for managing, planning, controlling, or making decisions.

There are two approaches to the storage of data in a computer-based system. The first is to store 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 with only 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 need to be planned so that data are organized for efficient storage and effective retrieval. Data warehouses are very large databases that store summarized data relating to a specific subject so queries are answered very efficiently. Business intelligence is built around the concept of processing large volumes of data, sometimes called big data. Business analytics uses quantitative tools to analyze big data and inform decisions of managers and computer systems.

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. As his business grew, he added 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."

In a paragraph, 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? Answer the question by making a recommendation to scrap the old system or just to improve it. Discuss the implications of your decision in two paragraphs.

Databases

A database is not merely a collection of files; it 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. A person who ensures that a database meets its objectives is called a database administrator.

The effectiveness objectives of a database include the following:

1. Ensure that data can be shared among users for a variety of applications.
2. Maintain accurate and consistent data.
3. Ensure that all data required for current and future applications is readily available.
4. Allow the database to evolve as the needs of users grow.
5. Allow users to construct their personal view of the data without concern for the way data are physically stored.

This list of objectives provides us with a reminder of the advantages and disadvantages of the database approach.

One advantage of shared data is that data need to be stored only once. That 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 the data 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 is more flexible than separate files because it can evolve as the applications and the needs of users 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 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 to answer queries specific to the end user's needs.

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 graphical user interface (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. In addition, the Microsoft Office Suite has special functions that allow users to export data from a corporate database to other applications. These data can be imported to Microsoft Access as well.

Databases are highly useful technologies for organizations to store, access, and retrieve their data, but many security issues surround their design and use. For those who are designing the database as well as for those who are administering it and using it, important security issues will arise. It is critical that everyone involved in the design of the database agrees on the value of the data and the cost of protecting it, because securing data has costs as well as benefits. Risk assessment is an essential part of database planning.

Cyber attacks, including malware and denial of service attacks, are on the increase, and companies must consider these questions: What is the likelihood of an attack? What is the value of the data that are being protected? What are the implications of a security breach for the company's customers and, in the aftermath, for the company's image? Everyone involved in using a database including database administrators and users needs to undergo appropriate training on security issues and the accessing of databases. Getting users involved in business continuity planning and disaster recovery approaches will help make databases and the organization resilient if and when security is breached, thereby minimizing damage.

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 examined, including the abstraction of data from the real world to the storage of data in tables and database relations.

Reality, Data, and Metadata

Data collected about people, places, or events in reality will eventually be stored in a file or database. (In this section, we refer to the real world as *reality*.) To understand the form and structure of the data, information about the data themselves is required. The information that describes data is referred to as *metadata*.

The relationship between reality, data, and metadata is shown 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). An entity can also be an event or a 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 called an entity subtype. Its symbol is a smaller rectangle within the entity rectangle.

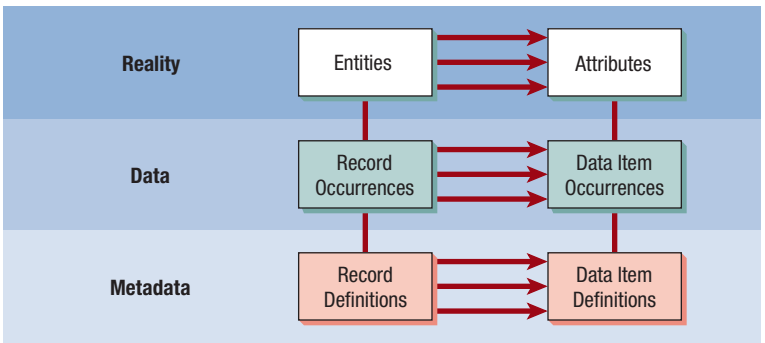


FIGURE 13.1
Reality, data, and metadata.

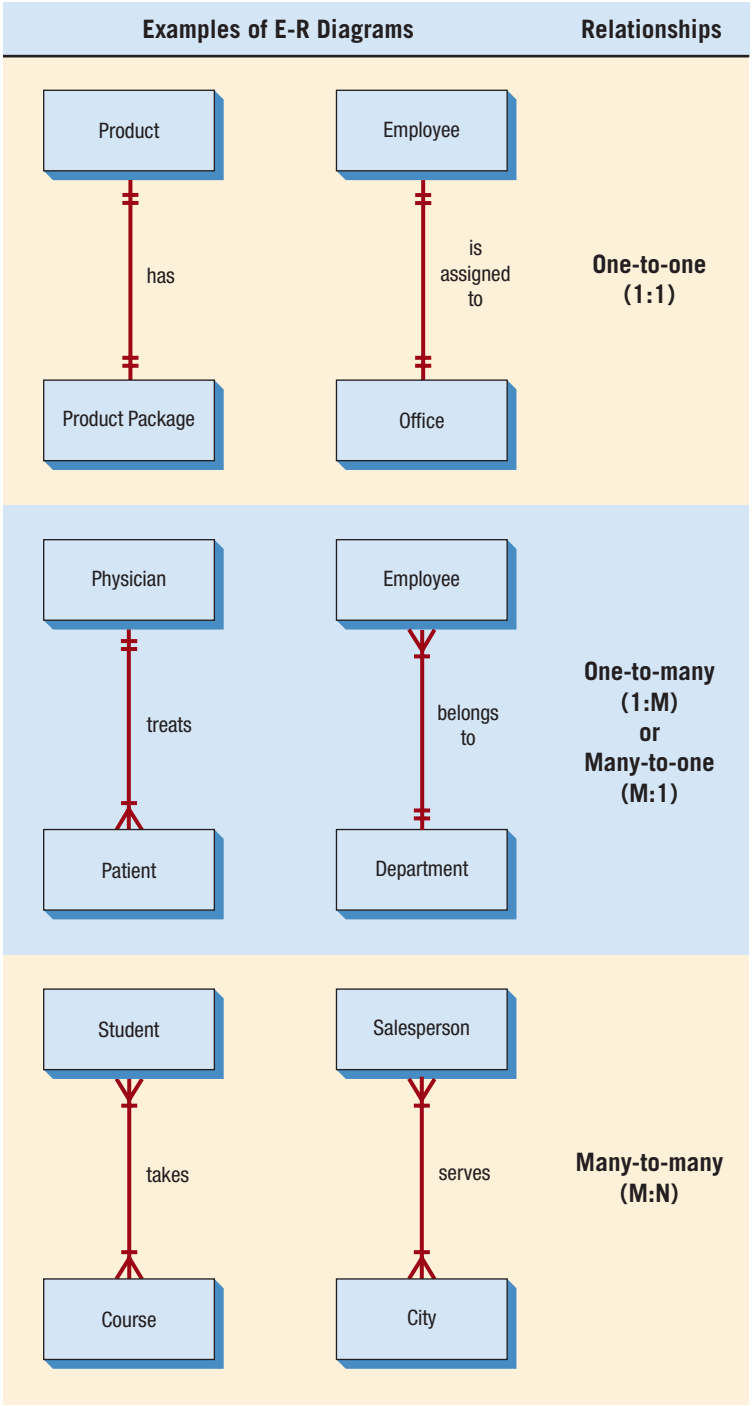
An entity subtype is a special one-to-one relationship used to represent additional attributes (fields) of another entity that may not be present on every record of the first entity. Entity subtypes eliminate the situation in which an entity may have null fields stored on database tables.

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 only a small number of students may have internships.

RELATIONSHIPS Relationships are associations between entities (sometimes referred to as *data associations*). Figure 13.2 shows a number of entity-relationship (E-R) diagrams that portray a variety of relationships.

FIGURE 13.2

Entity-relationship (E-R) diagrams can show one-to-one, one-to-many, many-to-one, or many-to-many associations.



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

Entity-relationship diagram symbols and their meanings.

The first type of relationship is a one-to-one relationship (designated 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 (for example, 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 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.

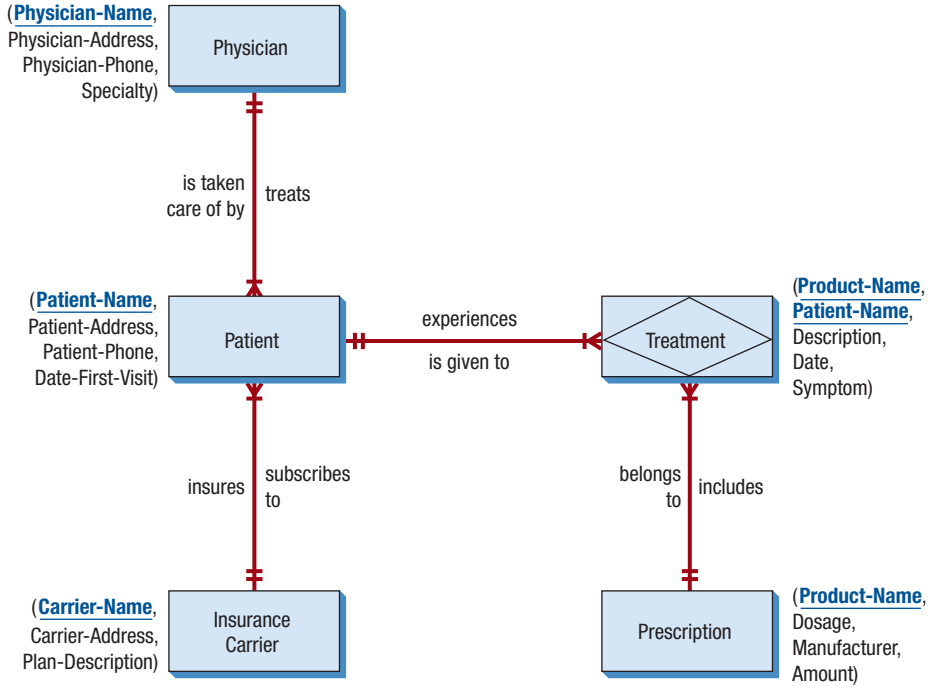
Finally, a many-to-many relationship (designated as M:N) describes the possibility that entities may have many associations in either direction. For example, a STUDENT can have many COURSE(s), and at the same time a COURSE may have many STUDENT(s) enrolled in it. The second M:N example in Figure 13.2 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 mean are 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. 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).

FIGURE 13.4

An E-R diagram for patient treatment. Attributes can be listed alongside the entities. In each case, the key is underlined.



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.

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 the text. 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).

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

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	6
	Length	6
	Weight	1
	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	01/03/2013
	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.

PRODUCT-NAME, DOSAGE, MANUFACTURER, and AMOUNT. Ideally, it would be beneficial to design a database in this fashion, using E-R 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, and each entity may have many attributes. 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 additional attributes. The smallest particular described in a data dictionary is called a data element (see Chapter 8). 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 are illustrated in Figure 13.5.

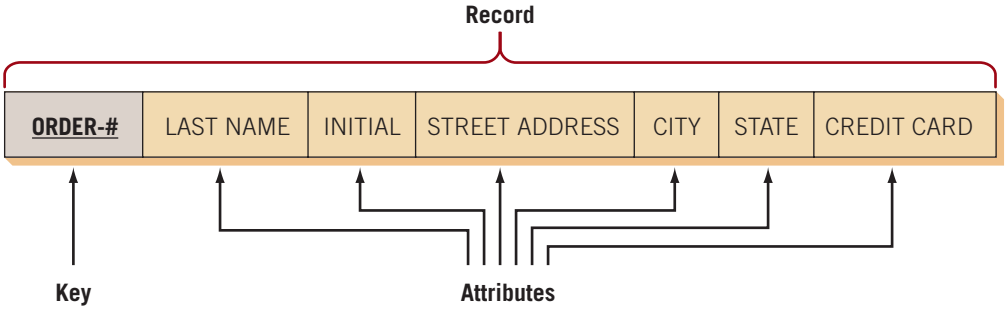
Sometimes a data item is also referred to as a *field*. A field, however, represents something physical, not logical. Therefore, many data items can be packed into a field; the field can be read and converted to a number of data items. A common example of this is to store the date in a single field as 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 illustrates a record with many related data items. The record shown is for an order placed with a mail order company. 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.

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.

FIGURE 13.6

A record has a primary key and may have many attributes.



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.

An example of a primary key based on data is 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 be minimal and contain no more attributes than those necessary to identify a record.

A key is called a secondary key if it cannot uniquely identify a record. Secondary keys 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 New Jersey).

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 a 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 a 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: for example, 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.

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 next, 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. Temporary files are usually called transaction files, work files, or report files.

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	MM/DD/YYYY
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 include a description of what the value of each data item looks like.

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 an 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 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 (for example, 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 users see data in different ways. We refer to the way a user pictures and describes the data as a user view. The problem, however, is those different users have different user views. These views need to be examined by the systems analyst so an overall logical model of the database can be 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.

In database literature, 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).

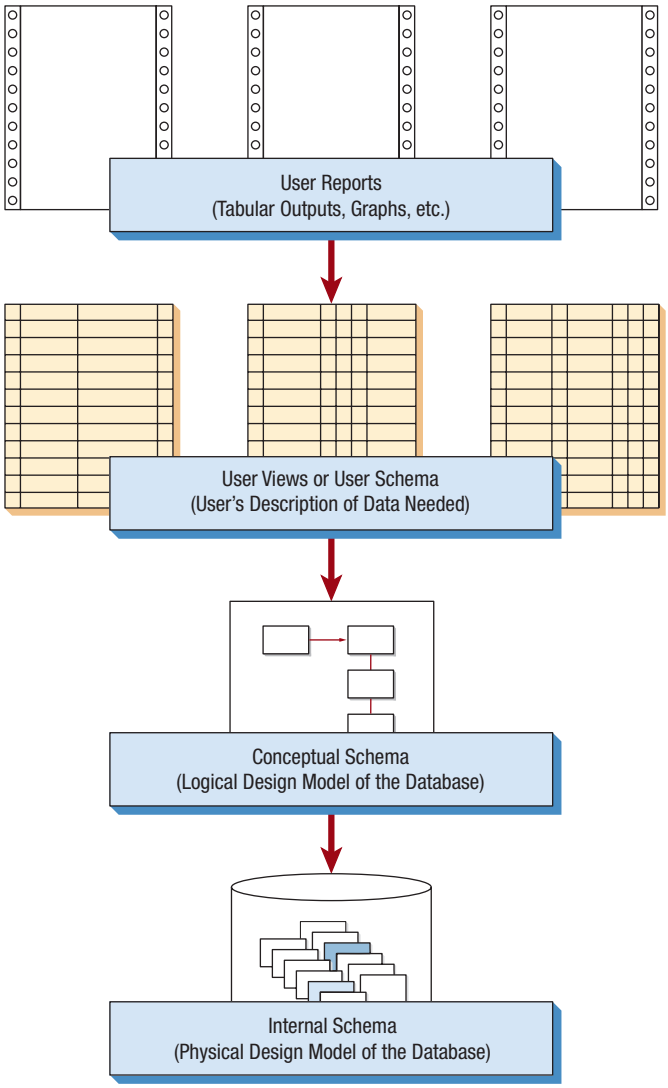


FIGURE 13.8

Database design includes synthesizing user reports, user views, and logical and physical designs.

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.

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 compared to maintaining a hierarchical or network structure. One of the primary advantages of relational structures is that ad hoc queries are handled efficiently.

When relational structures are discussed in database literature, different terminology is often used. A file is called either a table or a 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

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), an analyst normalizes a data structure in three steps, as shown in Figure 13.10. Each step involves an important procedure 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 involves 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 involves ensuring that all nonkey attributes are fully dependent on the primary key. All partial dependencies are removed and placed in another relation.

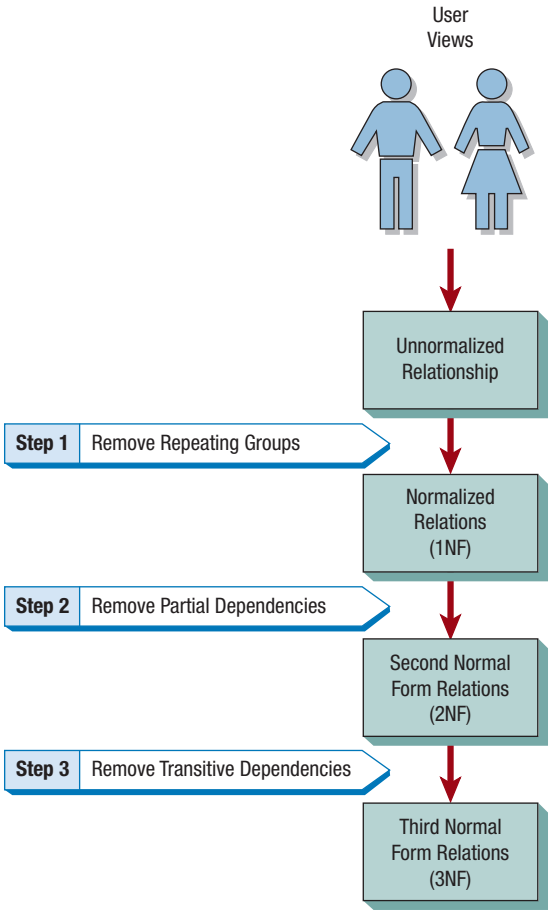
The third step involves removing any transitive dependencies. A transitive dependency is one in which nonkey attributes are dependent on other nonkey attributes.

A Normalization Example

Figure 13.11 is a user view for the Al S. Well Hydraulic Equipment Company. The report shows the (1) SALESPERSON-NUMBER, (2) SALESPERSON-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

FIGURE 13.10

Normalization of a relation is accomplished in three major steps.



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

FIGURE 13.11

A user report for the Al S. Well Hydraulic Equipment Company.

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 were 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 a *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 SALESPERSON-NUMBER assigned to each SALESPERSON-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 SALESPERSON-NUMBER. For each SALESPERSON-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

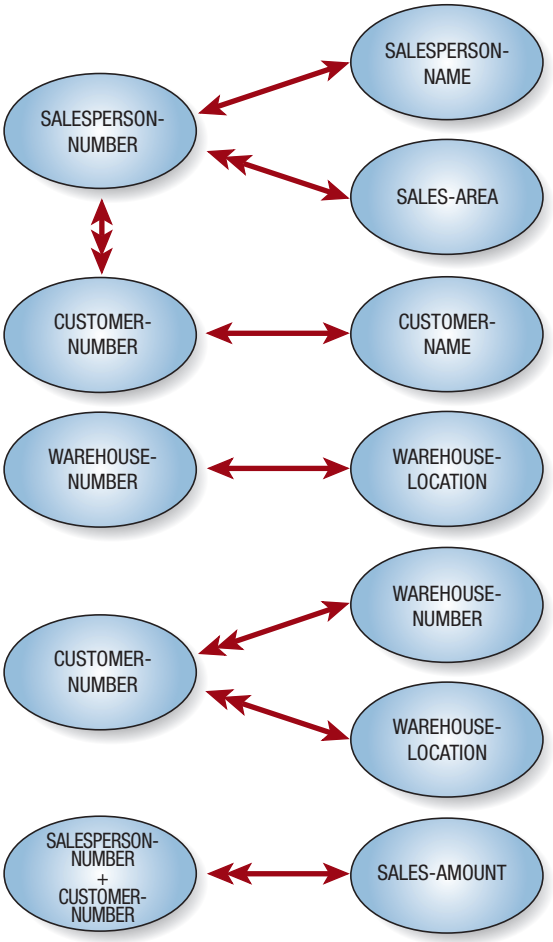
```
SALESPERSON-NUMBER
SALESPERSON-NAME
SALES-AREA
CUSTOMER-NUMBER* (1-)
    CUSTOMER-NAME
    WAREHOUSE-NUMBER
    WAREHOUSE-LOCATION
    SALES-AMOUNT
```

FIGURE 13.12

The analyst would find a data structure (from a data dictionary) useful in developing a database.

FIGURE 13.13

Drawing data model diagrams for data associations sometimes helps analysts appreciate the complexity of data storage.



WAREHOUSE-LOCATION may 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 just discussed 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 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

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	Delta Systems	4	Fargo	13,540
			18830	M. Levy and Sons	3	Bismarck	10,600
			19242	Ranier Company	3	Bismarck	9,700
3593	Dryne	East	18841	R. W. Flood Inc.	2	Superior	11,560
			18899	Seward Systems	2	Superior	2,590
			19565	Stodola's Inc.	1	Plymouth	8,800
etc.							

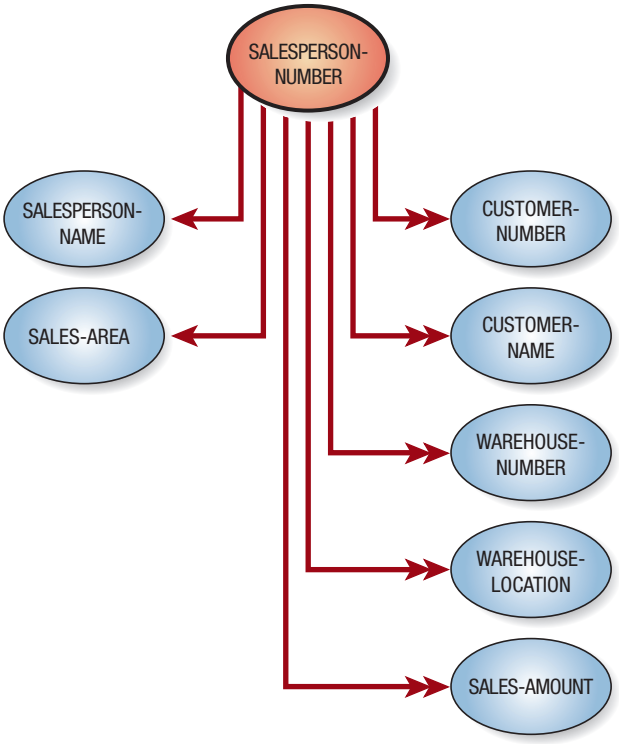


FIGURE 13.15

A data model diagram shows that in the unnormalized relation, SALESPERSON-NUMBER has a one-to-many association with some attributes.

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 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.

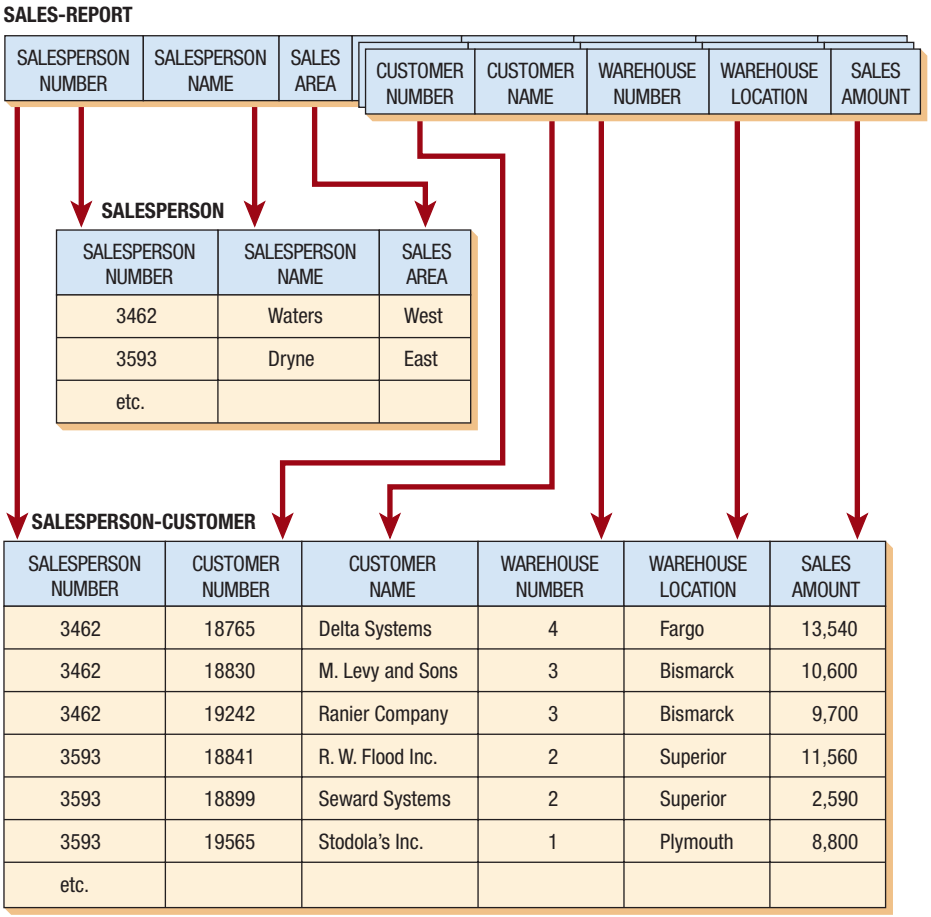
FIRST NORMAL FORM (1NF) The first step in normalizing a relation is to remove the repeating groups. In our example, the unnormalized relation SALES-REPORT will be broken into two separate relations. These new relations will be named SALESPERSON and SALESPERSON-CUSTOMER.

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

FIGURE 13.16

The original unnormalized relation SALES-REPORT is separated into two relations, SALESPERSON (3NF) and SALESPERSON-CUSTOMER (1NF).



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 (that is, SALESPERSON-NUMBER, CUSTOMER-NUMBER). In other words, some of the nonkey 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.

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

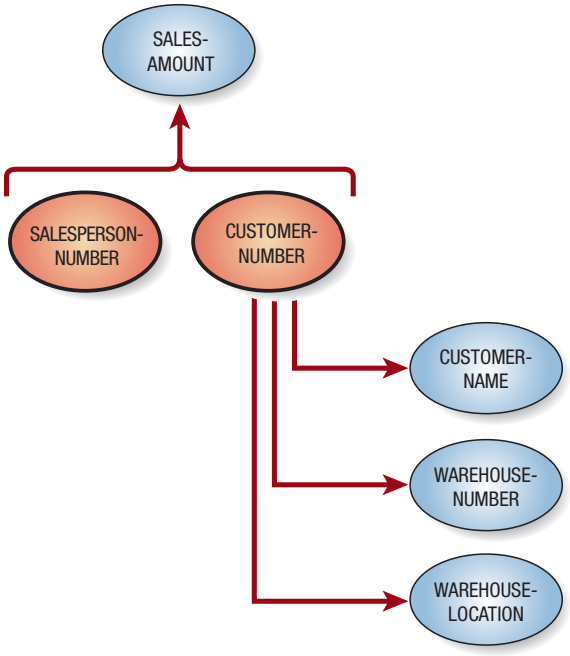


FIGURE 13.17

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.

SALESPERSON-CUSTOMER

SALESPERSON NUMBER	CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER	WAREHOUSE LOCATION	SALES AMOUNT

CUSTOMER-WAREHOUSE

CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER	WAREHOUSE LOCATION
18765	Delta Systems	4	Fargo
18830	M. Levy and Sons	3	Bismarck
19242	Ranier Company	3	Bismarck
18841	R. W. Flood Inc.	2	Superior
18899	Seward Systems	2	Superior
19565	Stodola's Inc.	1	Plymouth
etc.			

SALES

SALESPERSON NUMBER	CUSTOMER NUMBER	SALES AMOUNT
3462	18765	13,540
3462	18830	10,600
3462	19242	9,700
3593	18841	11,560
3593	18899	2,590
3593	19565	8,800
etc.		

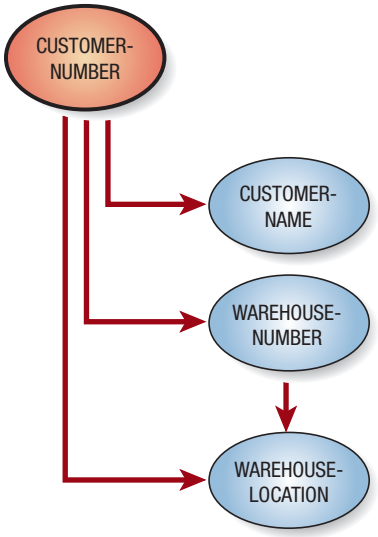
FIGURE 13.18

The relation SALESPERSON-CUSTOMER is separated into a relation called CUSTOMER-WAREHOUSE (2NF) and a relation called SALES (1NF).

SALESPERSON-CUSTOMER is split into two new relations: SALES and CUSTOMER-WAREHOUSE. 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

This data model diagram shows that a transitive dependency exists between WAREHOUSE-NUMBER and WAREHOUSE-LOCATION.



These relations also can be expressed as follows:

SALES (SALESPERSON-NUMBER, CUSTOMER-NUMBER, SALES-AMOUNT)

and

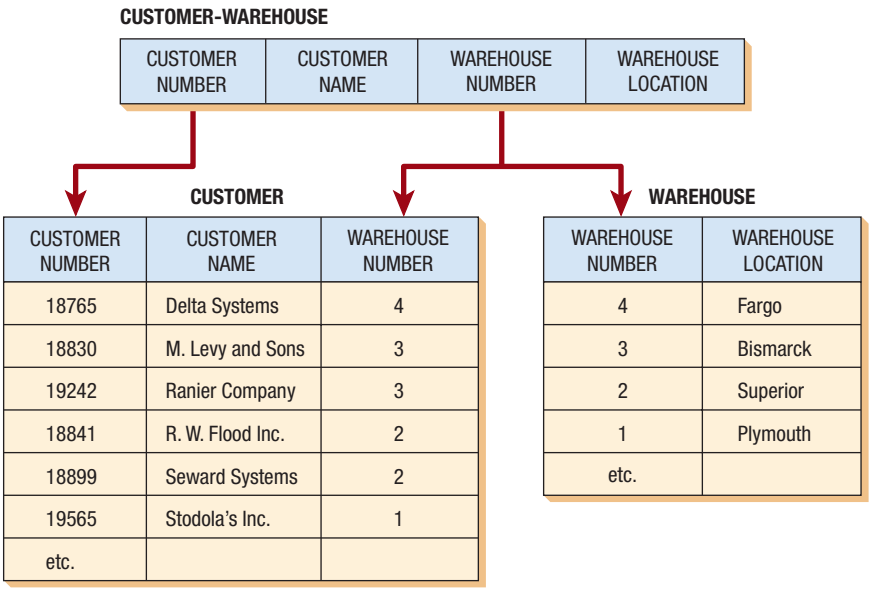
CUSTOMER-WAREHOUSE (CUSTOMER-NUMBER, CUSTOMER-NAME, WAREHOUSE-NUMBER, WAREHOUSE-LOCATION)

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.

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.

FIGURE 13.20

The relation CUSTOMER-WAREHOUSE is separated into two relations called CUSTOMER (1NF) and WAREHOUSE (1NF).



CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER
18765	Delta Systems	4
18830	M. 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 NUMBER	WAREHOUSE LOCATION
4	Fargo
3	Bismarck
2	Superior
1	Plymouth
etc.	

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 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, we can see that the single relation SALES-REPORT was transformed into the following four relations:

SALESPERSON (SALESPERSON-NUMBER, SALESPERSON-NAME, SALES-AREA)

SALES (SALESPERSON-NUMBER, CUSTOMER-NUMBER, SALES-AMOUNT)

CUSTOMER (CUSTOMER-NUMBER, CUSTOMER-NAME, WAREHOUSE-NUMBER)

WAREHOUSE (WAREHOUSE-NUMBER, WAREHOUSE-LOCATION)

SALESPERSON

SALESPERSON NUMBER	SALESPERSON NAME	SALES AREA
3462	Waters	West
3593	Dryne	East
etc.		

SALES

SALESPERSON NUMBER	CUSTOMER NUMBER	SALES AMOUNT
3462	18765	13,540
3462	18830	10,600
3462	19242	9,700
3593	18841	11,560
3593	18899	2,590
3593	19565	8,800
etc.		

CUSTOMER

CUSTOMER NUMBER	CUSTOMER NAME	WAREHOUSE NUMBER
18765	Delta Systems	4
18830	M. 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

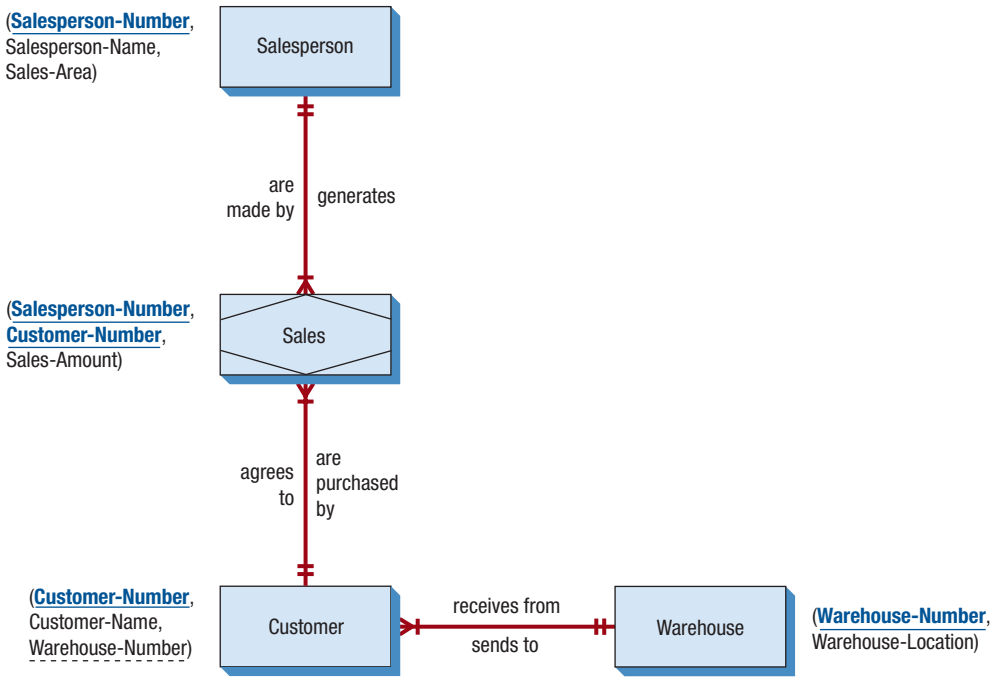
WAREHOUSE NUMBER	WAREHOUSE LOCATION
4	Fargo
3	Bismarck
2	Superior
1	Plymouth
etc.	

FIGURE 13.21

The complete database consists of four 1NF relations called SALESPERSON, SALES, CUSTOMER, and WAREHOUSE.

FIGURE 13.22

An E-R diagram for the Al S. Well Hydraulic Company database.



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.

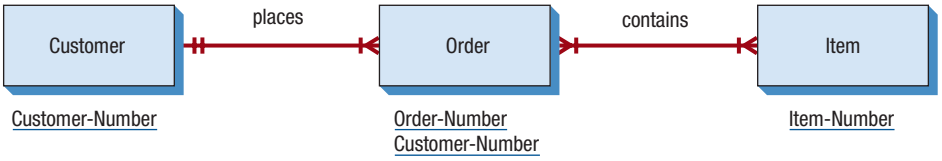
Using an Entity-Relationship Diagram to Determine Record Keys

An E-R diagram can 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. 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 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.

FIGURE 13.23

An E-R diagram for customer orders.



One-to-Many Relationships

A one-to-many relationship is the most common type of relationship because all many-to-many relationships must be broken down into two or more one-to-many relationships. When a one-to-many relationship occurs, the primary key in placed on the table at the one end of the relationship as a foreign key and on the many end of the relationship. For example, one customer may have many orders, so you 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. Because the order is for one customer, the result would be fields from the order and a single customer.

Designing the reverse is more complicated because 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 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 customers' orders. If there were a large number of records from the many end, scroll bars would appear.

In simple situations, the relationship might be implemented 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 websites, 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 Relationships

With a many-to-many relationship, 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, you 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

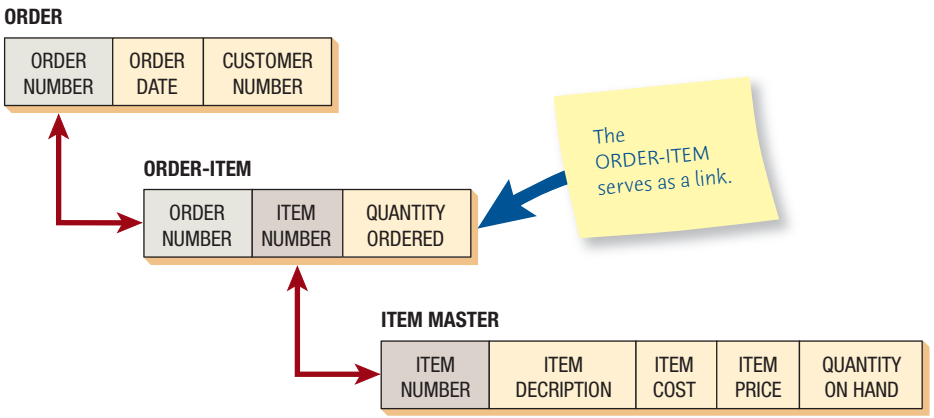


FIGURE 13.24

With a many-to-many relationship, three files are necessary.

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 because 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.

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, 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 *c*reate, *r*ead, *u*pdate, and *d*elete (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

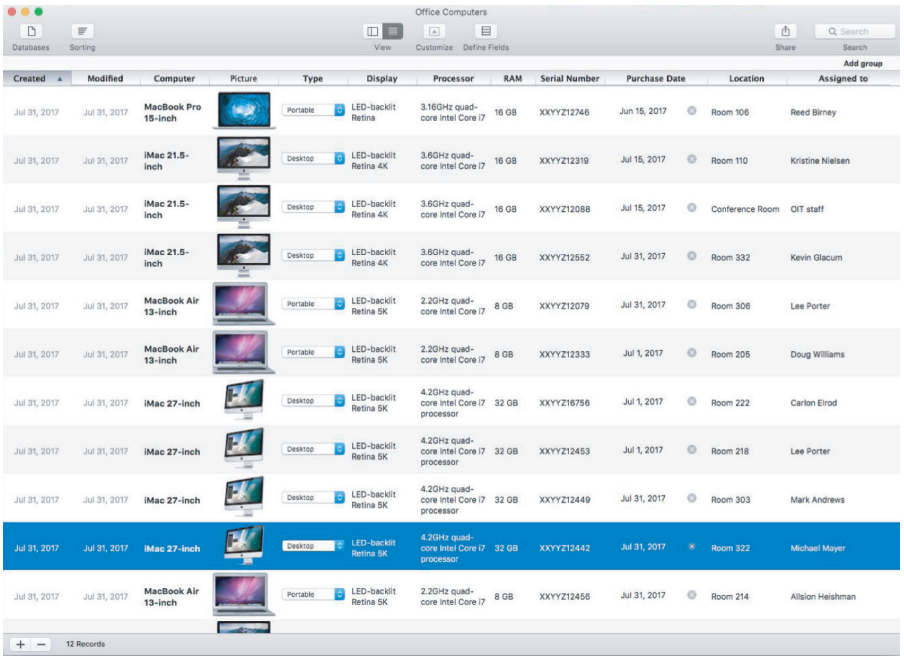
Entity integrity constraints are rules that govern the composition of primary keys. The primary key cannot have a null value, and if the primary key is a composite key, none of the component fields in the key can contain a null value. Some databases allow you to define a unique constraint or a unique 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

MAC APPEAL

Microsoft Word, Excel, and PowerPoint are available for the Mac operating system, but the only way to run Microsoft Access on a Mac is to run Windows in virtualization mode or by booting into Windows. However, there are a couple of other database options for the Mac. One is FileMaker Pro (FileMaker is a subsidiary of Apple). FileMaker Pro 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. Another option is to use iDatabase by Apimac and FileMaker Pro. iDatabase 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. It has more than 20 ready-to-use templates, and users can exchange templates by email.



Created	Modified	Computer	Picture	Type	Display	Processor	RAM	Serial Number	Purchase Date	Location	Assigned to
Jul 31, 2017	Jul 31, 2017	MacBook Pro 15-inch		Portable	LED-backlit Retina	3.16GHz quad-core Intel Core i7	16 GB	XXYYZ12746	Jun 15, 2017	Room 106	Reed Birney
Jul 31, 2017	Jul 31, 2017	iMac 21.5-inch		Desktop	LED-backlit Retina 4K	3.6GHz quad-core Intel Core i7	16 GB	XXYYZ12319	Jul 15, 2017	Room 110	Kristine Nielsen
Jul 31, 2017	Jul 31, 2017	iMac 21.5-inch		Desktop	LED-backlit Retina 4K	3.6GHz quad-core Intel Core i7	16 GB	XXYYZ12088	Jul 15, 2017	Conference Room	OIT staff
Jul 31, 2017	Jul 31, 2017	iMac 21.5-inch		Desktop	LED-backlit Retina 4K	3.6GHz quad-core Intel Core i7	16 GB	XXYYZ12552	Jul 31, 2017	Room 332	Kevin Glacum
Jul 31, 2017	Jul 31, 2017	MacBook Air 13-inch		Portable	LED-backlit Retina 5K	2.2GHz quad-core Intel Core i7	8 GB	XXYYZ12079	Jul 31, 2017	Room 306	Lee Porter
Jul 31, 2017	Jul 31, 2017	MacBook Air 13-inch		Portable	LED-backlit Retina 5K	2.2GHz quad-core Intel Core i7	8 GB	XXYYZ12333	Jul 1, 2017	Room 205	Doug Williams
Jul 31, 2017	Jul 31, 2017	iMac 27-inch		Desktop	LED-backlit Retina 5K	4.2GHz quad-core Intel Core i7 processor	32 GB	XXYYZ16756	Jul 1, 2017	Room 222	Carlon Elrod
Jul 31, 2017	Jul 31, 2017	iMac 27-inch		Desktop	LED-backlit Retina 5K	4.2GHz quad-core Intel Core i7 processor	32 GB	XXYYZ12453	Jul 1, 2017	Room 218	Lee Porter
Jul 31, 2017	Jul 31, 2017	iMac 27-inch		Desktop	LED-backlit Retina 5K	4.2GHz quad-core Intel Core i7 processor	32 GB	XXYYZ12449	Jul 31, 2017	Room 303	Mark Andrews
Jul 31, 2017	Jul 31, 2017	iMac 27-inch		Desktop	LED-backlit Retina 5K	4.2GHz quad-core Intel Core i7 processor	32 GB	XXYYZ12442	Jul 31, 2017	Room 322	Michael Mayer
Jul 31, 2017	Jul 31, 2017	MacBook Air 13-inch		Portable	LED-backlit Retina 5K	2.2GHz quad-core Intel Core i7	8 GB	XXYYZ12456	Jul 31, 2017	Room 214	Allsion Heishman

FIGURE 13.MAC

A screen from iDatabase, available for the Mac operating system. (Screenshot from iDatabase, a personal database. Copyright © by Apimac. Reprinted with permission.)

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 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 a Database

A number of steps must be taken in sequential order to ensure 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 the 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 (see Chapter 11) provides a more detailed look at presentation objectives, forms, and methods.

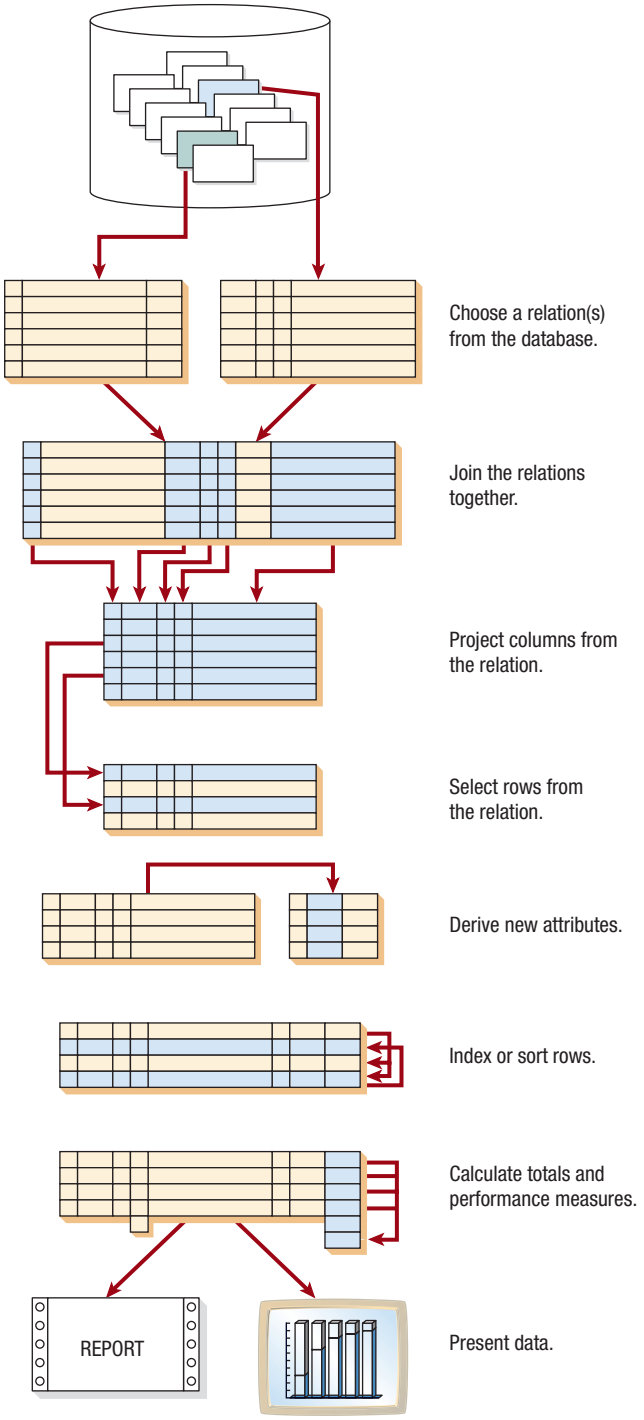


FIGURE 13.25

Data are retrieved and presented in eight distinct steps.

Denormalization

One of the main reasons for normalization is to organize data in order 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 an analyst to reduce the amount of storage needed, which was very important when storage was expensive.

To use normalized data, we have to progress through a series of steps that involve 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 transforming a logical data model into a physical model that is efficient for the most-often-needed tasks. These tasks can include report generation, but they also can mean more efficient queries. Complex queries such as online analytical

processing (OLAP), as well as data mining and knowledge data discovery (KDD) processes, also use denormalized databases.

Denormalization can be accomplished in a number of different ways. Figure 13.26 depicts some of these approaches. In a many-to-many relationship, such as that of SALESPERSON and CUSTOMER, which share the associative entity SALES, the attributes from SALESPERSON and SALES can be combined to 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.

Another reason for denormalization is to avoid repeated reference to a look-up table. It may be more efficient to repeat the same information—for example, the city, state, and postal code—even though this information can usually be stored as a postal 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.

Data Warehouses

Data warehouses differ from traditional databases. The purpose of a data warehouse is to organize information for quick and effective queries. Data warehouses are seen as a critical part of business intelligence (BI). In effect, they store denormalized data, but they go one step further. They organize data around subjects. Most often, a data warehouse consists of more than one database in which the data represented are processed in uniform ways. 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 more traditional databases are normalized and structured 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 siftware) 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. An analyst needs to gather data from a variety of sources and translate those 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." An 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.

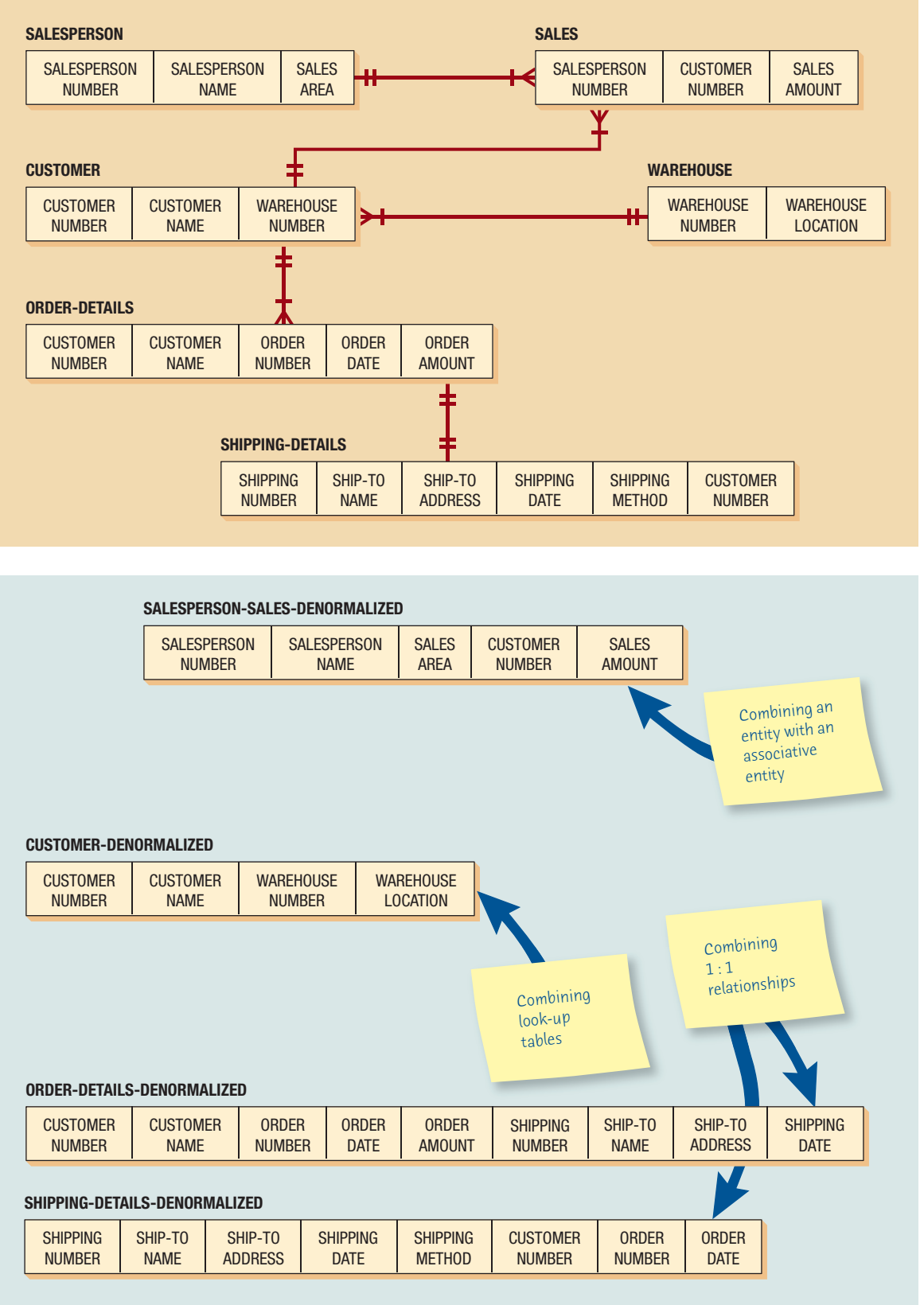


FIGURE 13.26

Three examples of denormalization in order to make access more efficient.

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 the customer 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.

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 Analytical Processing

First introduced in 1993 by E. F. Codd, online analytical 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 manipulate the data by twisting or turning it so 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. Business intelligence (coming up in a later section) includes querying as well as reporting OLAP, and sending a variety of notifications to users.

Data Mining

Data mining can identify patterns a human is unable to detect. Either the decision maker may not be able to 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.

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, it 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 buying premium brand name products.

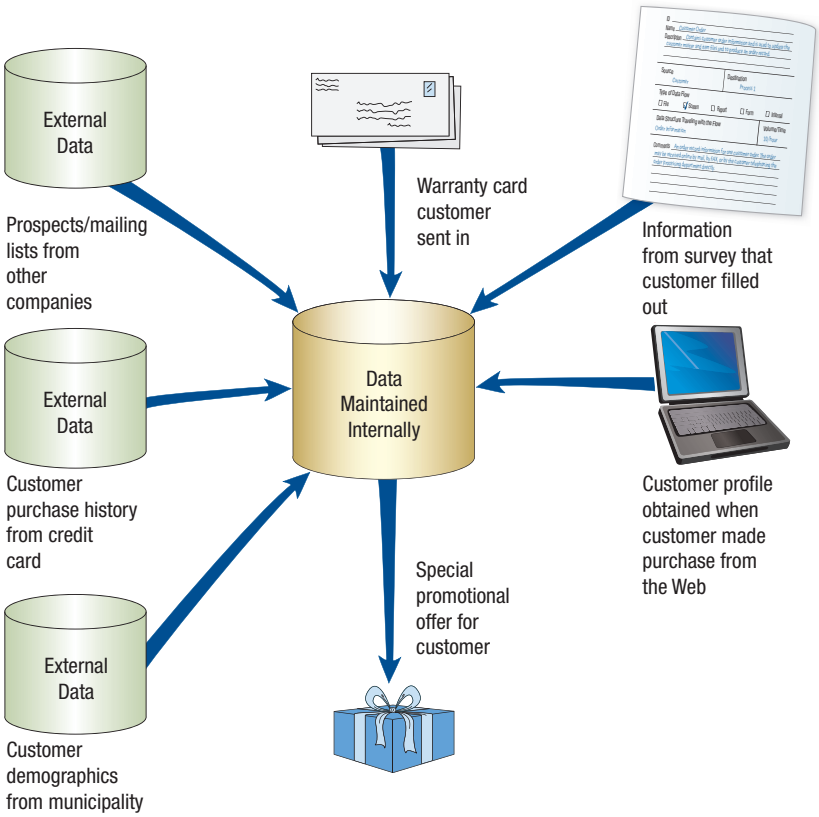


FIGURE 13.27

Data mining collects personal information about customers in an effort to be more specific in interpreting and anticipating their preferences.

The concept of data mining came from the desire to use a database for 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 that 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 that past behavior is a good predictor of future purchases, large numbers of data are gathered on a particular person from credit card purchases, social media posts, and emails. A 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 in a fitness club. 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 customers discount offers for new stores or entertainment when it sends their 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, and this may be discovered only 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, social media posts, or emails, 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, its confidentiality, the privacy safeguards included, and the uses to which inferences are put should all

CONSULTING OPPORTUNITY 13.3

Losing Prospects

"Market 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 is a powerful, relational database that is the heart of marketing systems. Our marketing database provides 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 or graphical query language 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 computer systems. 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. In a paragraph, describe how you would build a marketing database to minimize duplicates. 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 members of the organization . . .

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 resist or resent being pushed, the data mining efforts will backfire.

Business Intelligence (BI)

Although not a new concept, business intelligence (BI) has grown in prominence since the late 1980s, and its uses have spread to several types of organizational employees, not just those few at the strategic level of decision making. Business intelligence is at heart a decision support system (DSS) for organizational decision makers. It is composed of features that gather and store data and uses knowledge management approaches combined with analysis. This becomes input to decision makers' decision-making processes.

Business intelligence is built around the idea of processing large volumes of data. As a systems analyst, you may be asked to create systems that support BI, such as a data warehouse, the data from which is considered as the input to analytics. Or you might be involved with the creation of dashboards or even spreadsheets that convey BI to users. When data sets become too large or too complex to be handled with traditional tools or within traditional databases or data warehouses, they are often referred to as "big data."

Demand for experts possessing information management skills is ever increasing because the growth in data far outstrips our abilities to meaningfully store, process, or analyze it. Big data also has been called an approach to design for companies, essentially a strategy that permits organizations to cope with ever-increasing amounts of data from myriad sources—some human generated but many more generated via sensors of some type (for example, electronic road toll collections, satellite weather monitors).

Often analysts are in charge of the interface between users and a data warehouse. As with other systems, it is important to understand the data generated by the organization, the business itself, and the information requirements of the analysts who will be interpreting the output of any statistical models supported by the DSS.

Five prominent methods are used for analyzing business intelligence: slice-and-dice drill-down, ad hoc queries, real-time analysis, forecasting, and scenarios. Although there has been some consolidation in the industry, there are many large and small providers of BI software. Some are moving their services to the cloud to provide on-demand services, reduce overall costs, and improve startup times.

Business analytics (BA) is a term that covers the ideas of using big data along with a variety of *quantitatively* based analytical tools (such as statistics and predictive modeling) to answer management questions about trends and what-if questions that analyze a number of actions as part of strategic scenarios. Their output may be used as input for decision makers or as input for computerized systems.

Some of the problems inherent in BI are how systems handle semistructured and unstructured data. Most organizations still have many documents that are not available for analysis through BI because they don't fit the structured, stringent requirements of data warehouse entries. This means that a large portion of the important information and data an organization and its customers generate goes unanalyzed and, therefore, unused or underused in decision making. One approach to making the best use of this information is called data analytics.

Data Analytics

Data analytics use powerful algorithms to analyze vast amounts of structured data found in databases or to analyze huge quantities of unstructured real-time data that can support decision makers in making fact-based decisions. Analytics can refer to solving business problems and the decision-making process as well as the analytical approaches that help organizations create value through collecting, analyzing, and distributing large volumes of data. A broader term for both is business intelligence, often abbreviated BI (pronounced bee-eye).

To understand the role the systems analyst plays in the use of data analytics (both the process and the tools), we consider eight aspects of this type of analysis:

1. Ensure the quality of the data.
2. Facilitate communication between users and data analytics professionals.
3. Educate users and decision makers about how to use analytical tools and how to interpret reports based on use of those tools.
4. Create reports that can be user generated.
5. Work with users who prefer to have a data analytics professional create reports.
6. Develop a collaborative business intelligence platform by collaborating on the creation of reports and making it possible for decision makers to share insights.
7. Ensure that the process of data analytics has the desired impact on a business.
8. Provide deep insights and understanding that supports decision makers and data analysts in making sense of their individual and organizational experience.

Any or all of these eight actions may fall within the scope of the responsibilities of a systems analyst. Observe that many of these activities place the analyst as a collaborative partner with

their client, and perhaps other data analysts. Ensuring the quality of the data to be analyzed is of utmost importance, as is a user-centered focus for any data analytics work done.

There are numerous ethical, privacy, and security consideration in using data generated in large, nonconventional databases. These databases include big data generated by people who participate on a routine, or almost daily basis in social networks, blogs of social influencers, cloud applications for the public cloud, and public and government sponsored data. Data are generated by people interacting with such systems who are largely unaware that the data are being used for data analytics purposes. A developer may use mash-ups of big data, combining Google maps and data from social media to develop networks, relationships, or predictions of behavior.

Researchers have gone further in their suggestions about what data analytics has to offer users in terms of helping users and data analysts find ways to make sense of their organizational experience, and even to use past events as predictive of future occurrences. Systems analysts should be aware of these larger purposes, including retrospection, social engagement/collaboration, cue extraction, plausibility, and ongoing access (Namvar et al., 2016).

Blockchains

A blockchain network is a data structure built on an Internet platform that permits sharing and creation of a digital ledger of data, which can be shared with others on a network that is either public or private. It is useful whenever a business or an individual wants to possess a verifiable electronic record to track any kind of business asset: digital currency, materials that contribute to a manufactured product (whether it is organic or inorganic), a tangible asset, an intangible asset, or a digital asset. It requires no intermediary (such as a commercial bank for digital currency) to conduct transactions.

Blockchains came into the public consciousness with the introduction of the crypto currency called bitcoins, but blockchains have many other uses. For example, a blockchain can be used to verify that food labeled "organic" actually arises from organic farming practices in every step of the growing, harvesting, and packaging. Or it can be used to track the provenance of an artist's work such as a painting, showing who created the painting, where and when that happened, who exhibited it, who purchased the painting, and whether it is held in a private collection or in a museum. A big advantage of a blockchain is that it cannot be altered. IBM Blockchain provides a way for member banks of a global banking network to share reference data. IBM Blockchain is also being used to track the origin and movement of automotive parts through a complex supply chain including manufacturer, components, and original sources of all components that compose a vehicle.

Blockchain is especially useful in food supply chains for tracking perishable products. For instance, a blockchain would be useful to track which cows in the herd contributed milk to production of certain numbered cartons, at what time the milk was contributed to storage vats after cows were milked, what temperature the vats were maintained at during storage and before milk was bottled. It could also track the trucks and drivers that had milk product put on their trucks and at what time and what locations, as well as how the milk was handled while it was on a refrigerated delivery truck. The blockchain ledger could reveal how long particular cases of milk product sat on the loading dock before being taken to coolers in the backroom of the store, and even when it was loaded into dairy cases for customers to purchase.

Large deviations in delivery time, temperatures in trucks, length of wait on a delivery dock, and temperatures in grocery store display cases can all be added to transactional data in the blockchain. Thus, a blockchain could help pinpoint defects in perishable products (possible exposure to higher than average temperatures, or slowdown of off loading product due to a shortage of docks for unloading, for example) and could speed recall of products that experienced logged deviations in the expected supply chain.

A blockchain is an open, immutable record of transactions. Blockchains were created to solve problems that habitually arise from conducting transactions. They are meant to improve security, cut down on risk, and improve reliability and efficiency when conducting transactions of all sorts. Blockchains can be thought of as distributed databases that feature controls on information that also store information and share it. Blockchains are integrating technology platforms worldwide.

A proprietary, London-based firm called *Blockchain* makes software that allows consumers and businesses to make transactions using digital currencies such as bitcoin. It has made ease of

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: Mr. Ketcham and Mr. Evans have agreed to think about moving toward a database of some sort. Would you have this ready in the next two weeks? Mr. Ketcham is at a conference in Minneapolis, but when he returns you should have some database ideas worked up for Mr. Evans and him to discuss. Keep at it."

HYPERCASE Questions

Use the table that appears in this exercise to complete these questions. Assume that your team members have used the Training Unit Client Characteristics Report to design this database table to store the relevant information contained on this report.

1. Apply normalization to the table your team has developed to remove repeating groups. Display your results.
2. 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 (Veterans 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 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

use an important feature, explaining that an ordinary consumer who is not tech savvy can use it on their smartphone with no problem or special training.

Businesses use special permissioned blockchains. A permissioned blockchain offers better privacy, upgraded auditability, and increased efficiency for operations. A permissioned blockchain means that transactions can be trusted, costs are lower because there is little duplication of effort, and the rapidity of transactions is more akin to what actually happens in business transactions in real time, rather than a prolonged wait for outside authorities to approve or update transactions before they can be executed. Many large businesses are announcing new blockchain-based products, including introduction of blockchain-based insurance products in the next few years.

Blockchain is in need of designers who can bridge the technical complexities of blockchain and make it usable for less tech savvy customers. This includes creating interfaces that allow participants to examine information they need in the supply chain based on blockchain, and being able to trust what they are seeing, without needing to know the underlying technical complexities of blockchain (Schwab, 2017).

Startups such as blockgeeks.com, which is a blockchain media tech startup in Toronto, Canada, states: "Our mission as Blockgeeks is to teach over 10,000 developers a year in blockchain to accelerate the ecosystem." They are proposing to do most training online, and they are projecting that the demand for blockchain developers will increase rapidly over the next few years.

In the community space, there is Hyperledger (https://www.hyperledger.org), "an open source collaborative effort created to advance cross-industry blockchain technologies. It is a global collaboration, hosted by The Linux Foundation, including leaders in finance, banking, the Internet of Things (IoT), supply chain, manufacturing and technology." Hyperledger has recently released its first version of Hyperledger Fabric, a type of distributed ledger code that will allow corporations to begin building blockchain-based business applications.

Four critical features of a blockchain network are: (1) consensus, all parties to a transaction must agree that it is valid; (2) provenance, all parties to the transaction are aware of where the asset has come from and understand how it has changed over time; (3) immutability, once a transaction has been recorded to the ledger, none of the parties can tamper with it or change it (a separate transaction is required to remedy an error and both transactions are visible to members of the network); and (4) finality, there is only one place for anyone to check ownership of an asset or whether a transaction has been completed.

Trust still poses one of the biggest organizational barriers to blockchain adoption (Clancy, 2016). Customers and developers still must get accustomed to the idea that their supply chain data will not be in a central repository, but will be shared across the supply chain with a variety of entities who have a vital interest in the information that is accessible via the blockchain. Trust in the capabilities of participants is also key when implementing blockchain. Participants must be trusted to accurately and honestly enter transactions into the blockchain ledger.

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.

It is critical that everyone involved in the design of the database agrees on the value of the data and the cost of protecting it because securing data has costs as well as benefits. Risk assessment is an essential part of database planning.

An understanding of data storage requires a grasp of three realms: reality, data, and metadata. An entity is an 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 a process that transforms user views 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).

An 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 records.

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 (8) presenting the results to the user.

Denormalization is a process that transforms the logical data model 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 are organized around subjects. Data warehouses allow easy access via data mining software, called siftware, which searches for patterns and identifies relationships not imagined by human decision makers.

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.

Business intelligence (BI) is composed of features that gather and store data, as well as using knowledge management approaches combined with analysis. This becomes input to decision makers' decision-making processes. Business analytics (BA) refers to statistical tools and models to quantitatively process structured data like that found in data warehouses. This in turn is input for both humans and computers. When data sets become too large or too complex to handle with traditional tools or within traditional databases or data warehouses, they are often referred to as "big data." Data analytics use powerful algorithms to analyze vast amounts of structured data found in databases or to analyze huge quantities of unstructured real-time data that can support decision makers in making fact-based decisions.

A blockchain network is a data structure built on an Internet platform that permits creation of a digital ledger of data, which can be shared with others on a network that is either public or private. A blockchain is an open, unchangeable record of transactions. It is useful whenever a business or individual wants to possess a verifiable electronic record in order to track any kind of business asset. The biggest organizational barrier to participating in blockchain is trust—trust that the data are safe even though they are not in a central repository but shared across the supply chain with interested parties, and trust that the participants in the supply chain will enter transactions accurately and honestly.

Keywords and Phrases

attribute
big data
blockchain
bubble diagram
business analytics (BA)
business intelligence (BI)
clean data
concatenated key
conventional file
CRUD (create, read, update, and delete)
cyber attack
data analytics
data element
data item
data mining
data model diagram
data storage
data warehouse
database
database administrator
database management system (DBMS)
delete anomaly
denormalization
domain integrity
entity
entity integrity constraint
entity-relationship (E-R) diagram
entity subtype
first normal form (1NF)
hierarchical data structure
information retrieval
logical view
master file
network data structure
normalization
object identifier (OID)
online analytical processing (OLAP)
partial dependencies
physical view
primary key
qualitative data
quantitative data
reality, data, and metadata
record
referential integrity
relational data structure
relationship
repeating group
report file
retrieval
risk assessment
second normal form (2NF)
secondary key
security breach
special characters
table file
third normal form (3NF)
transaction file
transitive dependencies
unnormalized relation
update anomaly
work file

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. Explain the need for a relational database for PCs. What improvements has it seen over the years?
5. Give two examples of a primary key that can be used to identify a person or a thing.
6. What is the difference between a primary key and a secondary key?
7. Define the term *metadata*. What is the purpose of metadata?
8. Define relationships. List some examples of relationships that exist between entities.
9. What are E-R records?
10. What is an entity subtype?
11. List the different file types, their purpose, and their examples.
12. Explain the role of the logical and physical views of data in database design.
13. List the three steps used to normalize a relationship or a data structure.
14. List the three entity constraints. In a sentence, describe the meaning of each entity constraint.
15. Describe the four anomalies that may occur when creating database tables.
16. Explain with examples how a one-to-many relationship can be implemented in Web design.
17. List the guidelines for designing master files or database relations.
18. Define *denormalization*.
19. Explain the differences between traditional databases and data warehouses.
20. List the problems with data mining.
21. List five methods of analyzing business intelligence (BI).
22. What is big data?
23. Explain the analyst's role in data analytics.
24. What is a blockchain network? Provide an example from business.
25. What are the four critical features of a blockchain network? List them.

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 2017

Name: I. M. Smarte — Major: MIS

Student: 053-6929-24 — Status: Senior

Course Number	Course Title	Professor	Professor's Department	Grade
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 2017

Name: E. Z. Grayed Major: MIS

Student: 472-6124-59 Status: Senior

Course Number	Course Title	Professor	Professor's Department	Grade
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 gym has branches in three locations in a city. It has hired multiple trainers and maintains a daily schedule for them to adhere to. In addition, there is a schedule for the general staff responsible for administrative work. Customer details such as the programs they have opted for and their gym timings need to be recorded in a system. The system should be able to manage overdue payments and the entry and exit times of the customers. The gym equipment also needs to be maintained and the inventory managed. List the necessary assumptions for this situation.
8. List the tables and keys that are needed to implement the gym management system in Problem 7.
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 in Problem 9.
11. A bus operator transfers data every day from a handheld ticket machine to his agency's server at the end of his workday. The data contains trip details: journeys for the day, the number of tickets issued, total fare collected, passes availed, and so on. At the end of the day, the shift manager enters the trip number, the operator number, and the date in the server's trip management system to generate a report of totals for verification. Draw an E-R diagram for this situation considering only three entities: trips, operator, and fare.
12. Define the primary key used for each entity in Problem 11.
13. Swiftly is a logistics service provider that connects customers directly to product manufacturers and sellers. When consumers look for a certain product or product category on Swiftly, the site lists all available manufacturers and sellers along with different available prices in that category. The site also shows ratings and feedback from the seller based on past customer reviews. A customer picks a seller of their choice and places an order, and Swiftly ensures timely delivery of the product.
    a. Draw an E-R diagram in the third normal form showing the relationship between orders placed, manufacturers, sellers, and consumers at Swiftly.
    b. In a paragraph, discuss how a blockchain application might be implemented here and what it would require.
14. A hospital launches a package deal of immunization plans. A patient has to register with their details at the hospital to avail it. The hospital system fetches the latest immunization plan from the server and creates a specific schedule with due dates and the names of vaccinations customized for the patient. Assume that each patient registers only once. The hospital may update the plan intermittently with the latest available vaccines and create a new plan and schedule for the patient. Draw an E-R diagram linking the patient, the hospital, and the immunization plan. Try to normalize the diagram.
15. Identify the primary and foreign keys for the E-R diagram created in Problem 14.
16. Develop a list of questions to help you make a risk assessment of a database you are developing that keeps track of all patents applied for by a new electronics firm called ElectricEel, LLC. Write a list of five key questions you would like to ask executives, managers, and software engineers who are applying for patents of their work and who will use the database to store original plans for new smartphones, intelligent personal agents, and so on, and records of team meetings and data about customers and vendors.

17. CreativeCo, a Milan-based fashion design company in Italy run by business partners Justin and George, would like to use data analytics to understand their customers better through their database. In two paragraphs, discuss how you can help Justin and George approach the use of data analytics for this application. Include a list of six questions you will ask them about their needs for data.

Group Projects

1. A state transport agency has recently launched electronic ticketing machines (ETM) for fare collection and accurate auditing for its bus transport system. When a trip begins, the ETM machine number and the identification numbers of the conductor and the driver are transmitted to the agency's server and a unique number is generated for the trip. This number appears on all tickets, receipts, etc. for that trip. The conductor accesses different menus on the ETM to issue tickets, select the route, update the source location, and so on. The ETM also generates a status report, an end-of-shift report, and a fare collection report, which can all be used for future audits. The menus in the ETM also allows the operator to check and verify advanced reservations on the route. Describe how this electronic ticketing system works, stating your assumptions. Explain how the operator generates unique trip reports and verifies advanced reservations on the trip.

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14

Human–Computer Interaction and UX Design

LEARNING OBJECTIVES

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

1. Understand human–computer interaction (HCI).
2. Design useful touch screen interfaces for smartphones and tablets.
3. Design a variety of user interfaces.
4. Apply user experience (UX) design when developing customer-centered ecommerce website experiences.
5. Design effective onscreen dialogue for HCI.
6. Understand the importance of user feedback.
7. Articulate HCI implications for designing ecommerce websites.
8. Formulate queries that permit users to search the Web.

Your awareness of human–computer interaction (HCI) and its significance to your task as a systems analyst is important. The next step is to master the concepts surrounding HCI and become proficient at assessing human information requirements and incorporating your findings into your designs. Ensure that systems are user centered and appropriately include users' needs as well as organizational needs. Understanding HCI concepts, considering interfaces in the light of HCI issues, and applying standard design concepts to computers in new ways is central to an HCI approach.

User experience (UX) design is a customer-first method for designing software. It is a process that observes the behavior of customers and strives to enhance customer satisfaction and loyalty. It accomplishes this by improving usability and ease of use. UX is also a design culture that emphasizes a good experience for the user over maximizing short-term profit.

This chapter fills in some of the details about HCI and working with users and reveals the potential of UX design. It also gives you some experience in applying HCI and UX concepts in your design of human–computer interfaces for computers, smartphones, and tablets; feedback; ecommerce websites; 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).

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 (which could be screens, forms, interfaces, and the like), refine the design based on the suggested changes, and try 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. 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. They want to make the best possible use of people in designing a computerized task that is intended to meet an organization objective. Better fit results in better performance and greater overall well-being for the human involved in the system.

TASK 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, enterprise resource planning (ERP) systems, and wireless systems inside and outside the organization. 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.

PERFORMANCE The definition of the word *performance* in the HCI context is key; it refers to a combination of the efficiency involved in performing a task and the quality of the work produced by the task. For example, if analysts are creating data flow diagrams (DFDs) using high-level software or a computer-aided software engineering (CASE) tool with which they are proficient, the quality of the DFDs produced will be high. The performance is also efficient because 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 DFDs 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 unified modeling language (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 a human's 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 analysts are working in an environment in which 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 being valued monetarily by the employing organization.

Psychological attitudes (the affective component) are important. How users feel about themselves, their identities, their work life, and performance can all be gauged through assessing their

attitudes. Analysts taking an HCI perspective are concerned with how attitudes color the way humans feel about technology and their tasks, and whether their attitudes hinder or enhance their experience.

Usability

Usability is defined differently depending on which branch of science you are investigating. For our purposes in exploring usability through an HCI lens, we 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 thoroughly as possible. Usability studies (according to www.useit.com) are all about finding out what works in the world and what doesn't.

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 websites. 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.

Figure 14.1 shows a usability survey administered 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.

FIGURE 14.1

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.)

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 ____/____/_____

Human–Computer Interaction Factors	Very Poor		Average		Very Good
Physical/Safety Concerns					
1. How well were you able to read the display or form?	1	2	3	4	5
2. If audio was used, were you able to hear it?	1	2	3	4	5
3. Did you consider the system safe to use?	1	2	3	4	5
Usability Concerns How well did the system:					
4. Help you cut down on making errors?	1	2	3	4	5
5. Allow you to recover from an error if you made one?	1	2	3	4	5
6. Help you use it easily?	1	2	3	4	5
7. Help you remember how to use it?	1	2	3	4	5
8. Make it easy to learn how to use it?	1	2	3	4	5
Pleasing and Enjoyable Attributes					
9. Was the system attractive?	1	2	3	4	5
10. Was the system engaging (you wanted to use it)?	1	2	3	4	5
11. Do you trust it as a system?	1	2	3	4	5
12. Was it satisfying to use?	1	2	3	4	5
13. Was it enjoyable to use?	1	2	3	4	5
14. Was the system entertaining?	1	2	3	4	5
15. Was the system fun to use?	1	2	3	4	5
Usefulness Attributes How well did the system:					
16. Support your individual task or tasks?	1	2	3	4	5
17. Help you to extend your capabilities?	1	2	3	4	5
18. Make itself rewarding to use?	1	2	3	4	5
19. Permit you to do tasks that the other system would	1	2	3	4	5
not allow you to do?	1	2	3	4	5

Designing for the Cognitive Styles of Individual Users

One important consideration is that data, particularly data used for decision-making, need to be made available in different forms so 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.

PIVOT TABLES It is possible that the same person might want 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 allow users to arrange data in a table in any way they choose.

VISUALIZATION Visualization is the representation of data as a chart, graph, or other image. 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. Some charts are crammed with so much information that they become too complex for the average user. The consumer of information must be able to interpret the information in the diagram or it adds little value, so it is wise to use software to generate these charts and graphs.

Physical Considerations in HCI Design

In Chapters 11, 12, and 13 you learned the basis for sound design of screens, forms, websites, 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 this design, it is useful to look at human sensory capabilities and limitations that will inform the design. In keeping with the HCI philosophy, an analyst should be able to compensate, overcome, or replace human senses to a varying extent.

VISION Systems analysts become 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, analysts also think in terms of limitations on human vision. Factors such as 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 the International Organization for Standardization (ISO) and other national and international groups.

HEARING Humans have limits on 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 use a personal music player, but these solutions may have the effect of isolating a person from the organizational setting and may even diminish their capability to perform tasks. Analysts need to consider noise when designing office systems.

TOUCH When using an HCI perspective to evaluate the usefulness of keyboards and other input devices, systems analysts 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 a person doing data entry. Users know by the firmness of the key under their finger that the keystroke has been entered.

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 in a different order than numbers on a numeric keypad or a 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. 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. Systems designers 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, 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. Systems analysts are subject to the legal provisions of the country in which they are working. For instance, when designing for workplaces in the United States, you may want to check on the obligations of an employer on the Americans with Disabilities Act website.

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 people with disabilities are necessary, there are many sources to examine and many assistive devices to consider.

For people who lack certain perceptual sensitivity (incorrectly called color blindness), test the colors being chosen choosing for screens or forms to be 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 users who experience impaired hearing, make sure documents and screens include access to written versions of the audio material. Alternatively, design tasks in a way that headphones can be used successfully.

When designing computer tasks for those with limited mobility, think of speech input rather than keyboarding. In addition, 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 available who are involved in the practice of usability per se. 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 14.2 provides a list of guidelines for taking an HCI approach to systems design.

FIGURE 14.2

The HCI approach to systems design emphasizes the fit among human, computer, and task.

Guidelines for the HCI Approach to Systems Design

- Examine the task to be done and consider fit among human, computer, and task.
- Identify what obstacles exist for users in their attempts to accomplish their assigned tasks.
- Keep in mind perceived usefulness and perceived ease of use of technology.
- 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 gained beforehand to figure out the physical and organizational environmental characteristics. Design with prototyping to accommodate diverse users and users with disabilities.

CONSULTING OPPORTUNITY 14.1

School Spirit Comes in Many Sizes

Matt 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, hoodies, 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 listing 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 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 it may not be the best approach.

Consider the size of the schools because this may become the most important factor when determining how Matt Scott should adjust his ordering for St. David's, Hyde, and Pierce.

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*.

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.

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 by typing or speaking a sentence or special commands such as "Schedule an appointment on Wednesday at 1 P.M. with Karla Salguero in marketing." On an Apple iPhone, Siri is a voice-enabled interface that uses natural language. Alexa is a digital assistant used in devices such as Amazon's Echo, that can be voice activated. See the upcoming section on designing intelligent personal assistants for more on the use of 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. Wizards or software setup assistants 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 which drive to use to install the software on the system or answers questions about customizable features.

Menus

In using a 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 want to perform.

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 move users quickly through the program.

GUI menus are used to control software and have the following guidelines:

1. The main menu bar is always displayed either at the top of the application (Windows) or the top of the screen (Mac OS).
2. The main menu should have secondary options grouped into similar sets of features. For example, on a **Format** menu you can format a **Font, Paragraph, Document,** and so on. Each of these will be a secondary menu.
3. Menu items that are unavailable at this time should be grayed out to signify that they cannot be used at this 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."

Carrie says, "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 continues 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 paper medical insurance forms sent in by claimants.

Compare and contrast interfaces such as natural-language, question-and-answer, menus, and Web-based form-fill interfaces 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 these qualities. Is there more than one feasible choice? Why or why not? Respond in a paragraph.

An object menu, also called a pop-up menu or context 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 of them duplicate functions of main menu items.

Form-Fill Interfaces

Form-fill interfaces consist of onscreen forms or Web-based forms displaying fields that contain data items or parameters that need to be communicated to the user. Figure 14.3 shows widgets that can be useful in designing forms for iPads and iPhones using software called FormEntry by Widget Press, Inc. In this instance, the designer is creating a patient admission form using widgets to add a date picker.

Forms for display screens are set up to show what information should be input and where. Blank fields requiring information can be highlighted. The user moves the cursor from field to field by using a single stroke of an arrow or Tab key. This provides the user with good control over data entry. Web-based forms afford an 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

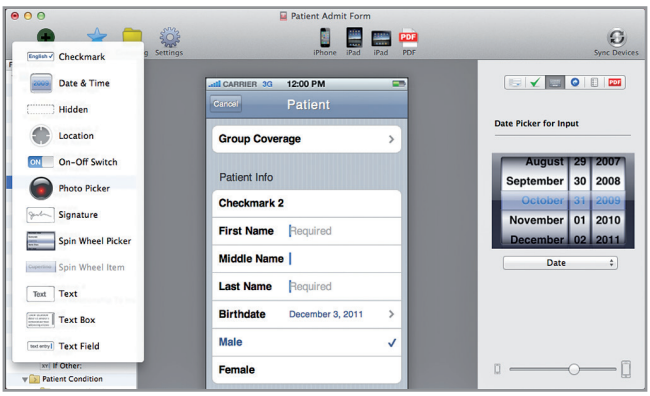


FIGURE 14.3

Many useful widgets for designing forms for iPads and iPhones are available to the designer in software called FormEntry for Mac by Widget Press, Inc. (Screenshot from "FormEntry." Copyright © 2012 by Widget Press, Inc. Reprinted by permission.)

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.

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 in red, and the user is required to complete the entry before moving on to the next Web page.

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, seven-day-a-week, worldwide basis.

Choosing and Evaluating Interfaces

When choosing and evaluating interfaces, keep these 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 errors are few and those that do occur are not occurring because of poor design.
4. The time 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.

UX Design

UX design is a customer-first method for designing software that observes the behavior of customers and strives to enhance customer satisfaction and loyalty. It accomplishes this by improving usability and ease of use, but it also understands the customer must enjoy interaction with the product.

There is a difference between user interface (UI or GUI) design and user experience (UX) design. UI involves designing for smooth interaction with emphasis on layout, menus, and buttons for input, and graphs, charts, and tables for output. UX designs are for users' requests and needs, human-centered flow, and, most important, usability.

There are many contrasts and comparisons between a traditional approach and a UX design approach. The top layer of Figure 14.4 shows how traditional designers *pull* strategic objectives from top management to guide information systems development. The designer works with the strategic objectives as outlined, formulates a design for the information systems, and then *pushes* that design to the user who is often in middle or operational levels of the organization. The bottom layer of the figure shows the user experience (UX) design approach. The designer interacts with users to gather their wants and needs, designs an information system after interacting with users and the proposed technology, then shares the resulting user objectives with management in the newly designed system.

Quality pioneer Joseph Juran said you could judge quality by whether a product can be used the way it was intended. This turns out to be at the heart of UX design. Usability means that a system is easy to understand, easy to use, and easy to appreciate. A few simple features, such as the ability for the user to save a password, might make the difference.

The UX designer considers these issues:

1. Have the user's needs been met without any complications?
2. Does the workflow proceed without requiring any extra or duplicate steps?

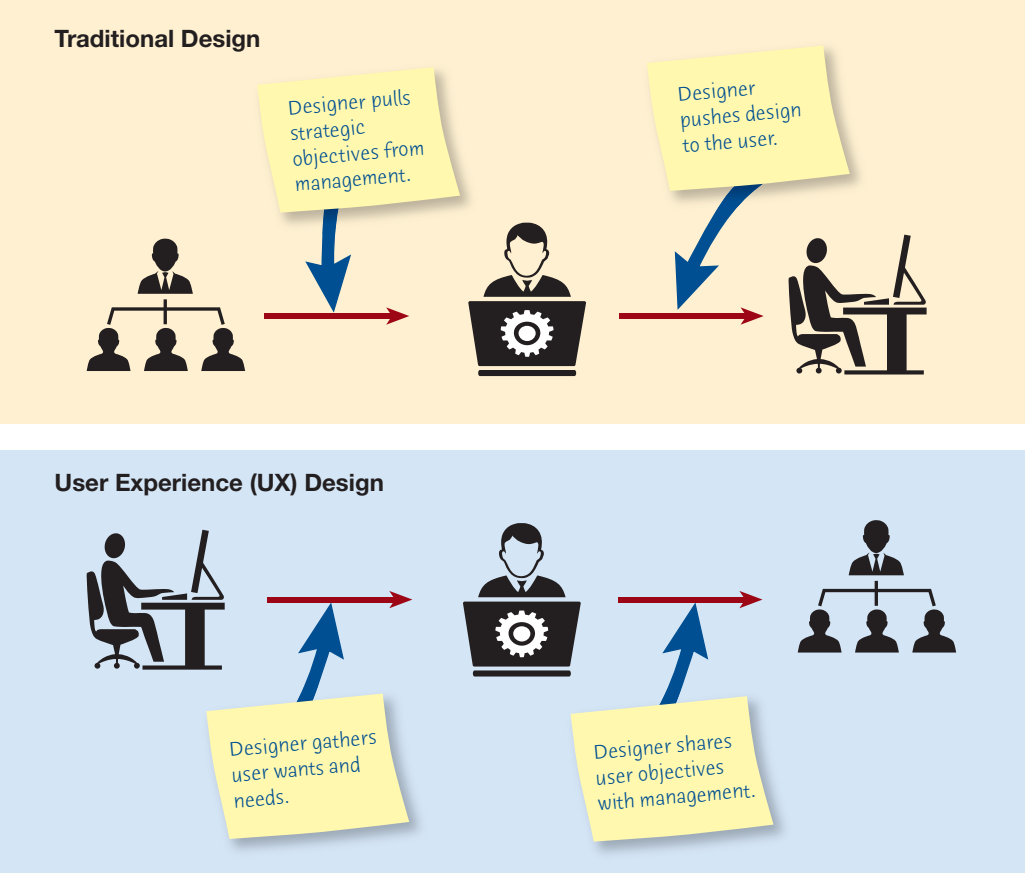


FIGURE 14.4

In traditional design, strategic objectives motivate the design effort, whereas in user experience (UX) design, the user motivates the design effort.

3. Is the user able to complete the task without being forced to recall something from an earlier step?
4. If the user makes a mistake, can it be corrected easily?
5. Is the interaction natural to the user?
6. Can the user be more efficient by using shortcuts?
7. Does the user feel in control of the system?

To design the user experience, a designer first has to know about people. Although the designer doesn't need a degree in psychology, the designer does need to have some knowledge about how people become motivated, what makes a person demonstrate loyalty, what makes a person happy, and how people make decisions.

In order to appreciate people more, the designer needs to gather information about people. This is covered more detail in Chapters 4 and 5, and it requires the analyst designer to master interactive and unobtrusive methods, including both quantitative and qualitative approaches.

When trying out new features or redesigning the site, prototypes prove to be extremely helpful in getting reactions from users. This subject is extensively covered in Chapter 6. New designs can start with a prototype. Even user reactions to a nonoperational prototype can elicit lots of information from the user.

Having a group of users walk through the current system is another way to gather useful information. If you ask the users to walk through a website and observe how easy or difficult it is for them to navigate the site, that is crucial information to their experience. If you ask users to use an app to perform a series of actions, it will show where the user stumbles, forgets, or gets frustrated.

When practicing UX design for websites, keep in mind the following 10 key adages listed in Figure 14.5. You will notice that each of the do's and don'ts encourage the designer to be observant of the user throughout the designed workflow and to be honest with the user in clearly delineating advertisements from actual content.

FIGURE 14.5

A list of do's and don'ts for practicing good UX design.

Do's and Don'ts of UX Design	
Do's	**Don'ts**
• Do create simple and stress free sign-ins • Do make the default choices user friendly • Do design to specs that describe the majority of users • Do provide a way out • Do keep your eye on users	• Don't masquerade ads as content • Don't block the user from seeing the content • Don't ask the user for too many permissions • Don't spring surprises at checkout • Don't stop testing

Five Designer Actions That Promote Good UX Design

DO CREATE SIMPLE AND STRESS FREE SIGN-INS Do not require something out of the ordinary. Although having a user sign in using Facebook may yield additional data about the person, the person may not want to give you that information. In the past, some games in the Apple App Store only notified users that a Facebook sign-in was required *after* they purchased the game. This was extremely rare, but the experience rattled many users who demanded their money back.

DO MAKE THE DEFAULT CHOICES USER FRIENDLY If you ask users whether they agree to send information back to the company, make the default "No." Observe all regulations in this regard as these can vary by country or region (for example, European Union rules versus guidelines from the United States). If you want users to have a good experience, don't trick them by making the default "Yes." Also, if you use colors, make sure green means "agree" or "yes" and red means "disagree" or "no." Also, countries or regions differ on whether companies must show users an "opt in" or an "opt out" option.

DO DESIGN TO SPECS THAT DESCRIBE THE MAJORITY OF YOUR USERS Don't assume your users have the latest hardware and software updates. Companies have gone out of business improving their product. They added features to the product, but assumed that users had the latest hardware. Users whose computers slowed to a crawl were disenchanted and removed the product from their systems forever. One bad experience can change the destiny of the company developing the app or system.

DO PROVIDE A WAY OUT If you decide on a subscription model, make sure users can easily get out of the agreement. Often a service will begin with a free 30-day trial, but collect credit card information as soon as the trial starts. Before users notice, they are into the second month. If you want to have a good user experience, warn them that their free trial is ending. If they continue, make sure they can stop their subscription easily. Consider giving them a link for ending the subscription when they first subscribe.

DO KEEP YOUR EYE ON USERS Users also change. They change their workflows, their preferences, and their hardware. Average users now looks at their smartphone 150 times a day, but in a few years wearable technology may change these patterns. UX design is user-centered, so above all keep monitoring your users and deliver a positive user experience.

Let's turn now to five actions that UX designers should avoid so they do not frustrate or thwart users as they learn and continue to work with software applications. Keeping users at the center of UX design and properly empathizing with users who must learn new software will help you avoid these design don'ts.

Five Designer Actions to Avoid in UX Design

DON'T MASQUERADE ADS AS CONTENT Interspersed between paragraphs on a website, there are often links that appear to lead to descriptions of products, other articles, or an offer to obtain more detail about a subject. Many of these are links to ads. The user feels deceived.

DON'T BLOCK THE USER FROM SEEING THE CONTENT A number of news sources block users after they have viewed a certain number of news stories per month, but that doesn't lead to a satisfying experience. Even worse, some websites force users to disable an ad blocker before proceeding. We all can understand that websites need to sell ads to be profitable, but websites will have a difficult time attracting new users if they present the user with a bad experience.

DON'T ASK THE USER FOR TOO MANY PERMISSIONS Asking users if they want to receive notifications as soon as they enter the site is unfriendly. Also, asking users to have access to the camera or their address book (or contacts) is poor design as well. If there is a legitimate reason for having access to the camera or address book, explain it at the outset.

DON'T SPRING SURPRISES AT CHECKOUT It is easy to find bargains on the Internet. Some companies will add unexpected costs or fees at checkout. These bad surprises can be extra shipping costs. If the item purchased is a service, or tickets for a concert to be held at the box office, "transaction fees" might be applied. Transactions will not be completed at this point if the user learns about unanticipated costs that are unreasonable or unforeseen. One online food delivery service in our area changed the default charge to include giving a driver an 18 percent tip. Because drivers do not do the same things servers in restaurants do, the delivery company upset many of its customers.

DON'T STOP TESTING Operating systems change. Make sure you keep up with the changes. If you allow information to be exchanged with other applications, make sure they still work.

We all realize that the company providing the website or application needs to make a profit or needs to deliver a message. Even so, when you adopt the principles of UX design, make sure users have a good experience. Avoid making users feel uncomfortable or awkward; instead, make them feel satisfied that they spent their time wisely in using the website or app.

UX Design Guidelines: An Ecommerce Example

Here are some good practices derived from UX design principles that can help in designing a successful ecommerce transaction:

1. Explain the shipping costs early and make them easy to discover. Allow users to see the types of shipping options (UPS, FedEx, and so on) and their typical costs before they check out. Include a dedicated tab so users can see how long shipping takes and the available choices.
2. Update the prices in a *Save for Later* area dynamically and provide a note to users. A change in price (either up or down) can remind users to act. Updates keep users engaged, reminds them they have merchandise saved in a cart, and spur them to action.
3. Allow customers to remove items from their shopping cart or bag and to easily change the quantities of items in the cart. Several small buttons or drop-down lists can facilitate these actions. The addition of a button that says *Edit* allows ecommerce customers to change their order (choosing a different size or color, for example), a button that says *Remove* allows them to take it out of their shopping cart, and a miniature drop-down list next to the item in the cart labeled *Quantity* can let them change the quantity ordered incrementally, to add or subtract items without going back into the original page that displayed the item.
4. Clearly indicate credit card fees and transaction fees. It should be clear to the customer how much the transaction would cost (certain credit cards or payment options may be more expensive than others). Also, if there are handling fees for any services, such as holding concert tickets at the Box Office, that should be noted as well.
5. Allow customers to continue shopping or proceed to checkout after an item has been placed in the shopping cart or bag. Once customers have added an item to their cart or bag, two options should be offered using two separate buttons: one that says *Continue Shopping*, another that says *Proceed to Checkout*. If these two choices are too stark, the developer can add buttons for *Save for Later* or *Add to Wish List*.
6. As customers move to the next page during *Checkout*, and before they enter payment information, remind them of the transaction details. For example, for an online purchase of live event tickets, this reminder can include date and time of the concert, the artist performing, the quantity of tickets, their location, and cost. For purchase of clothing or other items, this screen should provide a summary of a shopping bag or cart (a list of items and total costs). Some shopping carts show a thumbnail of the item being ordered as well. Consider adding

a 24/7 chat option to answer any questions prior to checkout so that the purchase will be completed. If a human is unavailable around the clock, you can develop a chatbot using one of several toolkits available, or even scale up to a hybrid that combines people and a bot, combining a high level of artificial intelligence (AI) (Heckstall, 2017).

Benefits of UX Design

If you base your design of ecommerce transactions on UX design practices, there are many benefits to gain:

1. **Tasks can be completed more quickly by the customer.** The organization of the ecommerce site will appear logical to the user, it will flow well, and the customer will be able to follow the flow of the process from browsing items, to selecting them, placing items in a cart or bag, returning to the website to make additional selections, exploring shipping and payment costs, to checking out with printable receipts, clearly posted return policies, and notifications of expected delivery dates.
2. **More tasks can be completed in a given amount of customer time.** At a website designed from a UX design perspective, the tasks to be accomplished online can be arranged efficiently, so customers needing an expedited checkout are supported (suppose a sale ends at midnight and they are still shopping at 11:55 P.M.) as well as those who want to take a more leisurely approach by comparing items and prices they have added to their shopping bag or cart over the course of a few days.
3. **Task results can be more accurate.** Customers will be prompted for information in the expected order, with some nonsensitive account information capable of automatically repopulating during checkout, so there is little room for transcription errors to creep into the transaction.
4. **Less support is needed to address user complaints arising out of a poor user experience.** Using UX design principles for ecommerce transactions means that the user is at the center of the online shopping experience. UX designers develop many different scenarios and paths through the website, all of which can end in a successful purchase. Having examined what can go wrong with the user experience and having sought remedies beforehand, poor user experiences become rare. The organization is free to devote more time to maintaining customer relationships and less time unraveling problems arising out of dissatisfaction with the user experience.
5. **Users will complete the transaction rather than abandoning their cart and leaving the site.** Designers have an opportunity to develop experiences that support the completion of the transaction in a satisfactory way, supporting numerous paths through the website and making checkout an option on every page. One encouragement to purchase added to a shopping bag can express a reminder similar in tone to the Nordstrom shopping bag message that states: *Popular items sell out fast. Adding an item here doesn't hold it, so get what you love before it's gone*.
6. **Customers will remain loyal and not seek other websites or software.** If customers have a good user experience, they are likely to return for multiple visits. The interface is familiar and logical, checking out is efficient and pleasant, the customer is recognized, and the customer has an account that can auto-fill many pieces of information to speed up checkout on the personalized pages. Many customers avoid setting up accounts on new sites and would far prefer to return to known sites that offer great user experiences.
7. **The user will be more satisfied with the overall experience.** UX design means that the customer is at the center of the website or software development. Looking at the ecommerce transaction through a customer's eyes helps developers create an experience that is satisfactory from the start of the sign on all the way to purchase and even through to merchandise arrival and possible return.

Designing Interfaces for Smartphones and Tablets

Smartphones and tablets open up a new creative approach for designers. Touch-sensitive screens allow a user to use a finger to activate the display. The operating systems for these small devices use multitouch gestures (capacitive sensing featuring screens controlled with a human finger or

a conductive stylus) for moving from one screen to another or from one state to another on the same screen. An example of the latter is enlarging a photo by flicking your fingers outward.

Gestures

Some gestures are basic. All humans start poking at objects before they know what a computer is; nudging and poking are inherent. It is also intuitive to swipe your finger from right to left when you need to turn a page when reading English, for example.

Using a pinching gesture to zoom in and out to shrink or enlarge a photo or to zoom in and out on a map is not intuitive. Once people learn it, however, they remember it. Somehow it makes sense to people.

Designers can take advantage of the fact that people easily adapt to new interfaces if they make sense. When you choose existing gestures or design new gestures for an app you are developing, make sure it is based on how most people prefer to use the gesture. Chances are that they won't think exactly like you. You have thought about the gesture; they have not. They may not discover a designed gesture on their own.

On a desktop, arrow keys are used to go from one screen to the next, and using a scroll bar is the common way to get to the bottom of a news story on the Web. On smartphones and tablets, a swipe may be more logical when going from left to right and a tug may be the preferred way to look down further at an article or a list.

When a designer creates new nonstandard gestures, problems can occur. Suppose that a user has other apps that use a swipe from left to right as a copy command, and you develop a calculator app where a swipe from left to right clears the display. A user who owns an app that regularly requires the copy gesture will likely be upset by your adoption of the gesture for something different (and potentially destructive of data). You just lost a customer.

Then there is the temptation to take advantage of the latest techniques without really thinking through what the user would like to actually do. One example of this is the use of a motion detector that detects motion in three dimensions, called an accelerometer, to change something in the app by shaking the smartphone. Shaking is incorporated into apps for games, seismometers, pedometers, and apps that give biofeedback. In those contexts the designer has made a choice that makes sense to the user.

Remember, however, that shaking is not an obvious or innate gesture. Although many users adapted to shaking their iPhone, fewer users wanted to shake their iPad. The size of the platform and the context of the app mattered. Also, shaking the iPhone may look odd at the office or on public transportation. If a designer still feels that shaking is highly useful for some apps, the designer should add an option for users uncomfortable with it. Pressing part of a screen or a button is subtle. Shaking is not.

Designers need to think about the metaphor before programming a gesture simply because it exists. Urbanspoon (an app that located and recommended restaurants) introduced an app that allowed the user to randomly select a restaurant, using the metaphor of spinning a slot machine; however, some users might not think the gambling metaphor adequately reflects their quest for fine dining.

Remember, too, that every gesture needs to provide the user with feedback. If the user tugs and nothing more is in the list, it needs to appear obvious to the user that he or she has reached the end of the list. If the user turns a page, the designer should show motion so that the user understands that the page is turning. Feedback is discussed in the section "Feedback for Users."

In Chapter 11, we discussed designing for both portrait and landscape modes. Make sure that the gestures are the same for both orientations.

Alerts, Notices, and Queries

Alerts, notices, and queries are forms of output on smartphones and tablets. An alert is useful if a severe thunderstorm is approaching, but if the user's phone is on during a theatre performance, the user may be asked to leave. Alerts can include a sound, but remember that they do not need to do so to still be helpful.

Alerts are for critical information that the user needs to know in a timely manner. It is not a good idea to use an alert to tell the user that signal strength is low, for instance. That's what the signal bars are for.

Notifications convey information to a user. Some of that information, such as the notification that an update to the app is ready, may not be urgently important. In this context it breaks the user's concentration, so a notification such as an update might be best kept as part of the app launch process but not used as an alert.

Some developers like to include queries such as "Would you like to rate this app today?" This makes the designer seem less professional, and by including it you could annoy the very people you are trying to please.

Always give the user a chance to opt out. Many users just do not want to be notified with information or alerts. Users can change their notification settings in the "Settings" area at any time, but it's nice if they have a chance to opt out during the first launch of the app.

Badges

Another feature of smartphones and tablets is the ability to put "badges" on home screen icons. On the iPhone and iPad, these are little red circles that appear to be affixed to the icon for the app. A badge for the App Store signifies how many updates are waiting for the user to download and install. Some weather apps use a badge to display the current temperature.

Badges are good because they are an unobtrusive way to send a message to the user. They are quiet and passive, not loud and active like alerts and notifications. One problem is that they are ignored; another is that they may be outdated. (For example, the temperature displayed as a badge on your weather app may indicate the last time you opened the app sometime last week, not the temperature for today.) So unless you have something meaningful to convey, try to avoid using a badge.

Design for Intelligent Personal Assistants

Intelligent personal assistants, also known as virtual assistants, are software agents that can accept commands written or spoken from users and perform tasks based on that input. They are not to be confused with personal digital assistants, which are hardware devices that were popular before introduction of the more capable smartphones.

Familiar intelligent personal assistants are Siri (from Apple), Google Assistant, Amazon Alexa, and Microsoft Cortana. In 2012 Apple introduced Siri, billed as your personal assistant that "helps you get things done, just by asking." A user can speak to Siri in natural language, just as he or she would talk to a friend. Unlike older voice recognition systems, Siri does not need to be taught to respond to your voice commands.

Intelligent personal assistants have been available on smartphones for some time, but usage increased with the introduction of smart speakers that are connected to smartphones or computers via Bluetooth or Wi-Fi. Intelligent personal assistants can be found on desktops, smartwatches, Facebook messenger, in cars and appliances, and even in apps (such as "Dom," the personal assistant within Domino's Pizza app). Intelligent personal assistants can recognize natural language voice commands and answer questions. Some of the tasks they can perform are listed in Figure 14.6.

Developers can design for intelligent personal assistants using platforms such as Apple's SiriKit, Actions on Google, or Amazon Lex. It is expected that intelligent personal assistants will continue to learn by using machine learning and other AI techniques.

FIGURE 14.6

Developers need to be aware of the many different tasks an intelligent personal assistant can do.

Some tasks an intelligent personal assistant can perform		
Make phone calls	Search the Internet	Provide driving instructions
Change the room temperature	Set reminders and alarms	Music playback
Stream podcasts	Order food deliveries	Manage email
Change device settings	Take a picture	Lock/unlock doors
Get information about movies that are playing	Interact with home automation systems	Provide traffic, weather, and news reports

Developing simple actions using application program interfaces (APIs) is not that difficult. Complex actions will take some time to develop and must be continually maintained. It is therefore a strategic decision whether a company should design for use by intelligent personal assistants. Questions that need to be asked are:

1. Will the adoption of an intelligent personal assistant be consistent with our strategic objectives?
2. Will use of an intelligent personal assistant give our customers a better experience?
3. Will use of an intelligent personal assistant expand our customer base?
4. Which platform is most appropriate for our users?
5. Which voice should speak for our brand?
6. Can we develop our voice interface in-house or do we need to outsource it to those more skilled in designing voice interfaces?

Before the development team jumps in and starts developing an interface with an intelligent personal assistant, these questions need to be addressed. The six questions posed in the list above are all business-oriented questions. "Which platform is most appropriate for our users?" will have technical considerations, but a company first has to decide whether company values are consistent with hosting the intelligent personal assistant. For example, one intelligent personal assistant was recently scrutinized for privacy concerns. If customers do not trust the intelligent personal assistant, would they trust your company and its use of that intelligent personal assistant?

The question "Which voice speaks for your brand?" can be rephrased "What should your company representative sound like?" Should it be a male or female voice? Should its voice be recognized as originating from a certain country or region? Should it use youthful pronunciation and slang terminology? Should it explain everything or assume the user is knowledgeable and experienced? Much needs to be decided, and this requires input from executives, technical staff, customers, and potential customers before proceeding with a company relationship with an intelligent personal assistant.

Designing for Virtual Reality and Augmented Reality

Virtual reality (VR) is an artificial, totally computer-generated world. The user interacts with this artificial world and in doing so is completely immersed in the experience through vision and hearing.

Augmented reality (AR) combines artificial elements with the real world. A developer creates images that appear to be realistic 3-D objects that can blend into the real world. The images exist in layers and allow the user to interact with the artificial objects.

The uses of VR and AR are numerous. With VR, a developer may design a simulation that can be used for what-if analysis. In the event of a large forest fire, for example, during the VR simulation decisions can be changed to reveal different strategies and their results. With AR, apps can be designed to help the user decorate an office, locate a place to eat with their coworkers, or practice navigating to a new client's office in an unfamiliar city. Figure 14.7 shows how a user can use the camera of a smartphone to get a view of the neighborhood and then request a list of nearby restaurants. These restaurants pop-up on the smartphone screen, indicating their location, their distance from the user, and even a food rating from 1 to 5 stars.

In designing for VR, the developer needs to realize that hardware advances will place a burden on the development team trying to maintain and update the app. VR hardware is currently relatively expensive. The application design must be of very high quality, but even then, the number of potential adoptions needs to be considered before launching into a project. AR hardware tends to be less expensive, and it can be successfully used on mobile devices such as smartphones and tablets.

Guidelines for Dialogue Design

A dialogue is the communication between a computer and a person. Well-designed dialogue makes it easier for people to use a computer and lessens their frustration with a computer system. There are several key points for designing good dialogue. They include the following:

FIGURE 14.7

A designer may add information to the image from a smartphone camera in real time, making this augmented reality experience more valuable to the user. (Adam Hoglund/Shutterstock)

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

A system should clearly present information 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 (GUI) 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. Websites must display more text and instructions to guide the user through the site. Intranet sites may have less dialogue because there is a measure of control over how well trained users are. Graphics used on externally facing Websites should have pop-up text or rollover 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 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 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 machine side of communication is that the computer should understand what the user has entered. Hence, all data entered on the screen should be checked for validity.

Minimal User Action

Keying is often the slowest part of a computer system, and good dialogue will minimize the number of keystrokes required. You can accomplish this goal in a number of 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 because the code is stored as a value of the drop-down list; it also provides meaningful communication because descriptions 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 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 website; 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, websites are an exception to this rule because 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 for a telephone number.
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 a dialogue 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 or another key. Figure 14.8 shows an example of nested pull-down menus.
7. **Using 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. **Providing cursor control for Web forms and other displays so 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: the cursor moves to the local phone number field following entry of the first three characters. Entering software registration key codes is another example. The codes are often in groups of four or five letters, the cursor moves to the next field when the first field is filled, 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.

CONSULTING OPPORTUNITY 14.4

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."

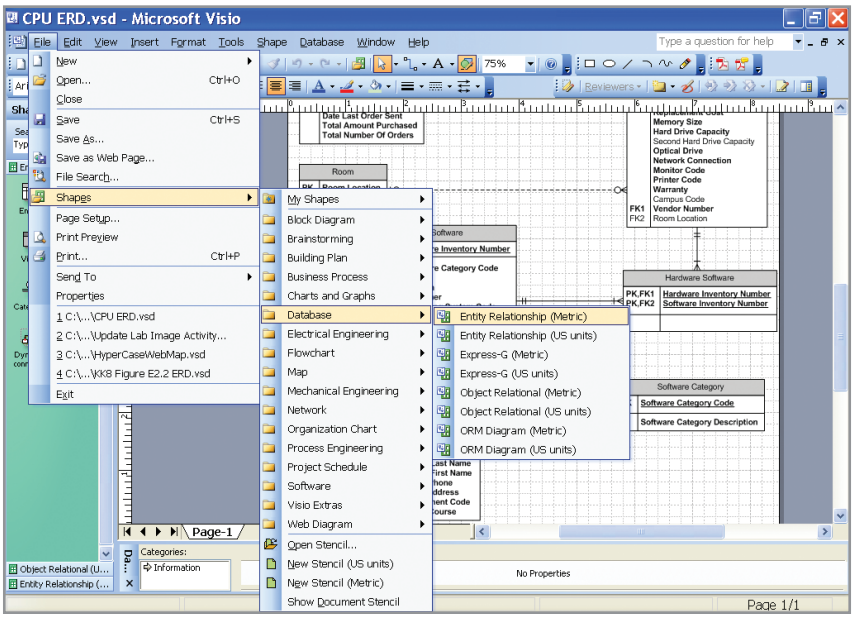
You are talking with Owen Itt, who is telling you about the sales unit's recent purchase of new software for its networked PCs that allows the input of sales data for each of its 16 salespeople, provides output showing comparison data for them, and projects future sales based on past sales records.

"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 open 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. They have a phone line, but 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 for designing good displays. Draw a prototype of the displays you think are necessary to address the problems Owen lists.

FIGURE 14.8

Example of nested pull-down menus with shortcut keys from Microsoft Visio Professional.



Standard Operation and Consistency

A system should be consistent throughout its 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 using 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 GUI.
7. Using consistent terminology in a display screen or website.
8. Providing a consistent way to navigate through the dialogue.
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 the 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 often can be used. For example, displaying an hourglass while the system is processing encourages the user to wait a while rather than repeatedly pressing keys to get a response.

Types of Feedback

Feedback to a user from a 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. Websites 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. Figure 14.9 provides some examples for each type 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 this message: "Your payment has been processed. Your confirmation number is 1234567. Thank you for your payment."

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." That message takes extra space, is cryptic,

Type of Feedback	Sample Feedback Response
Acknowledging acceptance of input	"Your payment has been processed."
Recognizing that input is in the correct form	An LED-like display turns from red to green.
Notifying that input is not in the correct form	"The telephone number should be separated by dashes (-)."
Explaining a delay in processing	An hourglass or a rotating circle.
Acknowledging that a request is completed	"You successfully renewed your membership. Thank you."
Notifying that a request was not completed	"Your attempt was not successful. Please try at a later time."
Offering the user more detailed feedback	"Your credit card was not charged. You must enter a valid expiry date. Press help if you need more information."

FIGURE 14.9

Feedback can take many forms.

and does nothing to encourage the input of more data. When placing an order on the Web or making an online 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. If a user enters a phone number incorrectly, the software or website needs to let the user know that. 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. An 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 because poor coding may put the browser into a loop, and the user will have to shut down the browser.

Additional feedback that tells the user that the input is not in the correct form might be to not permit the user to advance to the next field or screen, along with an appropriate pop-up message explaining what is wrong and supplying instructions on how to correct it.

Audio also has been used to inform a user that something was entered incorrectly, but audio feedback alone is not very descriptive, so it is not as helpful to users as onscreen instructions. Use audio feedback sparingly, perhaps to denote urgent situations. The same advice applies to the design of websites, 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.

When new software is being installed, a short tutorial on the new application may be run during delays, which is meant to serve as a distraction rather than feedback about the installation. A list of files that are being copied and a status bar often are used to reassure the user that the system is functioning properly. Web browsers usually display the Web pages that are being loaded and the time remaining.

ACKNOWLEDGING THAT A REQUEST IS COMPLETED Users need to know when their request has been completed and new requests may be input. A specific feedback message may be 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 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 go back and check to see whether 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. However, this convention is in widespread 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 user 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 memo they are word writing in Microsoft Word.

Besides building help into an application, software manufacturers offer online help (either automated or personalized with live chat or chatbots) or help lines (most customer service telephone lines are not toll free, however). Some commercial off-the-shelf (COTS) software manufacturers offer an email contact page where users can fill out a form stating the problem they are experiencing, and they will be emailed or phoned back, or a live chat will be opened to address the technical problem.

Finally, users can seek and find support from other users through software forums. This type of support is, of course, unofficial, and the information obtained may be true, partially true, or misleading. Approach any software fixes posted on bulletin boards, blogs, discussion groups, or chat rooms with wariness and skepticism. The principles regarding the use of software forums are the same as those for folklore and recommendation systems discussed in Chapter 16.

Besides informal help on software, vendor websites 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 support forums, blogs, and websites for useful programs that can be downloaded. Programs will forage vendor websites for the latest updates, inform the user of them, assist with downloads, and 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 websites. A few extra considerations discussed in this section can give your Web interface designs improved functionality.

Soliciting Feedback from Ecommerce Website Customers

You need to give users feedback about what is happening with an order, but you need to elicit feedback as well. Most ecommerce websites 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 the company.

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. These businesses lose valuable feedback, allow customers to harbor the impression that they are communicating, and engender ill will when they provide no response. If you design this type of feedback opportunity, you also need to design procedures for the organization to reply to email from the website. 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 website 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

CONSULTING OPPORTUNITY 14.5

When You Run a Marathon, It Helps to Know Where You're Going

Marathon Vitamin Shops was successful in getting its website 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 each type of customer would enjoy using the website. (See Consulting Opportunity 1.1 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 website. 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 website is projected at the front of the room. "The website 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 on the Web. 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 website.

"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 Bing Maps,"

Vita Ming, another member of the original systems development team, speaks up enthusiastically, saying, "We know of a couple good social media sites we can link to and chat rooms we can add to our website. 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 LiveChat," 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 a different city for an example. Some of those city websites use Google to search for information."

After listening intently, Bill speaks up. "Medical information could also be useful," he says. "I've noticed that some websites show medical news from Acquire Media. 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 website?" Ginger asks. "I notice that a company called Thomson Reuters 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 have been 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 social media links
- Blogs by users and also those written by Marathon Vitamin employees
- Search engines
- Medical information (preventive medicine and medical breakthroughs)
- Newsfeeds and financial markets information

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, an 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

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 and 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 (that is, 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.

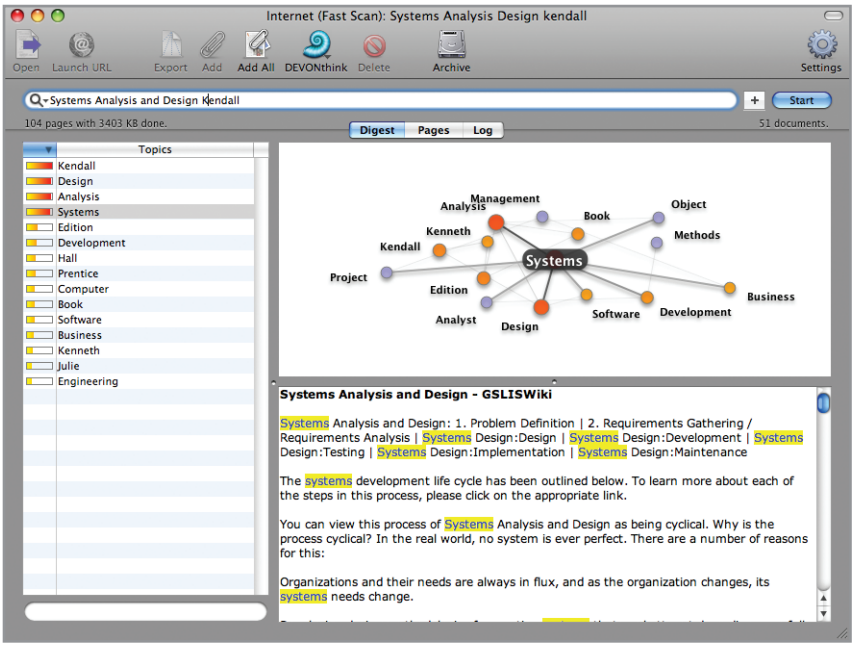


FIGURE 14.MAC

DEVONagent from DEVONtechnologies. (Screenshot from DEVONagent. Copyright © by DEVONtechnologies. Reprinted by permission.)

that makes it more likely that the company will be capable of spotting important trends (perhaps using data analytics) in customer response rather than simply reacting to individual queries.

Easy Navigation for Ecommerce Websites

Ecommerce websites are commonly designed to have "intuitive navigation." Users need to know how to navigate a site without having to learn a new interface and without having to explore every inch of the website before they can find what they want. The standard for this type of navigational approach is called one-click navigation.

You can add four enhancements to design easy, one-click navigation for an ecommerce site: (1) create a roll-over menu, (2) build a collection of hierarchical links so the home page becomes an outline of the key topic headings associated with the website, (3) place a site map on the home

page and emphasize the link to it (place this on every page on the site), and (4) place 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.

ROLL-OVER MENUS A roll-over menu (or roll-over button) can be created with cascading style sheets (CSS) with JavaScript and HTML divisions. The rollover menu appears when the customer using the website 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.

NAVIGATION BAR 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. Consider 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 website designer would incorporate many different ways to look up information on a particular subject. Figure 14.10 shows a Web page from DinoTech. A user interested in an international IT career can find information from the DinoTech website in three different ways. If the user is interested in working in Argentina, he or she can click on the Argentine flag, click on the name of the country, or click on the map representing Argentina.

Designing a website 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. They all add to the usability of a website.

FIGURE 14.10

A Web page that allows users to navigate to the desired page in different ways.

The main priority in navigation, however, is to 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 site. The main concern is keeping customers on the website. The longer customers are on the site, the greater the chance that they will purchase something. If users navigate to a link in the website, make sure they can easily find their way back. Doing these things will ensure the stickiness of the website. Do not create any barriers to the customer who wants to return to the client's website.

As detailed in Chapter 12 on *Designing Effective Input*, recall that analysts can use standard navigational elements and icons such as a hamburger icon or menu, context-sensitive help, input validation, a breadcrumb trail, and fat footers to give their Web designs a professional look that users can readily understand and navigate.

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 website that creates an entirely new application.

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 website, so customers can simply enter their zip or postal code and let the mashup display the location of the nearest retail store. Blipstar works on mobile devices.

Mashups are becoming a popular way to present information. Expect to see many useful mashup applications already in use. Look for them at www.programmableweb.com.

Designing Queries

When users ask questions of, or communicate with, a database, they are said to *query* it. Six different types of queries are among the most common. Your careful attention to query design can 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 14.11 illustrates all six query types.

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

$$V \longleftarrow (E, A)$$

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 2017?

can be stated more specifically as

What is the value of the attribute YEAR-2017 for the entity EMPLOYEE NUMBER 73712?

FIGURE 14.11

It is possible to perform six basic types of queries on a table that contains entities, attributes, and values.

The years are the attributes.

EARNINGS-HISTORY

EMPLOYEE NUMBER	EMPLOYEE NAME	DEPARTMENT	S/H	YEAR-2014	YEAR-2015	YEAR-2016	YEAR-2017
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
89760	Acquia	Accounting	H	38,755	40,040	41,380	42,540

The employee numbers are the entities.

The salaries are the values.

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 2017?

The notation for query type 2 is

$$E \longleftarrow (V, A)$$

In this case, three employees made more than $50,000, so the response will be a list 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-2014, YEAR-2015, YEAR-2016, YEAR-2017} have a value > 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

$$A \longleftarrow (V, E)$$

In this example, Waters (employee number 72845) made over $50,000 for two years. Therefore, the response will be year 2015 and year 2017. 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

$$\text{all } V \longleftarrow (E, \text{all } A)$$

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

$$\text{all } E \longleftarrow (V, \text{all } A)$$

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

$$\text{all } A \longleftarrow (V, \text{all } E)$$

The response will be YEAR-2015, YEAR-2016, and YEAR-2017. 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 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)

FIGURE 14.12

Arithmetic, comparative, and Boolean operators are processed in a hierarchical order of precedence unless parentheses are used.

Type	Level	Symbol
Arithmetic Operators	1 2 3	* * * / + −
Comparative Operators	4	GT LT EQ NE GE LE
Boolean Operators	5 6	AND OR

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 14.12.

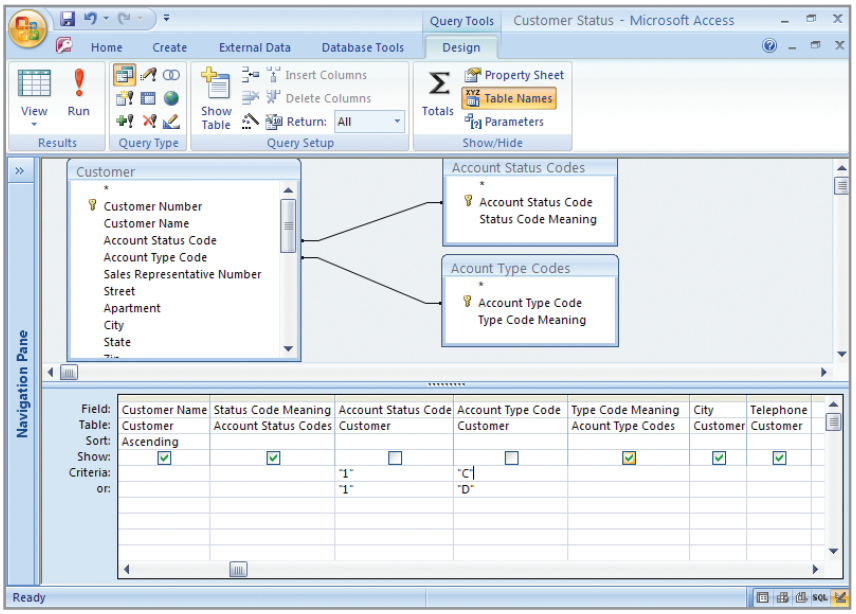
Query Methods

Two popular query languages are query by example (QBE) and structured query language (SQL).

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 entered either 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 14.13 is an example of a query using

FIGURE 14.13

Query by example using Microsoft Access.



CONSULTING OPPORTUNITY 14.6

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 hyperlinked 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

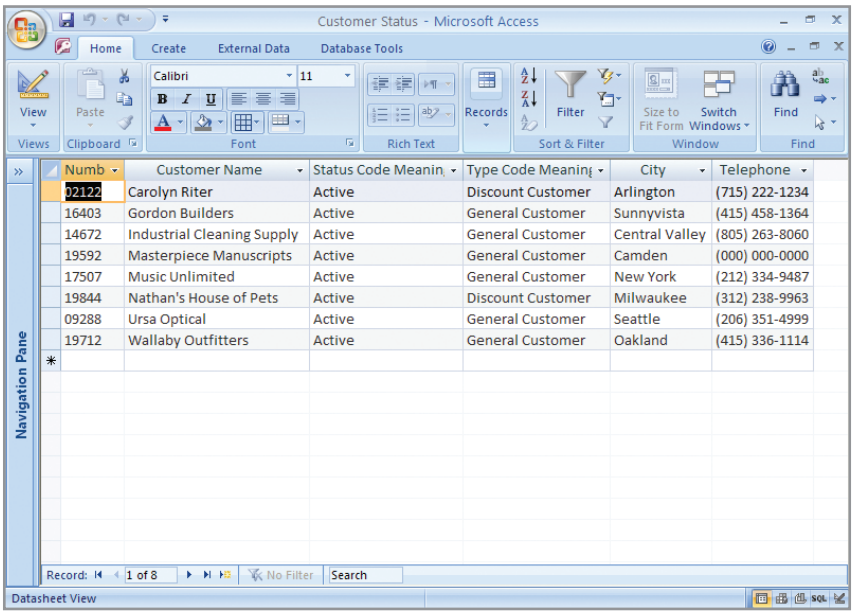
A portion of the database from Merman's Costume Rental shop.

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

FIGURE 14.14

A query by example for CUSTOMER STATUS yields these results.



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

the 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 *1* 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 represent 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 14.14. 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 language for implementing queries. It uses a series of words and commands to select the rows and columns that should be displayed in the resulting table. Figure 14.15 contains SQL code. The SELECT DISTINCT ROW 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.

FIGURE 14.15

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] & "*")));
```

HYPERCASE EXPERIENCE 14

"I have no problem with using a mouse or any other rodent you throw my way. Really, though, whatever Mr. Evans 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 simple commands 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 because she wants to see if what you're doing could be applicable to ecommerce systems. Mr. Evans 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 for the training group using a CASE tool, such as Visible Analyst, a software package such as Microsoft Access, or paper layout forms. 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 in a concluding paragraph.
4. Design a user interface for the users of the B2B ecommerce systems Melanie Corazón described using a CASE tool, such as Visible Analyst, a software package such as Microsoft Access, or paper layout forms.. 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 Heatherford the usability expert consultant for MRE might have with the interfaces you designed.

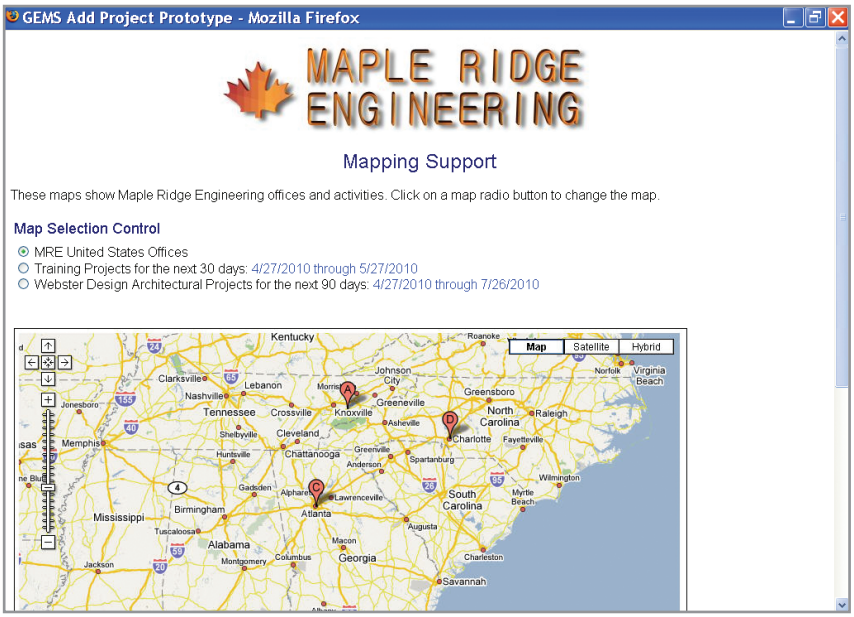


FIGURE 14.HC1

In HyperCase, you can see how users process information to create a more effective user interface.

Summary

In this chapter, we examined human–computer interaction (HCI), a variety of interfaces, designing the user interface, We also introduced User Experience (UX) design, developing multitouch gestures to interface with smartphones and tablets, designing user feedback, and designing ecommerce website 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.

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.

UX design was discussed as a customer-first method for designing software. UX is an abbreviation for "user experience." It is a process that observes the behavior of customers and strives to enhance customer satisfaction and loyalty. It accomplishes this by improving usability and ease of use, but it also recognizes that users must enjoy interacting with a software product or system. UX is also a design culture, which chooses to give the user a good experience over maximizing short-term profit. The seven benefits of using UX design for ecommerce transactions include (1) tasks can be completed more quickly by the customer, (2) more tasks can be completed in a given amount of customer time, (3) tasks results can be more accurate, (4) less support is needed to address user complaints arising out of poor user experience, (5) users will complete the transaction rather than abandoning their cart and leaving the site, (6) customers will remain loyal and not seek other websites or software, and (7) the user will be more satisfied with the overall experience.

This chapter also provided some experience in applying HCI to help in your design of human–computer interfaces for computers, smartphones, and tablets; feedback; ecommerce websites; and Web queries. The Web has posed new challenges for designers because the user is not known.

Creative opportunities for developers to design multitouch gestures for interfacing with touch-sensitive (capacitive-sensing) smartphones and tablets are increasing. Some conventions should be observed, users should be able to learn the interface quickly, and gestures should make sense to users. Developers can include alerts, notices, and queries for smartphones and tablets but should always offer an opt-out option to them. Using badges is an unobtrusive way to provide additional information to users, but badges should be used with caution so that they don't rely on user interaction to display accurate information.

Users' need for feedback from a system is 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 websites by eliciting customer feedback through automatic email feedback buttons or by including blank feedback forms on the website. Four important navigation design strategies improve the stickiness of ecommerce websites: (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. QBE and SQL are two common languages for querying database systems.

Keywords and Phrases

accelerometer
alerts
application programming interface (API)
augmented reality (AR)
badges
Boolean operators
capacitive sensing
cognitive considerations of HCI
continuous speech system
dialogue box
disabilities and design
feedback
feedback for users
fit
form-fill interfaces
gestures
graphical user interface (GUI)
intelligent personal assistants
intuitive navigation
mashup
menu
multitouch gestures
natural-language interface
navigation bar
nested menus
notices
one-click navigation
performance

physical considerations of HCI
psychological considerations of HCI
pull-down menu
query
query by example (QBE)
question-and-answer interface
rollover menu
site map
smartphone
speech recognition and synthesis
stickiness
structured query language (SQL)
stylus
tablet
task
template
touch screen
touch-sensitive screen
usability
UX design (user experience design)
virtual assistants
virtual reality (VR)
Web-based form-fill interface
voice recognition

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 context?
5. List two ways in which data can be made available to a decision maker in different forms according to their cognitive needs.
6. List three physical considerations that HCI design addresses.
7. List three ways analysts can improve task or interface design to help a person who is visually impaired, hearing impaired, or mobility impaired, respectively.
8. What are the five objectives for designing user interfaces?
9. Define *natural-language interface*. What is the major drawback of these interfaces?
10. Explain what is meant by question-and-answer interfaces. To what kind of users are they best suited?
11. Describe how users use onscreen menus.
12. List the guidelines for designing a GUI menu.
13. Discuss how forms can be set up for display screens. How are they simplified?
14. What are the advantages of Web-based fill-in forms?
15. List the types of menus and the user tasks that they perform.
16. Define *graphical user interface*.
17. Explain the difference between user interface design and user experience design.
18. List the design issues that a UX designer should consider.
19. List some methods of gathering information that can be used in a UX design approach.
20. Describe the variety of help options available to a systems user.
21. List some practices derived from UX design principles that can help in designing successful ecommerce transactions.
22. How do metaphors and feedback tie into the use of gestures in effective interface design?
23. List some features of badges in smartphones.
24. How do alerts and notifications play different roles in the interface design of smartphones and tablets?
25. Why is it a good idea to avoid the use of a badge on apps?
26. List four familiar intelligent personal assistants.
27. List some tasks that an intelligent personal assistant can perform.
28. What are the differences between designing for AR and designing for VR?
29. List the business-oriented questions that a company needs to address before they decide on the development of an intelligent personal assistant.
30. What are the three guidelines for designing good screen dialogue?
31. What are the roles of icons, graphics, and colors in providing feedback?
32. List eight ways to achieve the goal of minimal operator action when designing a user interface.
33. List five standards that can aid in evaluating user interfaces.
34. Explain the use of text and icons for feedback.
35. Explain the need for consistency in display design. Discuss ways in which a designer can achieve consistency.
36. List five Do's for practicing good UX design. List five Don'ts for practicing good UX design.
37. What are the seven benefits of using UX design for ecommerce transactions?
38. What are the seven situations that require feedback for users?

39. What is a suitable way of telling a user that input was accepted?
40. 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?
41. List four ways to notify a Web user that input is not in the correct form.
42. Why is it unacceptable to notify the user that input is **not** correct solely through the use of audible beeping or buzzing?
43. When a request is not completed, what feedback should be provided to the user?
44. Describe two types of website designs for eliciting feedback from customers.
45. What is the standard for "intuitive navigation" approach in the design of ecommerce websites? List some examples of how user navigation can be made flexible.
46. List five navigational options that use standard icons or elements that the designer can add to an ecommerce website to improve navigation and understanding.
47. List the popular query languages.
48. Describe what a mashup is.
49. 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 the Philadelphia suburbs. He wants to make sure that the HCI 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 check-out hotel reservation system that can be used internationally. Use numbers to select a menu item. Show how each menu would look on a computer display for a desktop system.
2. A multispecialty hospital requires its patients to be registered either through newly launched kiosks on the premises or through its website. After registration, the patient receives a unique "patientID" that can be used for all future transactions. Discuss the kind of interface that would be the most useful in such a situation. Decide on a system that ensures clear feedback for patients, such as, for example, a notification for successful registration.
3. Design an interface for the situation in Problem 2.
   a. Discuss issues that you considered.
   b. How would you ensure that user action is minimized in the interface design? Would an intelligent personal assistant be suitable here? How?
4. A UK-based travel agent, Euan Morton, LLC, would like your systems team to design a smartphone and tablet app he can give away free to his clients for booking seats for airlines with 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 smartphone display.
   b. Make a list of gestures to include for users to activate the display to book an airline seat and write down what each gesture does.
5. A store manager wants to effectively manage more than 100 members of the staff during the peak sale season, for which she plans to use a graphical user interface depicting different store areas, queues at billing counters, etc. Icons for phone calls, files, queues, reserve staff, and others are to be included in the design. Draw a representation of how the elements would appear on the manager's display screen.
6. Josh and Colleen, a celebrity chef couple and restaurant owners from Cherry Hill, New Jersey, want to be able to receive clear feedback on the systems used to manage food inventory at their four "farm to table" restaurants in Cherry Hill, New Jersey; Philadelphia, and Horsham, Pennsylvania; and New York City. Design a display that provides appropriate feedback for a user whose daily update reports on locally available produce has been successfully sent to the chefs.
7. Design a screen for a payroll software package that displays information telling Josh and Colleen (Problem 6) how to get more detailed feedback when viewing weekly and monthly payroll figures.
8. Design a Web-based display that shows an acceptable way to tell Josh and Colleen (Problem 6) that input to their system was accepted.
9. Using UX design, design three pages of an ecommerce website where Josh and Colleen's devoted restaurant customers (also known as foodies) (Problem 6) can purchase their cookbook, reserve spots in cooking and butchering breakdown classes with Josh, and purchase freshly prepared desserts that can be shipped to residential customers in the Northeast United States with one-day shipping.
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. The website FoodZone is a platform to connect consumers with food vendors operating in their city. A customer can search for a either a specific vendor or a food type and place an order through the website. Discuss the role of navigation in such a Web design and the different navigation options available to enhance it. At the same time, discuss how the stickiness of the website can be ensured.
13. Suggest query types for the auditor of a travel agency who needs data on the maximum and minimum fares collected every day, organized according to trips and bus operators. The data should include information on all trips with reservations and comparison of trip collection over the previous week.

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
   Change employee
   Delete employee
   Employee inquiry
   Position inquiry
   Employer inquiry
   Add employer
   Change employer
   Delete employer
   Match employee to opening
   Print open positions report
   Print successful matches report
   Add position
   Change position to upgrade required skills
   Delete position
2. In a paragraph, describe the problems your group faced in creating the menu in Group Problem 1.
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: (*Hint:* If you are unsure about the meaning of any of the applications, research them briefly on the Web before devising an answer.)

   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. Smartphone calendar (Chapter 3)
   g. Illustration in a drawing package
   h. CASE tool for developing data dictionaries (Chapter 8)
   i. Decision tree drawing program (Chapter 9)
   j. Website for collecting consumer opinions on new products (Chapter 11)
   k. Organizing bookmarks for websites

   For each solution your group designs, draw the display and show movement by using an arrow.
4. In a group, discuss how you can create an educational mashup of concepts that will help students learn the analysis of specific systems and design topics. Think of all the possible links, forms, graphics, text, icons, videos, soundtracks, and more that you can use in the mashup. Search online for tools that would allow you to create an actual digital mashup. Prepare a summary of your findings.
5. Look at the following mashup websites and describe how each one of them adds value by providing a service:

   a. Real estate information, www.housingmaps.com
   b. Twitter mashup, www.trendsmap.com
   c. Songs mashup, www. songdna.me
   d. A U.S. government data mashup, www.thisweknow.org
6. Compare the industrial use of QBE and SQL.

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15

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 websites.

Making sure users are able to enter data into a system accurately is of utmost importance. It is by now axiomatic that the quality of data input determines the quality of information output. A 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 human data entry by cutting down on the sheer quantity of data and thus the time required to enter the information.

When users enter data efficiently, data entry meets 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 assurance of data quality through validation procedures are all data entry objectives covered in this chapter.

Effective Coding

Data can be entered more accurately and efficiently through the knowledgeable use 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 a 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 also can help in the appropriate sorting of data at a later point in the data transformation process. In addition, coded data saves valuable memory and storage space. Coding is a way of being eloquent but succinct in capturing data. In addition to 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
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 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 multiple times. 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. For example, consider 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.

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

Code	Explanation of Code
68506KND7533TVG	99999XXX9999XXX Abbreviation of magazine Four digits of street address First three consonants in last name First five digits of zip code

FIGURE 15.2

Identifying the account of a magazine subscriber with an alphabetic derivation code.

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.

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. Using them is 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

Code	Tax-Deductible Item
I	**I**nterest Payments
M	**M**edical Payments
T	**T**axes
C	**C**ontributions
D	**D**ues
S	**S**upplies

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.

Code	Tax-Deductible Item
I	Interest Payments
M	Medical Payments
T	Taxes
C	Contributions
D	Dues
S	Supplies
S	Subscriptions
C	Computer
I	Insurance
M	Miscellaneous
B	Subscriptions
P	Computer
N	Insurance

These duplicate codes . . .

. . . are corrected by "forcing" the codes to fit.

for items such as interest, medical payments, contributions, and so on. The coding system is simple; use 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 previously used. 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 graphical user interface (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.

FIGURE 15.5

Using a block sequence code to group similar software.

Code	Name of Software Package	Type
100	Apple Safari	Browser
101	Mozilla Firefox	
102	Microsoft Internet Explorer	
103	Google Chrome	
.		
.		
.		
200	Microsoft Access	Database
201	MySQL	
202	Oracle	
.		
.		
.		
300	Adobe Dreamweaver	Web design
301	Freeway Pro	
302	BlueGriffon	

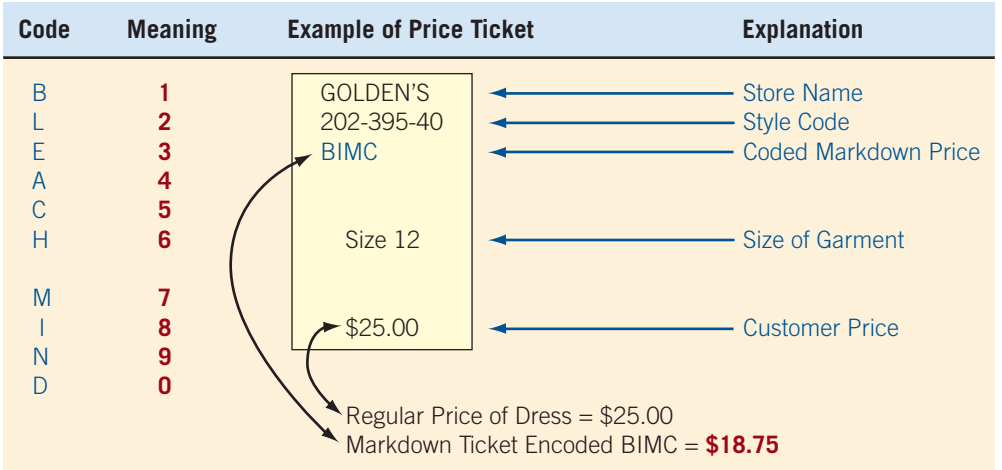


FIGURE 15.6

Encoding markdown prices with a cipher code is a way of concealing price information from customers.

Concealing Information

You can use codes to conceal or disguise information you do not wish others to know. There are many reasons a business user may want to do this. 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 shows 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 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.

To the casual observer or customer, the item description appears to be one long number. A salesperson knows, however, that 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.

FIGURE 15.7

Using a significant-digit subset code helps employees locate items belonging to a particular department.

Code	Merchandise Described	Explanation of Code
2023954010	Red maternity dress, style 395, size 10	202 — 395 — 40 — 10 202: Department (Maternity) 395: Product (Dress Style 395) 40: Color (Red) 10: Size (Size 10)
4142191912	Beige winter coat, style 219, size 12	414 — 219 — 19 — 12 414: Department (Winter Coats) 219: Product (Coat Style 219) 19: Color (Beige) 12: Size (Size 12)

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'-ïk) is a human memory aid. Any code that helps either a data entry person remember how to enter the data or a 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

FIGURE 15.8

Mnemonic codes function as memory aids by using a meaningful combination of letters and numbers.

Code	City Hospitals
BGH	**B**uffalo **G**eneral **H**ospital
ROS	**Ros**well Park Memorial Institute
KEN	**Ken**more Mercy
DEA	**Dea**coness Hospital
SIS	**Sis**ters of Charity
STF	**S**aint **F**rancis Hospital
STJ	**S**aint **J**oseph's Hospital
OLV	**O**ur **L**ady of **V**ictory 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 a computer must perform.

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, and Hebrew, do not use the Western alphabet. These languages may use Greek letters or glyphs or symbols representing syllables or whole words. The International Organization for Standardization (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 こにち&#x308F. In Japanese, the word looks like this:

こにちわ

ko ni chi wa

hello

The Unicode characters are grouped by language and may be found at www.unicode.org.

Requesting Appropriate Action

Codes are often needed to instruct either a computer or a 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 an analyst or a programmer desires a 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

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 service person in the office can tell the customer, 'It's a coonskin (Coo) cap for boys (m for male) ages 5–9 with a fake fur 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.

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 9 trillion customers. Because the numbers are not assigned sequentially, chances of guessing a credit card number are very slight.

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.

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

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

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.

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.

It is important to make sure 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 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.

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	L0S 1J0	Niagara-on-the-Lake, Ontario	Zero and Oh look alike S looks like a 5 1 looks like an I

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 orders. 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.

ALLOW FOR MODIFICATION OF CODES Adaptability is a key feature of a good code. An 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. An 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.

Effective and Efficient Data Capture

To ensure the quality of data users enter into a system, it is important to capture data effectively. Data capture has received increasing 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 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, a systems analyst must take advantage of what computers do best. For the advertising agency ordering office supplies, it is not necessary for the operator entering the stationary 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 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 have to be cataloged only 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.

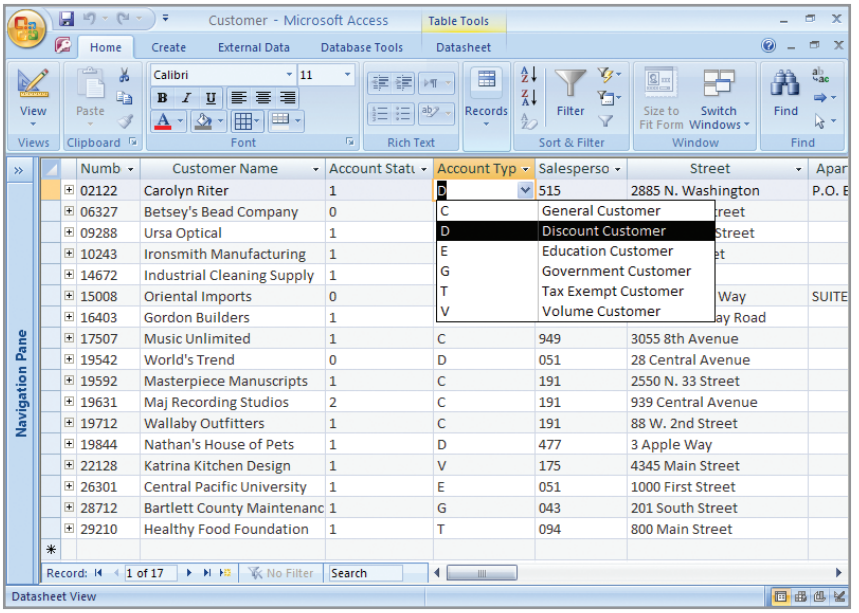
The calculating power of the computer should be taken into account when deciding what *not* to reenter. Computers are adept at long calculations, using data already entered. For example, a person doing data entry may enter the flight numbers and account number of an air trip taken by a customer belonging 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 also may 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, 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 for easy updating.

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 displays both the code and the code meaning. This method helps to ensure accuracy because

FIGURE 15.13

A table of codes used in a drop-down list shown in Microsoft Access. This list is used to select a code for adding or changing an item in a record.



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 data being entered. One way a bottleneck can be avoided is by ensuring that there is enough capacity to handle the data 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. Beyond the obvious consideration of saved labor, avoiding extra steps is 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. A 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 12 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 organization members are most familiar. Some improvements have been made over the years to improve keyboards. Features include special function keys to open programs, keys used to

One-Dimensional UPC Code	0 12345 67890 5
Two-Dimensional QR Code	

FIGURE 15.14

Examples of one-dimensional and two-dimensional bar codes.

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.

BAR CODES Bar codes typically appear on product labels, and 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. Many bar-coded labels include information for a particular product: the manufacturer identification number, the product identification number, a code to verify the scan's accuracy (such as a check-digit), and codes to mark the beginning and end of the scan.

Bar codes can be thought of as metacodes, or codes encoding codes, because they appear as a series of bars or objects that encodes numbers or letters. These symbols in turn have access to product data stored in computer memory. Until recently, scanners were needed to read linear codes, or one-dimensional codes, but today the camera in mobile phones or the camera built into your iMac can read universal product codes (UPCs). An inexpensive app such as Delicious Library (www.delicious-monster.com) can be used to scan one-dimensional bar codes and create a database of all of your movies, music, books, software, or games.

Matrix bar code squares are two-dimensional bar codes. They are still optical, machine-readable codes, and they take up much less space than the older linear bar codes. They are cheaper than RFID tags (discussed in an upcoming section) and can appear in print. There are more than 30 different versions of these bar codes in existence. These different codes are known generally as 2D bar codes. Both types of bar code are shown in Figure 15.14. Users can get apps for their mobile phones that will read these codes and direct them to their respective Web pages.

QR CODES Quick Response (QR) codes were first created in 1994 by DENSO WAVE, a Toyota subsidiary at that time. QR codes have been used in Japan and South Korea for some time. They are beginning to show up in the United States now and have the potential of becoming the dominant 2D bar code in the world.

A QR code is easily identifiable by the position marker (which looks like three nested squares) that appears in three of its corners. QR codes are completely free as the license holder has chosen not to exercise his rights.

2D code readers feature a couple of codes, but all (with the exception of the Microsoft Tag reader, explained in a later section) are likely to be able to read a QR code. You can easily find more QR creators.

Rutgers Law School is a leading national school for legal education. The Rutgers Camden Information Technology Department development team generates QR codes for all school events and electronically sends them to the school's digital signage system. Each code provides the user with a link to the event's Web page, giving users a way to easily view event data, register for an event, and add the event to a mobile calendar.

FIGURE 15.15

Two-dimensional bar codes can be used in many ways.

QR Codes Can
• Take you to a specific Web page
• Find the item you want for purchase at a lower price
• Initiate an email, SMS text message, or make a phone call
• Find and capture a digital coupon
• Use a digital coupon
• Tell you more about the art gallery painting you are gazing at
• Get you information about the time and place of an event
• Show you a promotional video for a movie, play, or concert
• Allow you to view or extend the amount of money on a transit card

QR codes are being placed outside student study rooms as well, allowing students to self-schedule reservations and activate video recording capabilities. Study room recordings of practice sessions are then sent to the student's mobile device and can be viewed instantly. QR codes can be used in imaginative ways. Figure 15.15 lists some ideas.

There are many advantages to incorporating 2D codes in your designs. Almost everyone in business already owns and uses a device (such as a smartphone) that can read different types of bar codes. The 2D codes are either nonproprietary or free. Bar coding affords an extraordinarily high degree of accuracy for data entry. Furthermore, 2D codes can be generated easily by using a Web-based creator or a stand-alone app.

One of the disadvantages of 2D codes is the ease with which a printed code can be stickered over or tampered with. There is growing concern that users of smartphones are vulnerable to malicious attacks launched when an unsuspecting user scans QR codes indiscriminately without checking whether the QR code is a genuine, authorized one. Some QR scanners such as Norton Snap have built in security that permit Android or iOS users to scan a code and find out instantly if it is malicious or will cause users to go to a malicious website before it is loaded into the user's browser. Unfortunately, many users and even designers are unaware of the potential risks of bar codes, which means you must remain vigilant regarding what websites the QR code is directing users to

RFID Radio frequency identification (RFID) allows the automatic collection of data. It uses RFID tags or transponders, each of which contains 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, and 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 cents per tag) and are typically the size of a postage stamp. They are used in large retail stores, including Walmart and Target. Walmart has been actively pursuing RFID technology in improving its inventory management and supply chain processes. RFID tags can be used to transmit data to a blockchain that securely stores, shares, and updates a supply chain.

Active tags are much more reliable than passive ones because they have their own power supply. The U.S. Department of Defense has used these tags to minimize logistics costs and to increase supply chain visibility. Active tags cost a few dollars each.

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 and 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 tollbooth. The tollbooth's RFID reader also can act as a writer to store a balance on the RFID chip.

The Moscow Metro was the first transportation system to use RFID smartcards in 1998. Other applications include tracking cattle to identify the herd of origin, which enables better tracking of mad cow disease, and RFID tracking in bookstores, airline baggage services, pharmaceuticals, and even tracking 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 UPCs because their advantages include security (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 using a credit card or a shoppers' card could be identifiable with such a system.

A systems analyst needs to think of the users involved and their rights when considering whether this technology is suited for an application.

NEAR FIELD COMMUNICATION Another approach to inputting data is near field communication (NFC), which builds upon RFID. NFC allows two-way communication and is used in contactless payment systems at checkout counters and other venues. Customers simply use a smartphone such as an Android with Android Pay or an Apple device (such as an Apple watch) to touch or come close to the point-of-sale device to establish radio communications.

NFC can be used for payment on transportation systems, to exchange information (such as a schedule or map), receive custom coupons, or exchange business cards. It is considered secure because of its short range of communication and the complexity of its security layers.

OPTICAL CHARACTER RECOGNITION Optical character recognition (OCR) lets a user read input from a source document (handwritten or printed) 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 percent 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-fraught 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. (Note that although faxes have been replaced by many other input and output technologies they are still stubbornly dispersed throughout businesses such as private medical offices and even fast food delivery restaurants, so they still are serving a purpose in many small businesses.)

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.

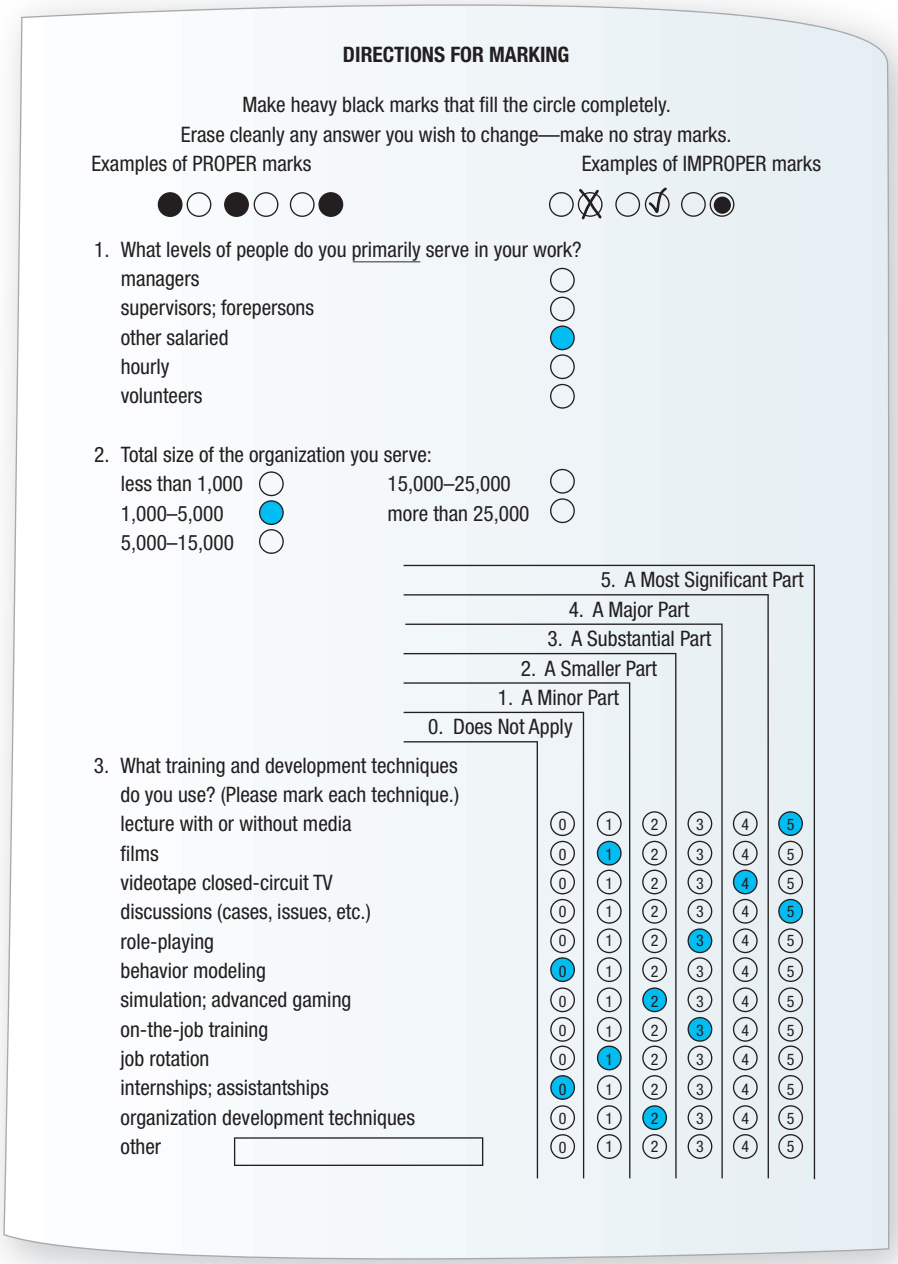
Some advantages of using MICR are that (1) it is a reliable and high-speed method not susceptible to accepting stray marks (because they are not encoded magnetically); (2) if it is required on all withdrawal checks, it serves as a security measure against bad checks; and (3) data entry personnel can see the numbers making up the code if it is necessary to verify the account number and check number.

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 response sheets for questionnaires, as shown in Figure 15.16. Little training of entry personnel is necessary, and a high volume of forms can be processed quickly.

One drawback of mark-sense forms is that readers can determine whether a mark has been made but cannot interpret the mark in the way optical character readers do. Stray marks on forms can be entered as incorrect data. In addition, choices are limited to the answers provided on the mark-sense form, forms have difficulty 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.

FIGURE 15.16

A mark-sense form that can be read by a scanner speeds data entry.



DIRECTIONS FOR MARKING

Make heavy black marks that fill the circle completely.
Erase cleanly any answer you wish to change—make no stray marks.

Examples of PROPER marks — Examples of IMPROPER marks

1. What levels of people do you primarily serve in your work?
   - managers
   - supervisors; forepersons
   - other salaried
   - hourly
   - volunteers

2. Total size of the organization you serve:
   - less than 1,000
   - 1,000–5,000
   - 5,000–15,000
   - 15,000–25,000
   - more than 25,000

3. What training and development techniques do you use? (Please mark each technique.)

	0. Does Not Apply	1. A Minor Part	2. A Smaller Part	3. A Substantial Part	4. A Major Part	5. A Most Significant Part
lecture with or without media	0	1	2	3	4	5
films	0	1	2	3	4	5
videotape closed-circuit TV	0	1	2	3	4	5
discussions (cases, issues, etc.)	0	1	2	3	4	5
role-playing	0	1	2	3	4	5
behavior modeling	0	1	2	3	4	5
simulation; advanced gaming	0	1	2	3	4	5
on-the-job training	0	1	2	3	4	5
job rotation	0	1	2	3	4	5
internships; assistantships	0	1	2	3	4	5
organization development techniques	0	1	2	3	4	5
other	0	1	2	3	4	5

Ensuring Data Quality through Input Validation

So far we have discussed ensuring the effective capture 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, 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 15.17.

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 part of a small cottage industry that manufactures imaginative toy villages for children seven years old and up. Our tiny hamlets consist of various kits that will build whatever 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 and Puerto Rico. 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.

Validating Input Transactions

Validating input transactions is largely done through software, which is a programmer's responsibility, but it is important that a 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, an unauthorized person submitting data, 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.

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

FIGURE 15.17

Validating input is important to ensure that most potential problems with data are eliminated early.

AN UNAUTHORIZED PERSON SUBMITTING DATA A system should 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 input data themselves, along with the transactions requested, be valid. Several tests can be incorporated into software to ensure this validity. In the following subsections, we consider a number of 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. A 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 REASONABLENESS Validity tests for range or reasonableness are really commonsense 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 were 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. Suppose the part number 53411 needed to be typed into the system. While that is being entered, different types of errors can occur. One possible error is a mis-keying a single digit; for example, the clerk types in 54411 instead of 53411. A second type of error is a transposed digit; it commonly occurs when the intended number 53411 gets typed in as number 54311 just because two keys are pressed in reverse order. Transposition errors are difficult for humans to detect.

The procedure for using a check digit 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. A well-known formula for check digits is the Luhn formula created in the 1960s. Credit card companies use it as described next.

VERIFYING CREDIT CARDS When credit cards are entered into a website or a 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, and American Express card numbers are 15 digits long.

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, the Luhn formula can be used. Suppose we are given a number 7-7-7-8-8-8, where 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 whether this is a valid number:

1. Double the second-last digit, then double every other digit (that is, 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: $5 + 7 + 5 + 8 + 7 + 8 = 40$.
4. Look at the total. If it ends in zero, the number is valid according to the Luhn formula. The number 40 ends in zero, so 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 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 digits) 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 tests for checking on validity of input can go a long way toward protecting a system from the entry and storage of erroneous data. As a systems analyst, you should always assume that 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 a 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 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 can 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.

Validating a single field usually is done with a series of IF . . . ELSE statements, but there are also pattern validation methods. These patterns can be 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 15.18 illustrates characters used in JavaScript regular expressions.

Here is an example of pattern validation used to test an email address:

```
[A-Za-z0-9]\w{2,}@[A-Za-z0-9]{3,}\.[A-Za-z]{3}/
```

FIGURE 15.18

These characters are used in regular expression (pattern) validation.

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

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: February 29 is valid only during leap years. Once single fields have been checked, cross-reference checks can be performed. Obviously, if one of the fields is incorrect, the cross-reference check is meaningless and should not be performed.

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 a date. A schema also checks a range of values, the number of digits to the left and right of a decimal point, and the values of codes. Free tools are available to validate a DTD or schema.

Data 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 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 still being entered via 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 at an ecommerce site, it may be stored on their own personal computers. Developers should use UX (user experience) design and should be especially attentive to creating a user experience that is functional and accurate for ecommerce transactions. If users visit ecommerce sites and fill out similar forms to complete a transaction, they will experience 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 is called autocomplete or autosuggestion.

Companies that want to store information to enable faster and more accurate transactions do so in small files called cookies. Once information is stored in a cookie, a website can suggest matches for credit card and password information as well, and this information is encrypted so websites cannot read the information stored on the user’s computer. 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 order fulfillment process. Hence, the information gathered to complete an order can 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

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 this time, I still enjoy the people I meet and what I do. Yes, I know Mr. Evans is 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 Mr. Evans 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 that 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.

manufacturer. It can be used again to send a printed paper catalog to the customer or to send a special offer by email as well.

These ecommerce enhancements replace the traditional approach of using a paper-based procurement process with purchase orders sent via mail or fax. This electronic process not only speeds up the delivery of the product but also increases accuracy, ensuring the product is delivered to the correct address. Rather than reading a mailed-in form or fax, 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, and is required when setting up a blockchain to share and secure supply chain information.

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. For example, suppose a customer mistakenly submits an order for pairs of jeans from Amazon, but was only intending to purchase one. After submitting the order, the customer receives an email from Amazon confirming the order. The customer notices the mistake, immediately goes back online, and has the order corrected, thereby avoiding having to return the extra pair of jeans. Accuracy is improved by better feedback.

Summary

Ensuring the quality of the data input to an 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 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 useful for concealing information that is sensitive or is restricted to employees.

Codes may be used to reveal information to users and to 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 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 consider input devices. Creating 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 speed data entry, improve data accuracy, and increase reliability. Quick response (QR) codes are becoming popular and efficient ways to direct users to information or to promotional websites. Many QR code scanner apps are available for smartphones, allowing users to interact easily with QR codes. RFID allows the automatic collection of data using RFID tags on products, people, or animals. They can improve inventory management and supply chain processes, and can support the use of blockchain technology.

Accurate data entry 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 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 experience (UX) design, 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
autocomplete feature
bar code
block sequence code
bottleneck
changeable
check digit
cipher code
classification code
coding
cookies
cross-reference test
differentiated
function code
keyboarding
Luhn formula
magnetic ink character recognition (MICR)
mark-sense form
mnemonic code
optical character recognition (OCR)
quick response (QR) code
radio frequency identification (RFID)
redundancy in input data
regular expression
self-validating code
significant-digit subset code
simple sequence code
supply chain management
test for class or composition
test for comparison with stored data
test for correct field length
test for invalid values
test for missing data
test for range or reasonableness
two-dimensional bar code
Unicode
validating input

Review Questions

1. What are the four primary objectives of data entry?
2. List the five general purposes for coding data.
3. List the disadvantages of the alphabetic derivation code.
4. When is it undesirable to use sequence codes?
5. Why are classifications necessary?

6. Define *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. What are mark-sense forms?
11. List eight general guidelines for proper coding.
12. What are changeable data?
13. What are differentiation data?
14. Explain how data redundancy can be removed in systems using graphical user interfaces.
15. How can extra steps be avoided in 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. What are the factors that shape the choice of data entry method?
20. What are the main functions of two-dimensional bar codes?
21. List the advantages and disadvantages of using 2D codes in systems design.
22. Define *RFID*. What are the differences between active and passive RFID tags?
23. Discuss how near field communication, magnetic ink character recognition, and optical character recognition can be used in data entry methods.
24. What are eight tests for validating input data?
25. When is a cross-reference check useful? When is it necessary to set up self-validating codes?
26. Explain the two ways in which XML documents can be validated.
27. Why is it necessary to test and validate the input data for reasonableness and composition?
28. How are codes stored in systems using a GUI screen?
29. List four improvements to data accuracy that transactions conducted over ecommerce websites can offer.
30. What is Unicode, and how is it used?
31. What is the process for validating data entered into fields?
32. What is a regular expression?

Problems

1. Savadove University, a small, highly selective private college specializing in graduate programs for the performing arts needs to keep track of the list of students who (a) apply, (b) are accepted, and (c) actually enroll in masters and doctoral programs at the university. For financial aid purposes, the university also must send a report to the federal student aid program to match with a list of students who receive loans but fail to register for a graduate program. Suggest a kind of code for this purpose, and give an example of its use for Savadove University that demonstrates its appropriateness. What are its advantages?
2. A firm has added a new feature to their website that allows sellers to manage their product portfolios themselves. Whenever the seller modifies an existing product or adds a new product, the system generates a new product ID by incrementing the one that already exists in the system for that seller. Explain the coding scheme that is being used here. How can this be a possible source of confusion for the sellers?
3. A software engineering company has developed a coding scheme for efficient performance appraisal of its employees. It contains code YYYYSPEC-REMP, where, for an employee, YYYY represents the year of joining, SPEC represents work specialization, R represents the performance rating, and EMP represents the three-digit employee number.
   a. What kind of code is used here? Describe the purpose behind each part of the code 1990PERT-A204.
   b. Construct a coded entry using the same format and logic for an employee with the employee number 116, who joined the firm in 1983, received a B rating, and specializes in mainframe computers.
   c. Construct a coded entry using the same format and logic for an employee who joined a few days back. Make your own assumptions. Discuss some possible limitations of this coding scheme in this scenario.
4. The data entry operators at Melanie Julian 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 that have been classified into two classes: fireproof and fire resistant? Respond in a paragraph.
d. Some of the materials coded in Problem 4a. above (natural wood siding, brick, shake shingles, and EZ color-lok enameled Masonite) are being used in innovative ways for scenic design for stage plays by some of the consultants for Melanie Julian Construction. Develop a code for the residential products you coded in 4b. above so consultants will recognize that they can be used on stage for scenic design as well.

5. A laboratory is planning to design a coding scheme for the payments it collects for all the tests it conducts on patients every day. As a systems analyst working with the lab, you are to include components in the payment coding based on the following considerations: The payments vary according to the customer categories—low-income groups, government employees, affiliated lab staff, general, emergency cases, and senior citizens. The lab tests should be categorized based on the collected sample—blood, urine, or stool. In addition, it should be categorized based on the affected body part and the likely treatment group, such as hematology, orthopedics, or oncology. All of these make up 26 major categories. The lab wants to have the month and year of the test included in the code for easier identification and analysis in future tests.
   a. Design a coding scheme listing the features that you used. Discuss whether there is a need for cipher codes.
   b. Which data capture technique would work best once the code is designed?
   c. Suggest some validation tests that you could use for this system, ensuring that only accurate data is captured by the new system coding scheme.
   d. Assume that the lab has tie-ups with specialized doctors and clinics. After a lab diagnosis, if a patient agrees, they are directed to the suitable doctor or clinic. How can you modify the existing coding scheme to integrate this information?
6. The d'Arcy James cosmetics firm requires its salespeople to use laptops 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 6b.
7. List the best data entry data method and your reason for choosing it for each of the following five situations:
   a. A retailing giant often puts up products nearing expiry on a clearance sale but has insufficient staff to address customer queries on new prices during the sale period.
   b. A university is organizing a workshop on the latest analytical skills required for systems developers. The workshop's organizers need a system to help address the students' queries.
   c. A food processing firm needs to track the supply of raw material through various modes of transport in real time.
   d. A retailer wants to speed up the payment process by removing the need for customers to swipe their card, enter card details, and then complete their payments.
   e. To reduce the time spent on evaluating test answer sheets, a university wants to develop a new marking scheme that makes the tests electronic.
8. One of the members of a systems analyst team proposing a website redesign suggests considering only tests for the validation of input data and not the validation of input transactions. Write a paragraph stating why this assertion is wrong and what effect it could have on the final system outcome.
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. Provide an example of submitting the wrong data to a payroll system. Also state at what time in the input process this error should be flagged.

11. Describe a good composition test for a program that accepts first and last names of users. What should the input be composed of? What input should it flag as unacceptable?
12. Recommend an appropriate range or reasonableness test for entering the birth date of a college student enrolling in a four-year college into the college registration system.
13. Explain how a test for comparison with stored data would work for a retailer that was adding new models of smartphones by manufacturers already represented in their database.
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 *n*s 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. A 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 in which 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 website:** *Hint:* Search the Web for standard language codes.
    e. **A driver's license number, composed of several parts:** The person's birth month, the birth day, 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. **Airport 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 1 through 4; and the last group must contain a letter, either an E, G, or C, two digits with values from 4 through 7, and two letters, either an A, B, or C. *Hint:* Using 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 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 screens 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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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 systems design.
4. Design appropriate training programs for users of a 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 a 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 an 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 an 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 (2015), the primary elements of TQM are meaningful only when they occur 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 exclusively a 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 TQM.

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 twentieth century, quality control was expressed in terms of three standard deviations from the mean, or three sigma, which equals about 67,000 defects per 1 million opportunities. Six Sigma implies a goal of no more than 3.4 defects per 1 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 website for the Juran Center at the Carlson School of Management, University of Minnesota, Twin Cities (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 Dr. Joseph M. Juran (1964) said, "All quality improvement occurs on a project-by-project basis and in no other way" (Section 5, p. 5.8). Systems analysts, project managers, and users should take that to heart.

Responsibility for Total Quality Management

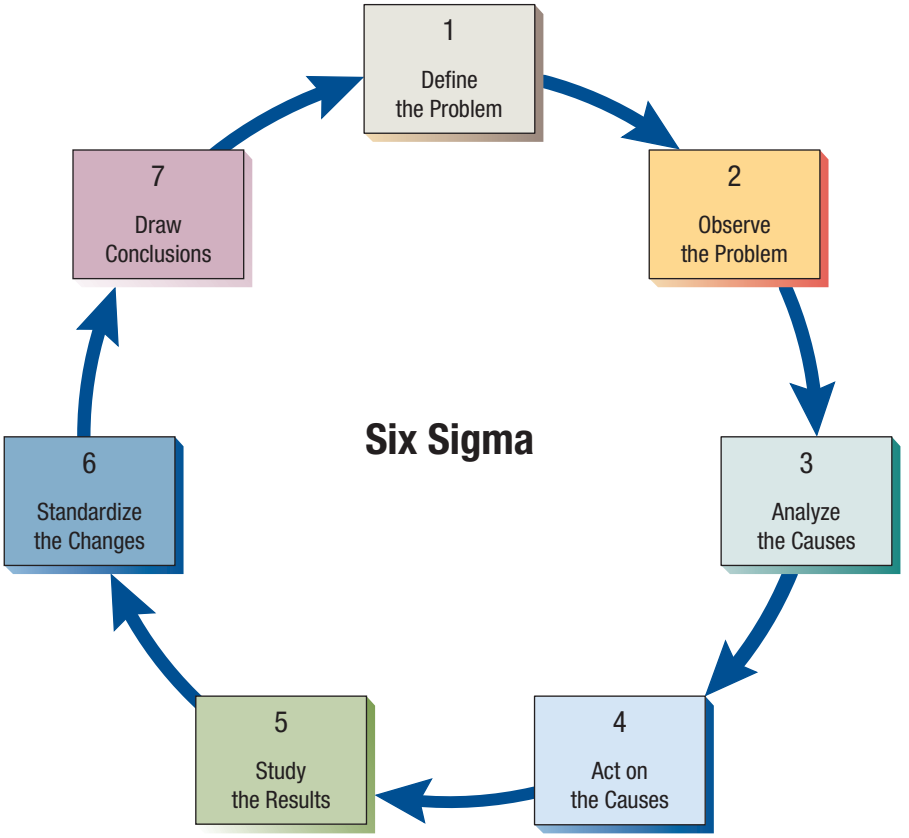
Practically speaking, a large portion of the responsibility for the quality of information systems rests with systems users and management. Two things must happen for TQM to become a reality with systems projects. First, the full organizational support of management must exist, which is a departure from merely endorsing the newest management gimmick. Such support means establishing a context for management personnel to consider seriously how the quality of information systems and information itself affects their work.

Early commitment to quality from analysts 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.

Organization support for quality in management information systems can be achieved by providing on-the-job time for information systems (IS) quality circles, which consist of six to eight organization peers specifically charged with considering both how to improve information systems and how to implement improvements.

FIGURE 16.1

Every systems analyst should understand the methodology and philosophy of Six Sigma.



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, 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 a systems analyst's job is to encourage 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 can be done with a system. In addition, human issues that have been overlooked or underrated by the analysis team may be designated as extremely pressing in users' quality standards. Getting users involved in spelling out quality standards for information systems will help an analyst avoid expensive mistakes in unwanted or unnecessary systems development.

Structured Walkthrough

One of the strongest quality management actions a systems analysis team can take is to do structured walkthroughs routinely. Conducting structured walkthroughs is a way of using peer reviewers to monitor a system's programming and overall development, point out problems, and allow the programmer or analyst who is 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

Report to Management on Structured Walkthrough

Date of Walkthrough: / /

Time:

Project Name:

Project Number:

Portion (Description) of Work Examined:

Walkthrough Coordinator:
List of Participants:

Comments:

Signature of Coordinator:

Date Report Is Filed: / /

Action Recommended (Check One):
( ) ACCEPT WORK AS FOUND
( ) REVISE WORK
( ) REVISE WORK AND CONDUCT FOLLOW-UP WALKTHROUGH
( ) 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.

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 TQM approach when performed throughout the systems development life cycle. The time they take should be short—half an hour to an hour at most—which means 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, it is important not to overuse them.

You can use structured walkthroughs as a way to obtain (and then act on) valuable feedback from a perspective that you lack. As with all other quality assurance measures, the point of walkthroughs is to evaluate a 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, commercial of-the-shelf (COTS) software for accounting, a different package for production scheduling, and another one for marketing.

CONSULTING OPPORTUNITY 16.1

The Quality of MIS Is Not Strained

"Merle, 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 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.

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 that 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, although pockets of users' needs may have been met, overall organization objectives are not considered and hence cannot be met.

Top-down design allows a systems analyst to ascertain overall organization 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.

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 the iPhone app Things. When the analyst return to the office, he or she can upload the information to the desktop version. Using Things is just another way to get organized. Things allow the user to organize tasks into categories and so that the user has a better understanding of the tasks. In this example, the user creates a walkthrough for a new release of the company website.

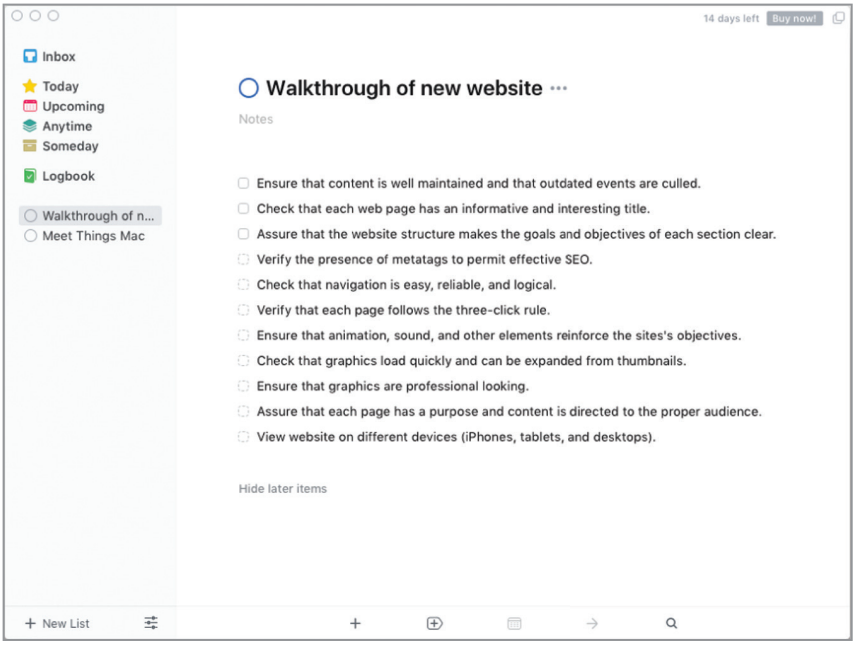


FIGURE 16.MAC

Things for Mac by Cultured Code (http://culturedcode.com). (Screenshot from THINGS courtesy of Cultured Code GmbH & Co. KG. Reproduced with permission.)

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 department goals that are important to the users involved.

Using Structure Charts to Design Modular Systems

With the top-down design approach, 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 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 shows a structure chart for changing a customer record, involving 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, an 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.

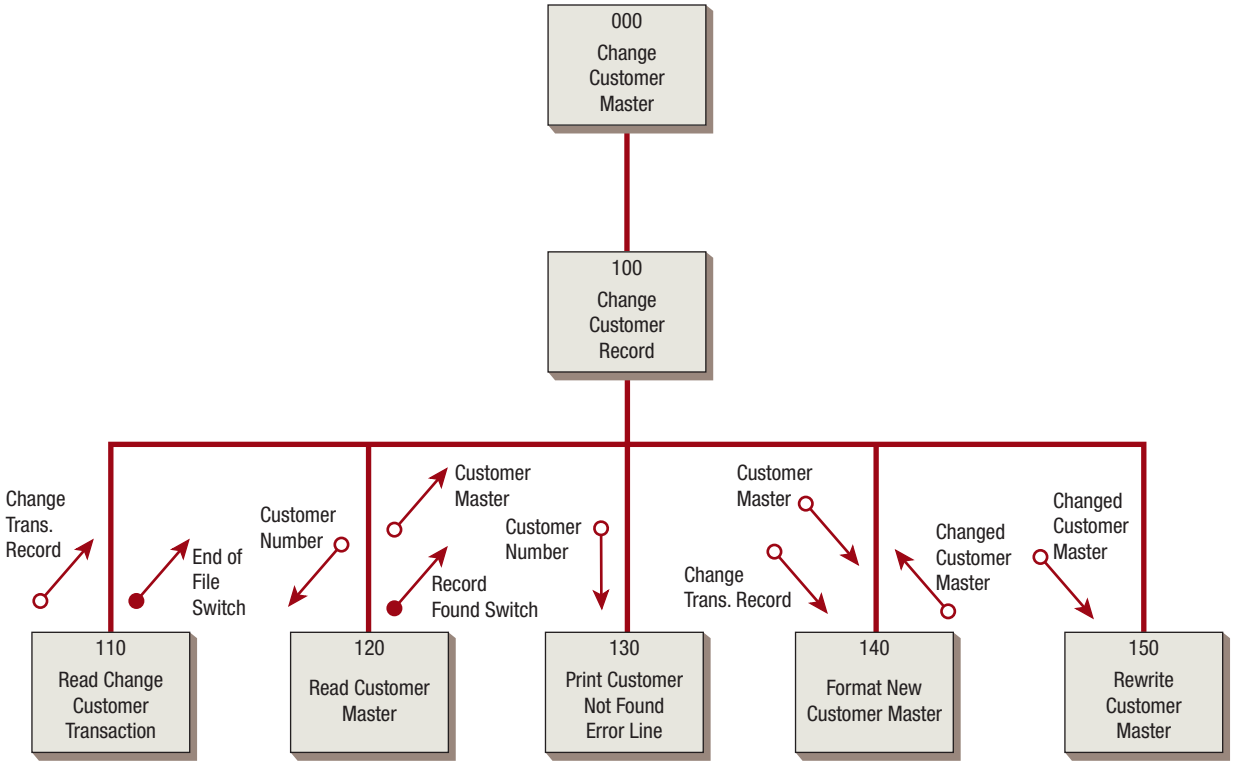


FIGURE 16.3

A structure chart encourages top-down design using 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 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 the concept of service-oriented architecture (SOA), which is very different from the modules in the structure chart. Instead of being hierarchical as in 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.

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 to 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 made available on the Web. Other services are more specialized and oriented toward the business itself. These enterprise-based services provide business rules and differentiate one business from another. Services can be called on at a specific 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 on a systems designer. This can even be accomplished by selecting services from a menu of services and monitoring them by setting up an SOA dashboard.

To set up SOA, the services must be:

1. Modular.
2. Reusable.
3. Able to work together with other modules (interoperable).
4. Able to be categorized and identified.
5. Able to be monitored.
6. Compliant with industry-specific standards.

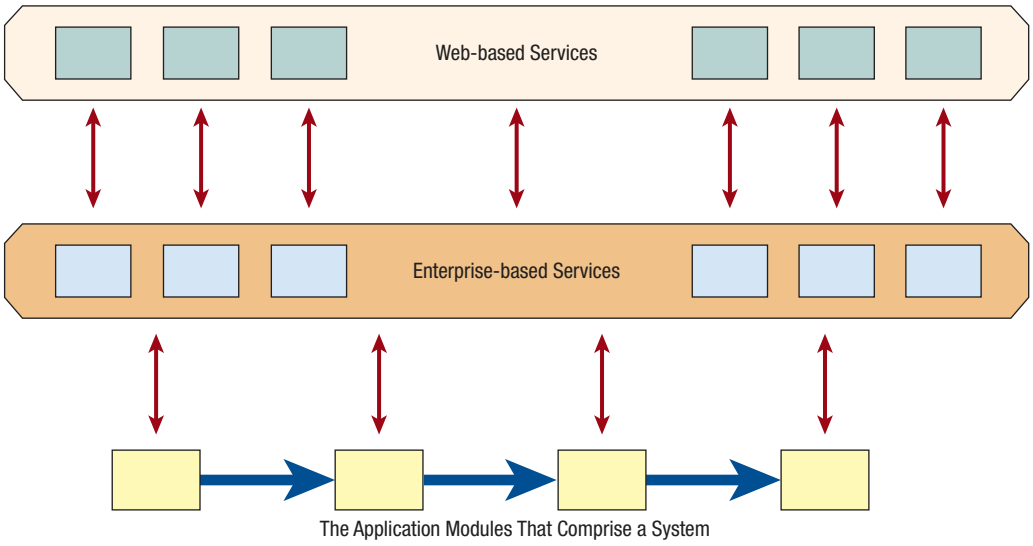


FIGURE 16.4

Modules in service-oriented architecture are independent and can be ubiquitous.

The advantages of reusability and interoperability are obvious, but SOA is not without challenges. First, industry standards must be agreed upon. Next, a library must be maintained so 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 it has made many of the features found in Web 2.0 possible. Others have called cloud computing an offspring of SOA.

Documentation Approaches

A 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.

Systems and programs are undocumented or underdocumented for many reasons. 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 systems development life cycle (SDLC) approach remind us that documentation accomplished by means of a computer-aided software engineering (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 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 software or equipment 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 (1986), well before the creation of blogs and user communities. FOLKLORE has two main advantages over commonly

CONSULTING OPPORTUNITY 16.2

Write Is Right

"It'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 computer programmer who will be working with your systems analysis team. Al is speaking at 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 computer programmers. "I'm sure we can agree on a better technique."

David, a senior 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 propose overcome some of the concerns they have voiced? What process will you use to decide on appropriate techniques? Compose your answer in one page.

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 depend 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 an 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.

When documenting customs, an 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."

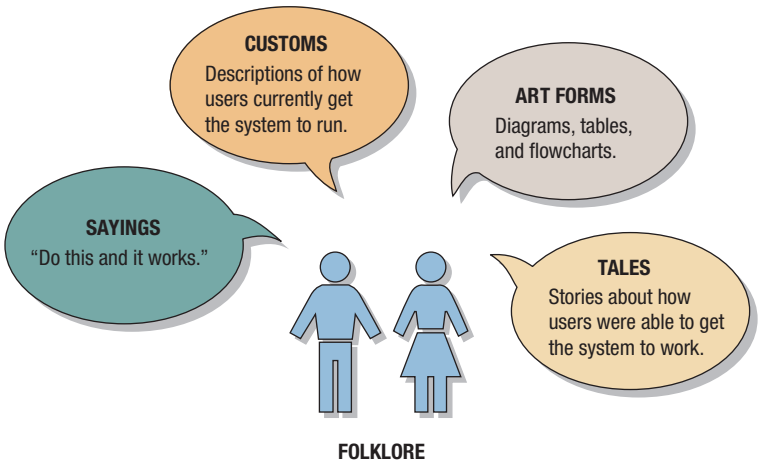


FIGURE 16.5

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 Mr. Evans expects, but every once in a while I make a mistake too. For instance, if I can send 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 Web-based approach for capturing the elements of FOLKLORE so it is not necessary to use a paper-based log. Make sure your suggested solution can accommodate graphics as well as text.
3. Design input and output screens for FOLKLORE that facilitate easy entry, and design onscreen promps so recall of FOLKLORE elements is immediate.

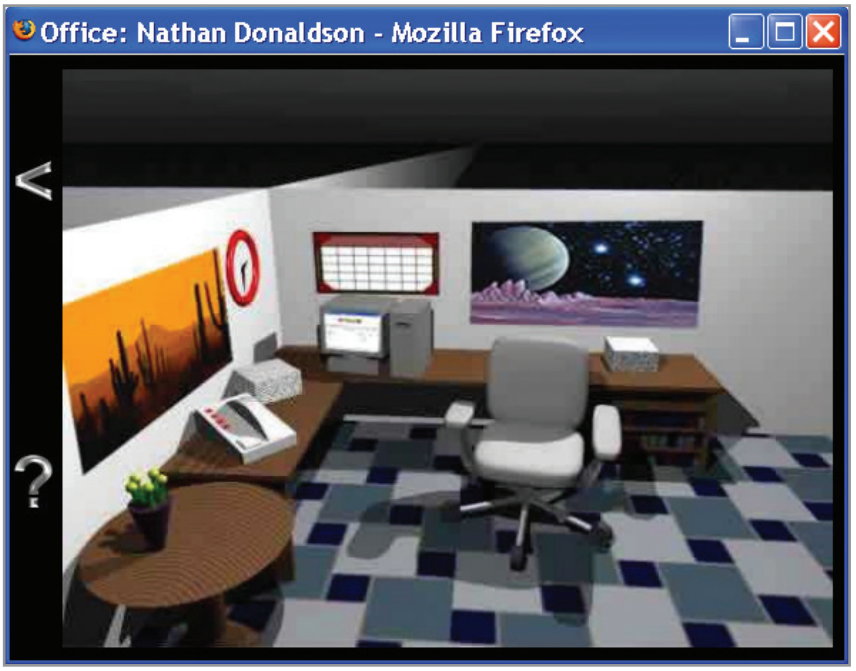


FIGURE 16.HC1

In HyperCase, use FOLKLORE to document art forms that users have created or collected to make sense of their systems.

Tales are stories that users tell regarding how the system worked. The usefulness of the tale, of course, depends on the user's memory and is at best an opinion about how the program worked. Stories typically 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). Stories often have a hero who is likely the teller of the tale.

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 an analyst should try to capture this advice and include it in FOLKLORE documentation. User stories that were gleaned in interviewing during the analysis portion of the project may still be relevant here.

Gathering art forms is another important activity of traditional folklorists, and a systems analyst should understand its importance too. Flowcharts, diagrams, and tables that users draw 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 a FOLKLORE document do not have to document the entire system, only the parts they know about. Just like with Web-based support 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. A systems analyst, however, is faced with a difficult decision regarding which method to adopt. The following is a set of guidelines to help an analyst use the appropriate technique. A systems analyst should choose a technique that:

1. Is compatible with existing documentation.
2. Is understood by others in the organization (or is easily taught to others).
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 an analyst has designed and coded the system, testing, maintenance, and auditing of it are prime considerations.

The Testing Process

All of a system's newly written or modified application programs—as well as new procedure 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 previously unknown problems, not to demonstrate the perfection of programs, manuals, or equipment.

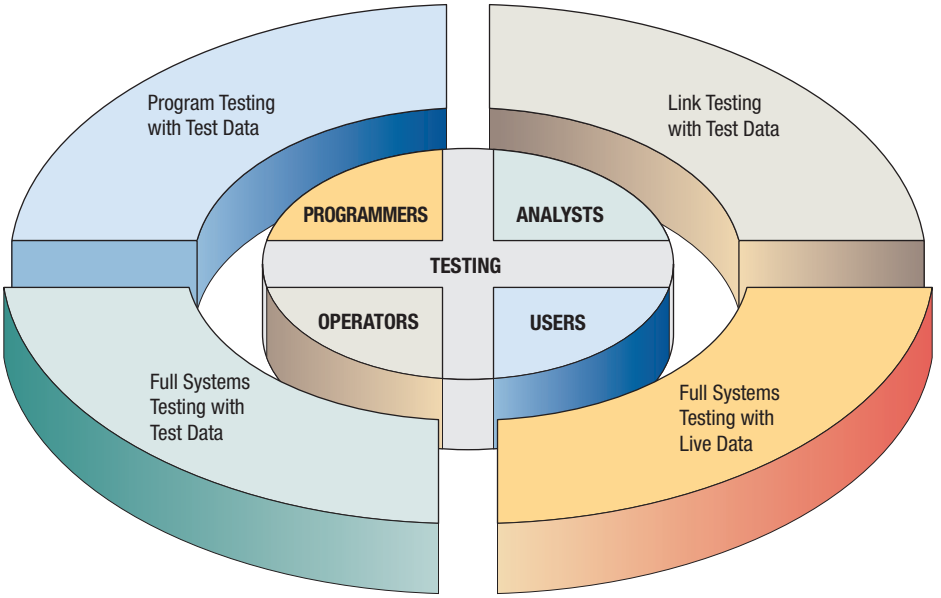
Although testing is tedious, it is an essential series of steps that helps ensure the quality of the eventual system. It is far less disruptive to test beforehand than to have a poorly tested system fail after installation. Testing is accomplished on subsystems or program modules as work progresses. Testing is done on many different levels at various intervals. Before a system is put into production, all programs must be desk checked, checked with test data, and checked to see whether the modules work together with one another as planned.

A 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 provided as a service by vendors of equipment, who will run their own tests on equipment when it is delivered on-site.

PROGRAM TESTING WITH TEST DATA Much of the responsibility for program testing resides with the original author(s) of each program. A systems analyst serves as an advisor and coordinator for program testing. In this capacity, an analyst works to ensure that correct testing techniques are implemented by programmers but probably does not personally carry out this level of checking.

FIGURE 16.6

Programmers, analysts, operators, and users all play different roles in testing software and systems.



At this stage, computer programmers must first desk check their programs to verify the way the system will work. In desk checking, the coder follows each step in the program on paper to check whether the routine works as it is written.

Next, computer programmers must create both valid and invalid test data. These data are then run to see whether base routines work and also to catch errors. If output from main modules is satisfactory, you can add more test data and 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, a systems analyst checks output for errors, advising the computer programmer of any needed corrections. An analyst will usually not recommend or create test data for program testing but might point out to the computer 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 whether programs that are interdependent work together as planned.

An 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, a 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, a number of factors must be considered when systems testing with test data:

1. Examine whether operators have adequate documentation in procedure manuals (hard copy or online) to afford correct and efficient operation.
2. Check whether procedure manuals are clear enough in communicating how data should be prepared for input.
3. Ascertain whether workflows necessitated by the new or modified system actually "flow."
4. Determine whether 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 systems testing. Unfortunately, this step often is dropped if system installation is lagging behind the target date.

CONSULTING OPPORTUNITY 16.3

Cramming for Your Systems Test

"We'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. It was supposed to be here from Guadalajara by now."

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, two key people from accounting 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, and 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, both 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 computer 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 double-spaced pages.

Systems testing includes reaffirming the quality standards for system performance that were set up when the initial system specifications were written. 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 website). As with test data, only small amounts of live data are used in this kind of system testing.

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 interact with a 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, Read Me files, 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, and 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; 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 a 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 systems maintenance.

Part of a 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 and to give them proper authorization to download product updates or patches from the Web.

Auditing

Auditing is yet another way of ensuring the quality of the information contained in a system. Broadly defined, auditing refers to having an expert (who is not involved in setting up or using a system) examine information 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 also may be brought in if something out of the ordinary is occurring that involves company employees, such as suspected computer fraud or embezzlement of corporate funds.

Internal auditors study the controls used in the information system to make sure they are adequate and 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, including 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. This would be considered two-tiered 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

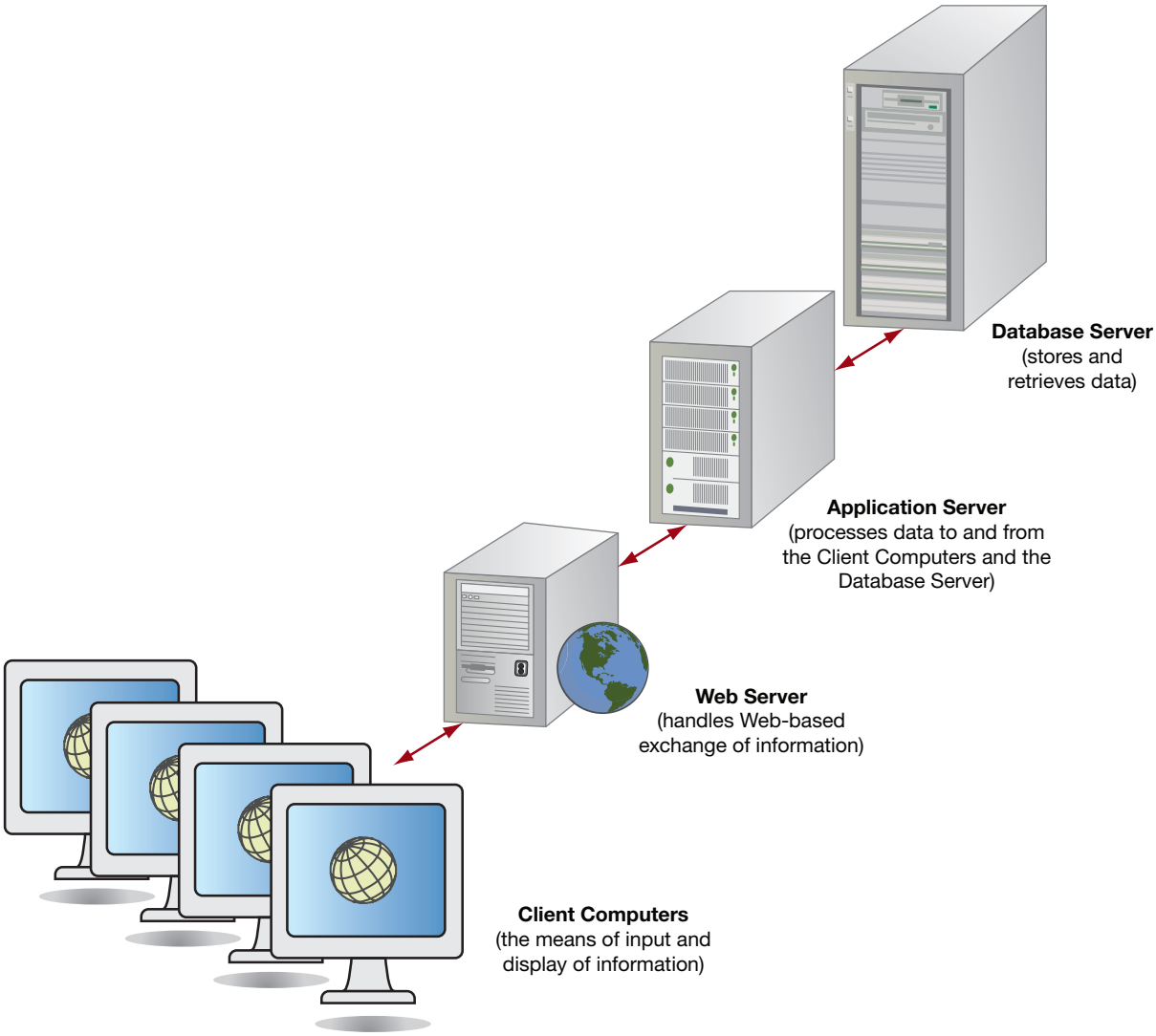


FIGURE 16.7

A three-tiered client/server configuration.

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 as 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; 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, notebook computers, or any other way in which the user can enter the system.

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 this model was 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 because 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 Google Chrome or Mozilla Firefox to access applications. As you can see, servers store software and data for businesses.

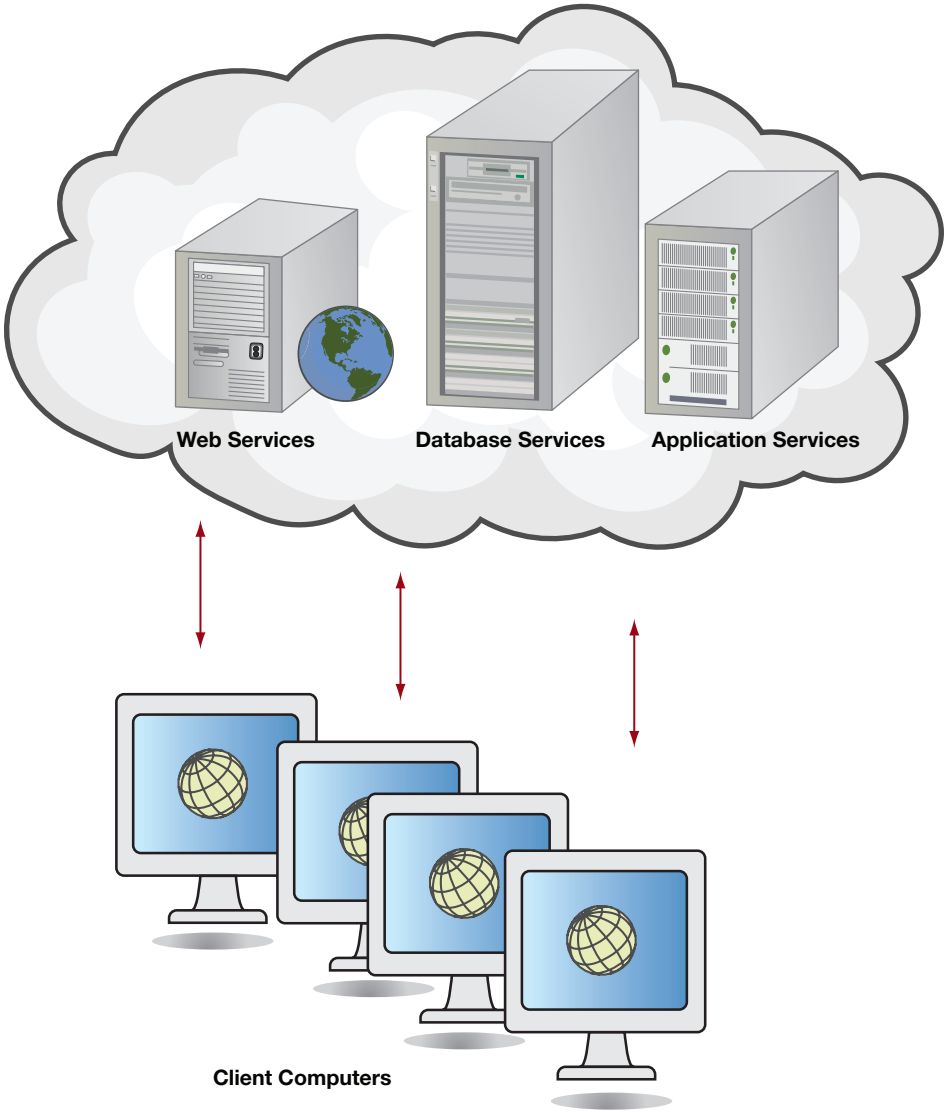


FIGURE 16.8

Cloud computing offers many services.

Many large, well-established hardware, software, and consulting companies such as Cisco, Dell, IBM, HP, Microsoft, SAP, Amazon, 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 (SaaS) is included in the concept of cloud computing.

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 systems or scale down systems, 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.

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, realizing increases in peak-load capacity and ensuring that underutilized systems are used more efficiently and widely.

Companies also hope to improve their ability to perform disaster recovery by using cloud computing, which provides many redundant sites. Cloud computing is not immune to outages, but 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 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 a 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" because they have never existed as brick-and-mortar enterprises) are offering applications using cloud computing, and users can use their Web browser to access applications. These include Google Apps (for spreadsheets and calendars), Amazon Web Services (AWS), Akami, and CRM software by Salesforce.com, which 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 past decade into their offerings of software, software tools, services, and computing power via the Internet.

CLOUD COMPUTING TRADE-OFFS Researchers note that concern about privacy and security serve as key barriers to organizations' adoption of cloud technology. They note that there are many ways to address such barriers; most frequently these take the form of fixes via technology (hardware or software) that can be implemented or business responses (improved staff training, making security of cloud computing a strategic priority, and so on) that can be strategized through management. Sometimes it is the local IT department that is wary of giving control over corporate data and processes to cloud providers that unnecessarily impede the adoption of cloud computing, raising fears that are not supported by risk assessment but rather bolstered by instincts for self-preservation, or at the very least, preservation of the status quo.

By now you are accustomed to the idea that businesses must make trade-offs in the adoption of a technological or organizational solution. Inevitably, businesses will be evaluating cloud providers, sometimes with the participation of the systems analyst. If that is the case, your ability to systematically evaluate and compare cloud providers can be valuable to your client.

One major decision is whether to use an external cloud provider (public cloud) or an internal one (private cloud) that can be realized by centralizing the organization's data centers through a privately configured cloud service. Sometimes the decision to use a public cloud has to do with how critical it is for the company to strategically control data. A hybrid approach, in which more critical data linked to strategic aims and corporate intellectual property are held in a private cloud, and less critical data for the same organization makes use of a public cloud, may be a solution.

One of the biggest contributions an analyst can make is to help with weighing risks to security of data versus the value of the data being stored and used. One way is to evaluate the disaster recovery plans of cloud providers who are dealing with any mission critical data that are being considered as candidates for cloud storage.

FACTORS IN CHOOSING A CLOUD PROVIDER Here are a few questions you will want to pose as you evaluate cloud service providers for your information systems clients:

1. If a client of the cloud services provider is hacked, how will it adversely affect other businesses the cloud provider is hosting?
2. How can your client be sure data are completely deleted from cloud systems when these systems are eventually decommissioned?
3. Are the data architectures being used by the cloud provider standard and transparent so if the client wants to switch providers for cost or over security concerns, it would be realistic to do so?
4. Are there too many nonstandard practices and proprietary programming structures in use, making transferring data out of the question?
5. How can your client be certain that no one at the cloud provider or their staff working for other clients has access to your organization's data?

Once you are able to compare answers of the cloud providers, your client and you can make a determination about which cloud service provider is most appropriate for the type of computing

requirements you have surfaced over the course of your project engagement. Because different countries and jurisdictions (such as the European Union or the United States) have differing laws covering privacy of data stored in cloud systems and whether the government can have access to data of private citizens, it has, in some cases, become a consideration to find out where cloud providers are located and whether all laws and regulations regarding privacy and security of the users and their location are being properly observed by cloud providers.

ERP SYSTEMS AND THE CLOUD Researchers are suggesting that many of the issues and challenges associated with implementing enterprise resource planning (ERP) systems can be mitigated by new, lower-cost ERP offerings that take advantage of cloud computing. Organizations do not have to purchase costly new IT; new versions and upgrades of ERP software are maintained and installed by the ERP cloud vendor, and switching to other modules may be less cumbersome than before.

A vendor called Workday, www.workday.com (created by two PeopleSoft veterans), provides SaaS solutions for midrange to large organizations. These solutions are advertised as low cost and easy to upgrade, offer a reduction in data storage costs, provide a greener IT footprint, and are less cumbersome than traditional ERP implementations using a predictable subscription pricing model. In addition, Workday asserts that its systems address some of the long-standing problems experienced with legacy ERP implementations, including unpredictable costs of on-premises ERP systems, piecemeal solutions to IT business problems, and variable level of service.

Another prominent cloud ERP vendor is NetSuite, www.netsuite.com, which offers accounting software real-time inventory management, customer relationship management software (CRM), ecommerce, and real-time global business management to small and medium-sized enterprises. NetSuite, which was acquired by Oracle in 2016, differentiates its services by emphasizing reduced IT cost and real-time visibility and anywhere, anytime access to business information that decision makers find critical to running an organization.

As with any other endeavor in the cloud, but especially an ERP system that can store sensitive corporate data and run mission-critical applications, organizations are creating new tools to assess the potential value to furthering strategic objectives, assess the risk to the enterprise, examine the security issues, gauge the probability of user acceptance, and gauge the likelihood of success in integrating a cloud-based ERP into their IT supply chain. As an analyst, you have developed several data collection and analytical tools that can facilitate the ability of the organization to come to reasonable decisions about adopting cloud-based ERP.

Network Modeling

Because networking has become so important, a systems designer needs to consider network design. Whether a systems designer is involved with decisions about the configurations of networks or 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 a network. It is useful to have distinct symbols to distinguish among hubs, external networks, and workstations (PCs, laptops, and so on). 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. World's Trend sells fashionable mens, women's, and children's clothing online and via mail and phone orders. Start by drawing a circle and labeling it "World's Trend Network." Now draw a number of circles below the first one, 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).

Extend this drawing further by drawing another level. This time, 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 Manager, and 30 Order-Entry Clerks). This network is simplified for the purpose of providing a readily understandable example.

FIGURE 16.9

Use special symbols when drawing network decomposition and hub connectivity diagrams.

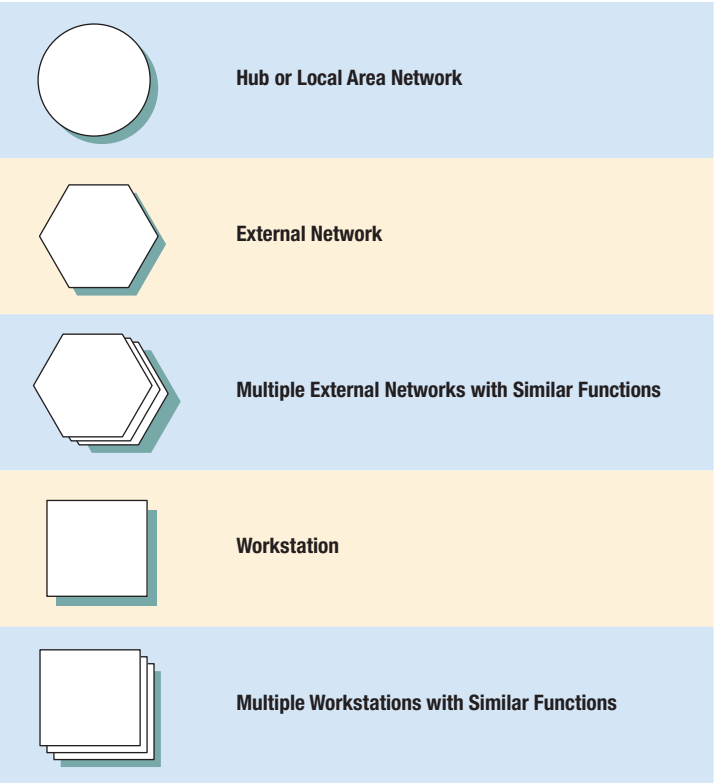
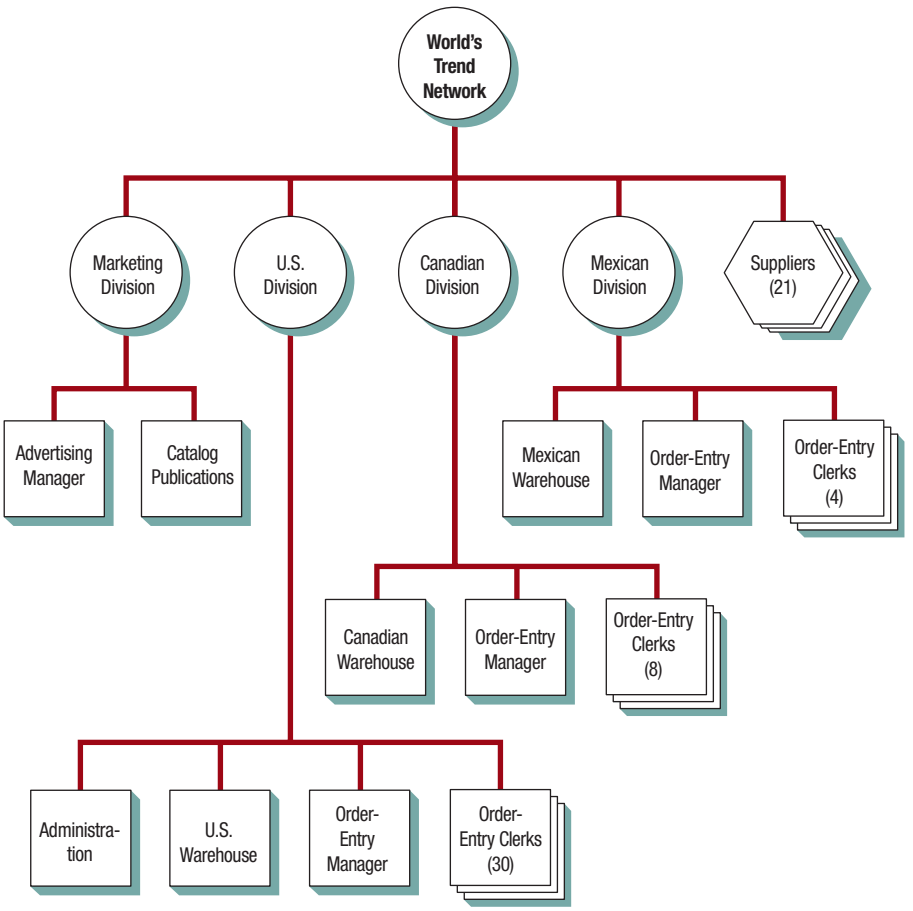


FIGURE 16.10

A network decomposition diagram for World's Trend.



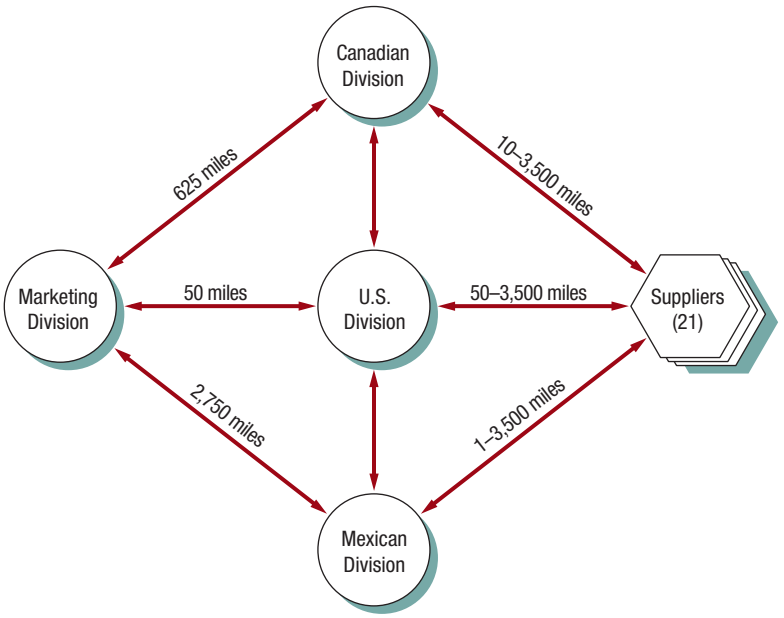


FIGURE 16.11

A hub connectivity diagram for World's Trend.

CREATING A HUB CONNECTIVITY DIAGRAM A hub connectivity diagram is useful for showing how the major hubs are connected. At World's Trend, shown in Figure 16.11, four major hubs are all connected to one another. In addition, there are external hubs (suppliers) that need 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, redraw the diagram so 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. Therefore, you need to explode the hub connectivity diagram. Figure 16.12 shows the 33 workstations for the U.S. Division and how they are to be connected.

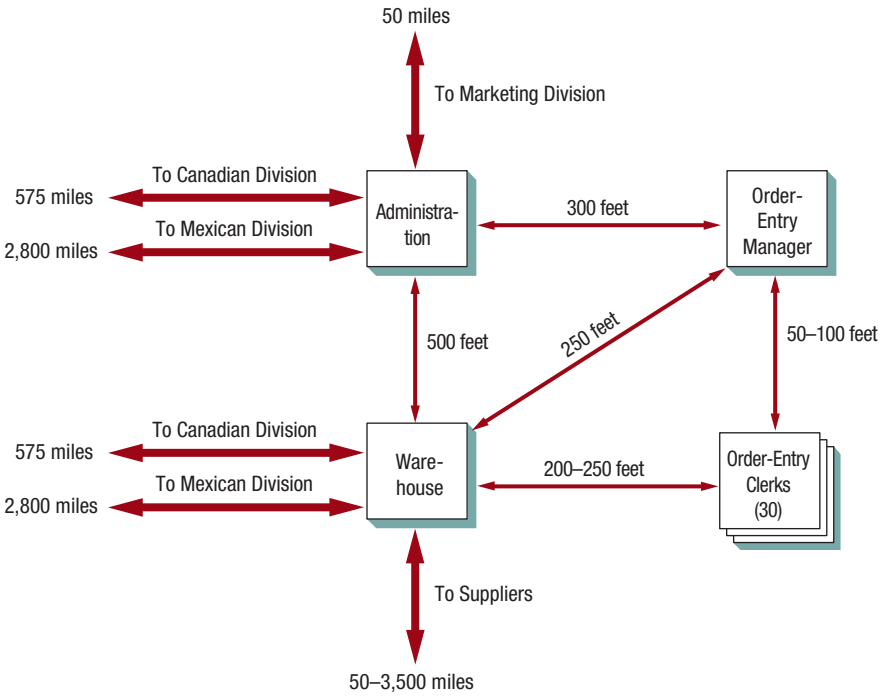


FIGURE 16.12

A workstation connectivity diagram for World's Trend.

The diagrams for this level are drawn by examining the third level of the network decomposition diagram. Group items such as Order-Entry Manager and Order-Entry Clerks together because 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.

Place workstations that must be connected to other hubs on the perimeter of the diagram. 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.

Training Users

Systems analysts engage in an educational process with users that is called training. Users have been involved throughout the systems development life cycle, so by now an analyst should have an accurate assessment of the users who must be trained.

In the implementation of large projects, an analyst often will be managing the training rather than personally being involved in it. One of the most prized assets an analyst can bring to any training situation is the ability to see the system from the user's viewpoint. An 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. An 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 a 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.

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 an 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 also may 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 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 an 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. These people can, in turn, train the remaining users. This approach works well if the original trainees 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

An analyst has four major guidelines for setting up training: (1) establish measurable objectives, (2) use appropriate training methods, (3) select suitable training sites, and (4) employ 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 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, using a combination of methods may be 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 organization context in which they must eventually perform.

On-site training in the users' organization is 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 organization context. A serious disadvantage is that trainees often feel guilty about not fulfilling their regular job duties if they remain on-site for training. Thus, full concentration on training may not be possible.

Off-site training sites are 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.

CONSULTING OPPORTUNITY 16.4

You Can Lead a Fish to Water . . . but You Can't Make It Drink

Sam 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 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 managers 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.

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 mockups of output. Users of larger systems sometimes will 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 websites that feature pages devoted to FAQs, which can be downloaded and printed. Changes to manuals can be gleaned from many vendors' websites.

The user's understanding of a system depends on training materials being clearly written for the correct audience with a minimum of jargon. Training materials should 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 16.13.

FIGURE 16.13

Appropriate training objectives, methods, sites, and materials depend on many factors.

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

Conversion to a New System

A third approach to implementing a system is to physically convert an old information system to a new or modified one. Many conversion strategies are available to analysts, as well as a contingency approach that takes into account several user and organization 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 shown in Figure 16.14:

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 CHANGEOVER 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 be successful only 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 to use an unfamiliar system, without recourse. Finally, there is no adequate way to compare new results with old.

PARALLEL CONVERSION Parallel conversion refers to running an old system and a new system at the same time, in parallel. When the same results can be gained over time, the new system continues to be used 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 by 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.

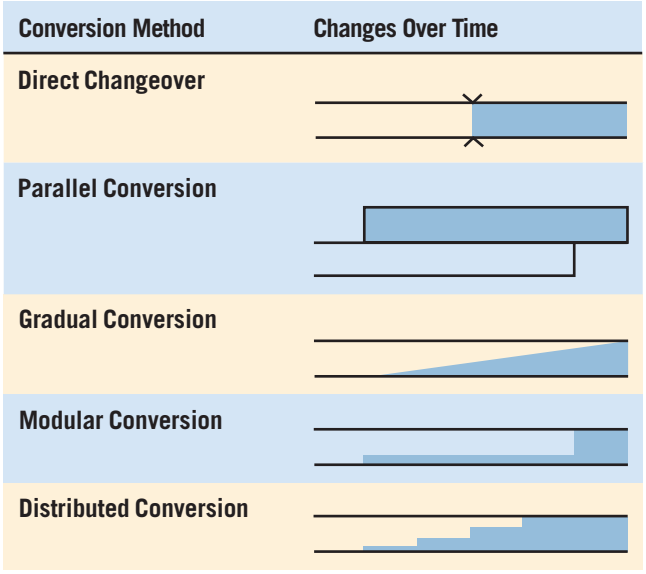


FIGURE 16.14
Five conversion strategies for information systems.

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 entails other details for an analyst, including 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 storage media.
3. Appointing a manager to supervise, or personally supervising, the preparation of the installation site.
4. Planning, scheduling, and supervising programmers and data entry personnel who must convert all relevant files and databases.

For many implementations, the chief roles of the systems analyst are to accurately estimate the time needed for each activity, appoint people to manage each subproject, and coordinate their work. For smaller projects, much of the conversion work is done by the analyst. 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 implementing a system 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 an organization describe the company as a zoo, you can infer that the atmosphere is chaotic; if they describe it 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.

Metaphors such as society, family, and the game also 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 16.15 shows that a traditional management information system (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

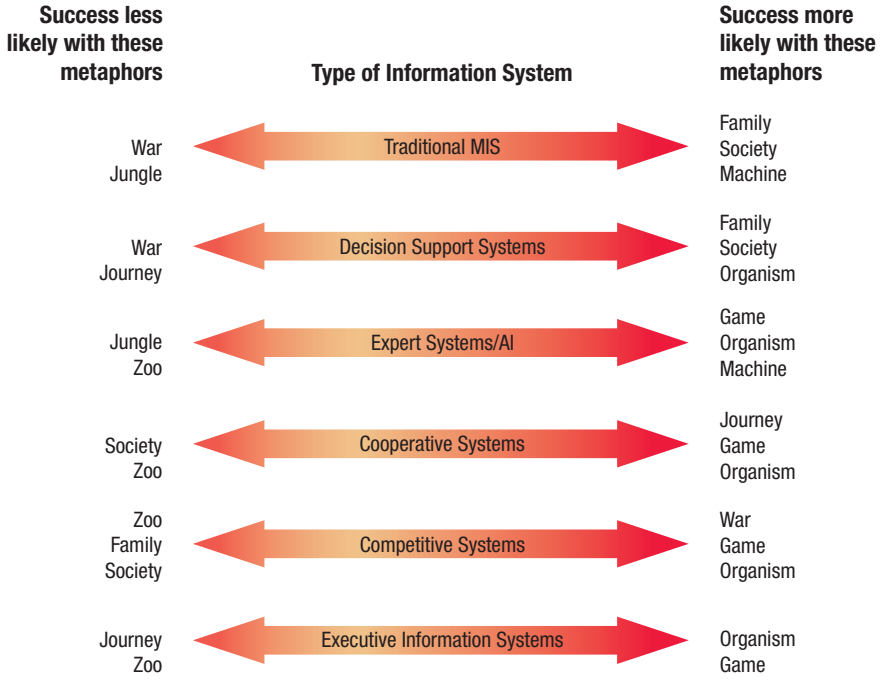


FIGURE 16.15

Organizational metaphors may contribute to the success or failure of an information system.

area. In the meantime, systems analysts should be aware that metaphors communicated in interviews could be meaningful and may even be a factor that contributes to 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. 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 a 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, or using data storage provided by cloud vendors.

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 an analyst is planning for computer facilities and equipment purchases. Obviously, physical security can be much tighter if anticipated in advance of 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. Few authorities are trained in catching Internet criminals, and a "wild west" or "last frontier" mentality is 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 organization and Internet security; it is, however, an additional layer of security that is now widely endorsed. There is 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 workrooms 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 that many attacks to information systems come from within the organization.)

Security can begin with screening 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 employees are fully aware of expectations and responsibilities. Typically, a 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 websites 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 a 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 the 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 whether there is use of video cameras, software, and phone monitoring.

Output generated by a system must be recognized for its potential to put an 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, provisions must be made for shredding documents that are classified or proprietary. 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. Analysts 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:

1. Software that can detect and remove malware.
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 versus the financial bottom line.
7. Security technologies such as secure sockets layer (SSL) for authentication.
8. Encryption technologies such as secure electronic transaction (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 a website more secure, you must ask the user or customer to give up some privacy.

Website designers 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 website 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 website so all customers can access the policy whenever they complete a transaction.
2. Ask only 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 website. 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-caused disaster that threatens security as well as the functioning of the business. Some disasters are quite common, such as power outages. 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 disaster 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 its own assets, as well as those of its 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 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 answers to these questions will guide 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 the 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 on site, such as analysis 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. An analyst 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,

CONSULTING OPPORTUNITY 16.5

The Sweet Smell of Success

Felix Straw, who represents one of the many U.S. distributors of the European soft drink Sipps, gazes unhappily at the weather app on his smartphone, which shows a map of the United States saturated with dark red, indicating that most of the country is experiencing an early spring heat wave, with no signs of a letup. Holding up the screen of his smartphone as he speaks to the assembled systems group, he says, "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 hung 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 email our orders to 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 served chilled or with ice, and it is particularly popular when the weather is hot. Sipps has sold briskly in Europe and grown in popularity in the United States since its introduction five years ago, but the company 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. A network of local distributors located throughout the United States and Canada distributes Sipps.

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.

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.

An 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 to send employees home, to have them remain on site, or to relocate them to a recovery facility set up to continue operations. The entire gamut of transportation options should be considered when developing this memo.

Organization and analysis team members must be able to communicate in the event that typical email is disrupted. If email is unavailable for broadcasting an emergency message, an emergency information Web page or emergency hotline can serve as a viable alternative. 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 an organization's backup systems and to ensure the continued, uninterrupted flow of banking transactions in the event of a disaster, regulations in the United States stipulate that off-site bank locations must be at least 100 miles away from the original site. Paper files and backups also present a monumental problem and are highly vulnerable to natural and human-caused 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).

Support for people 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. Although food is important, water is more so. Employees should 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 website (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, an analyst, management, and users have been evaluating the evolving information systems and networks to give feedback for their eventual improvement. Evaluation is called for following system implementation as well.

Evaluation Techniques

Recognizing that 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 can serve as a guide in the development of any future projects an analyst might undertake as well.

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 is illustrated in the evaluation of a blood inventory system in Figure 16.16.

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

Information Systems Modules	Form Utility	Time Utility	Place Utility	Possession Utility	Actualization Utility	Goal Utility
Inventory Lists **Success**	**Good**. Acronyms used were the same as shipping codes. As systems grew, too much information was presented; this overload called for summary information.	**Good**. Reports were received at least one hour before scheduled shipments on a daily basis.	**Good**. Inventory lists were printed at the regional blood center. Lists were delivered to hospitals with the current shipments.	**Good**. The same people who originally kept manual records received these reports.	**Good**. Implementation was easy because hospitals found the inventory lists to be extremely useful.	**Good**. Information about the location of particular units was made available.
Management Summary Reports **Success**	**Good**. Summary report was designed to exact format specifications of manual summary reports developed by the blood administrator for city hospitals.	**Good**. Same as listings.	**Good**. Summary reports were printed at the center where they were needed.	**Good**. Blood administrators who originally kept manual reports received these reports.	**Good**. Blood administrators participated in the design of the reports.	**Good**. Summary reports helped reduce outdating and prevent shortages.
Short-Term Forecasting **Success**	**Good**. A forecast was issued for each blood type.	**Good**. Forecasts were updated daily.	**Good**. Printed at blood center.	**Good**. Administrators concerned with distribution and collections received the report.	**Good**. Output design could have been more participative.	**Good**. Shortages were prevented by calling in more donors.
Heuristic Allocation **Failure**	**Poor**. The people who allocated blood mistrusted the mysterious numbers produced by the computer.	**Good**. Reports were provided one hour before allocation decisions were made.	**Good**. Printed at blood center.	**Fair**. Administrators responsible for daily blood allocation received the original.	**Poor**. Too many people were involved with blood inventories to be able to participate in the design of the system.	**Poor**. This was not an immediate goal of the blood region. Shipping costs were passed on to patients.

FIGURE 16.16

Evaluating a blood inventory information and decision support system using the information system utility approach.

document 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 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.

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 Mr. Schnieder raised about the system. Outline it in a page. What are the problems that can occur when a system is not evaluated systematically? Respond in a paragraph.

Evaluating Corporate Websites

Evaluating the corporate website analysts 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. An analyst or a Webmaster should go one step further and analyze Web traffic as well.

A visitor to the website can generate a large amount of useful information to analyze. This information can be gathered automatically by capturing information about the source, including the previous website the user visited and the keywords used to find the site; the information also can be obtained through using cookies (files left on a user's computer about when they last were on the site).

An analyst or a 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 a site in depth. The cost is an ongoing budget item for maintaining the website.) 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 website is visited.** The number of hits a website had in the past 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 website, or even the most downloaded files. If the website 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.
3. **Find out more about the website'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 is all valuable information when evaluating a website.
4. **Discover whether 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.

HYPERCASE EXPERIENCE 16.2

"As you know, Mr. Evans 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 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 Mr. Evans, 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. When Mr. Evans comes back from Poland, I think 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 Mr. Evans 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 Mr. Evans' 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.

5. **Find out who is referring website visitors to the client's site.** Find out which sites are responsible for referring visitors to the client's website. Get statistics on the top referring site, the top search engines leading to the site, and the keywords visitors used to locate your client's website. 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 whether the client's website visitors are interested in advertising.** Finally, find out whether visitors to the site are interested in the ad campaigns you have on your site, such as offering a product on sale for a specific period.

Web activity services can be helpful in evaluating whether a 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

A 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 a 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 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 an 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, a 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. The move to cloud computing is a potential 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 past decade into their offerings of software, software tools, services, and computing power via the Internet. There are trade-offs in choosing cloud technology, including organization privacy and security. Analysts need to help companies decide between using a public or private cloud, or adopting a hybrid approach instead.

Enterprise resource planning (ERP) systems are developed for use via the cloud. Standard types of organization 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 usually must be able to run the system without the intervention of an analyst. Conversion is the process of changing from an old information system to a new one. 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 organization 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 transaction, 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 when you take all possible measures to ensure system security, privacy, and stability, all employees and systems are vulnerable to natural or human-caused 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.

Keywords and Phrases

behavioral security
bottom-up design
client/server model
cloud computing
control flag (switch)
corporate privacy policy
data couple
desk check
direct changeover
disaster preparedness
disaster recovery
distributed conversion
distributed processing
enterprise system
enterprise resource planning (ERP) system
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
hybrid approach
information system utility
internal auditor
IS quality circle
link testing with test data (string testing)
local area network (LAN)
logical security
malware
modular conversion
modular design and development
network decomposition
network modeling
organizational metaphors
parallel conversion
private cloud
program testing with test data
public key infrastructure (PKI)
public cloud
service-oriented architecture (SOA)
Six Sigma
Software as a Service (SaaS)
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 a systems analyst for attaining quality in newly developed systems?
2. Discuss how Six Sigma has changed the approach to quality management. List the steps involved in its implementation and who the team members of such a project would be.
3. Define the total quality management (TQM) approach as it applies to the analysis and design of information systems.
4. What are the limitations of taking a bottom-up approach?
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. Discuss how a top-down approach and TQM can go hand in hand.
8. List the advantages of modular design.
9. List four guidelines for correct modular programming.
10. Describe the recommended tool for designing a modular, top-down system.
11. What are the challenges associated with service-oriented architecture (SOA)?
12. What is orchestration? What kind of services are necessary for orchestration in SOA?
13. In what four categories does the FOLKLORE documentation method collect information?
14. List six guidelines for choosing a design and documentation technique.
15. Explain program testing, link testing, and full systems testing.
16. What is the difference between test data and live data?
17. Discuss maintenance and auditing as means to ensure system quality.
18. List the four approaches to system 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 is distributed computing?
23. What are the advantages of using a client/server approach?
24. What are the disadvantages of using a client/server approach?
25. What are the benefits of implementing systems and software using cloud computing?
26. What does the term Software as a Service (SaaS) mean?
27. Discuss cloud computing trade-offs.
28. What is the difference between a private cloud and a public cloud?
29. Why does a systems designer need to consider network modeling? What are the steps for creating a network model? What symbols are used?
30. List the guidelines followed by an analyst to set up training for IS.

31. List the five possible sources of training for users of information systems.
32. When converting from an old to a new system, what is a direct changeover? Is it a modular conversion? A distributed conversion?
33. List the nine organizational metaphors and the hypothesized success of each type of system given their presence.
34. Define the terms *physical, logical,* and *behavioral security* and give an example of each one that illustrates the differences among them.
35. Define what encryption software means.
36. What is a firewall or firewall system?
37. List five of the measures an analyst can take to improve the security, privacy, and confidentiality of data, systems, networks, individuals, and organizations that use ecommerce Web applications.
38. List five guidelines for designing a corporate privacy policy for ecommerce applications.
39. In terms of disaster recovery, what are the seven elements that need to be considered during and after a disaster?
40. List and describe the utilities of information systems that can be used to evaluate the information system.
41. What are seven essential items that an analyst should include in performing a website 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 the manual is written with the user in mind.
3. Your systems analysis team is close to completing a system for Azuka Theatre. Kevin is quite confident that the programs he has written for Azuka's inventory system used for keeping track of stage scenery and props will perform as required 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. Mark and Allison, 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; Kevin 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 Azuka Theatre (Problem 3). Break down your plan into a sequence of detailed steps and use a paragraph to write a memo justifying why the new plan is superior to the one Mark and Allison proposed.
5. Brindisi Brothers is a family-owned, medium-sized construction company doing residential and commercial construction and remodeling in New Jersey. Their field staff including their project consultant use iPads to take pictures and measurements of room dimensions on site during the bidding process and also before and after pictures of any construction jobs they complete. The manager of field operations uses email and a mobile phone, as does his brother who is the president of the firm. Their offices, staffed by their sister who is the accountant and administrator, maintain two small networks at their two office locations, one at the shore and one in the New Jersey suburbs outside of Philadelphia. Sensitive consumer financial data as well as information on home security systems at residences and construction proposals and bids are maintained in a database. They are always up to date on the latest residential construction trends and feel their computer systems should reflect that too. They've heard a lot about cloud computing and would like to try it.
   a. Prepare a list of factors they should consider in choosing cloud computing, along with a list of advantages and disadvantages.
   b. In a paragraph, explain to the brothers the difference between a private cloud and a public cloud.
   c. In a paragraph, write a recommendation for upgrading the Brindisi Brothers networks that includes moving to cloud computing and specifies whether a private, public, or hybrid cloud option would be the ideal option for them.
6. 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 Architects,

a top commercial architectural firm, 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 team members make with architects in other cities (New York, Madison, Wisconsin, Carmel, Indiana, and Vancouver, Washington). 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. List the problems the company is encountering, analyze the symptoms, think of a solution, and then start drawing. (*Hint*: More than one network may be necessary, and not all problems will be amenable to a systems solution.)

7. Create a disaster recovery plan for one of the networks you recommended to Bakerloo Brothers Architects in Problem 6.
8. A regional bank has recently automated all its functions, with each employee working on a dedicated machine assigned to them. The bank has installed a token generation system to manage client queues, a passbook printing system, swipe machines for cash withdrawals, and automated deposit machines. However, the bank has been struggling to maintain its routine operations. The staff is unable to navigate through the new systems properly and, therefore, to perform even simple tasks at times. Clients often complain about the lack of information available on the new systems and machines that have been installed. You were a part of the system development and installation at the bank. Consider the problems occurring at the bank and answer the following:
   a. In a paragraph, explain what the causes are, in your opinion.
   b. Outline the steps you would take to ensure appropriate training. List the guidelines that you would include in the training design.
   c. Do you think documentation could be of use here? Justify your answer.
9. 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 computers 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 on-site training for users she had already authorized.
   a. In a few sentences, help Roseann argue the usefulness of on-site 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.
10. "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 too long. Suggest a way to end Tub 'n Stuff's dual systems that will provide enough reassurance to Buffy. (Assume that the new system is reliable.)
11. 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 14.5 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.
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 seem 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.

Group Projects

1. To expand its e-retailing platform, John Levin has decided on an omni-channel approach: offer the same experience to customers irrespective of the channel they shop at. To do this, it needs to almost entirely redesign its website. Some of the features it decided to include on the new website after conducting "challenge sessions" were a product management system that allows the staff and sellers to manage details of the product portfolio online; a content management system to manage content, images, and graphics on the website; and a system to manage the scalability of the website. These were in addition to the movement from a legacy system to this new website. In a group, discuss what else could be involved in the website redesign. Apply a top-down approach and identify the modules that would be necessary to successfully design the website.
2. Divide your group into two subgroups and have one subgroup interview the members of the other subgroup about experiences they encountered registering for a class. Design questions 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. Remember to include examples of customs, tales, sayings, and art forms.

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GLOSSARY

Numbers in parentheses refer to the chapters in which the terms are 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 a "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 that 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)

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.

BLOCKCHAIN A network data structure built on an Internet platform that permits sharing and creation of a digital ledger of data to create a verifiable electronic record for tracking any kind of business asset. (13)

BRING YOUR OWN DEVICE (BYOD) A corporate policy that permits employees to use their preferred personal mobile technology (for example, their mobile phone or tablet) for work purposes once the technology undergoes customization by the corporate IT department, which uploads work software, encryption for security purposes, and so on to prepare the device for work. (3)

BRING YOUR OWN TECHNOLOGY (BYOT) A special instance of BYOD that often refers to bringing one's own computer or tablet into (often) an educational setting or classroom. (3)

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 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)

BURNDOWN CHART A chart that shows progress on an agile systems project, depicting work remaining versus the time (measured in sprint cycles). (6) *See also* sprint cycle.

BUSINESS ANALYTICS Business analytics uses quantitative tools to analyze big data and inform decisions of managers and computer systems. (13)

BUSINESS INTELLIGENCE (BI) Information that is useful to an organization through the processing of large amounts of data with BI technologies to help an organization meet its strategic goals. (13)

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 A diagram that is 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 A system in which 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)

COMPUTER-AIDED SOFTWARE ENGINEERING (CASE) (1) *See* CASE tools.

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 A flag that is 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 The physical switch from an old information system to a new one. There are five conversion strategies: direct changeover, parallel conversion, phased or gradual conversion, modular prototype conversion, and distributed conversion. (16)

CRC CARDS Class, Responsibilities, and Collaborators cards that represent the responsibilities of classes and the interaction between the classes when beginning to model the system from an object-oriented perspective. Analysts create these 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)

CRUD When designing a master file/database relation design, each master table or database relation should have programs to **c**reate, **r**ead, **u**pdate, and **d**elete (abbreviated CRUD) the records. (13)

DASHBOARD A screen for decision makers that includes 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 a 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 that can be base or derived; should be defined in the data dictionary. (8)

DATA FLOW Data that move in a 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) A 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 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 a system; depicted using an open-ended rectangle in data flow diagrams. (7)

DATA STRUCTURE A structure composed of data elements, typically described using algebraic notation to produce a view of the elements. An 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. (13) *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. (10)

DECISION TABLE A tool for examining, describing, and documenting 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. (14)

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 Definition of 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)

DEVOPS Derived from the words "Development" and "Operations," DevOps is one way to decrease the deployment time for newly developed applications and maximize profit by rapidly addressing market opportunities and getting customer feedback in a timely manner. (6)

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 A GUI design element 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. (12)

EARNED VALUE MANAGEMENT A technique to help determine progress (or setbacks) of a project and involves project cost, the project schedule, and the performance of the project team. (3)

ENTERPRISE SYSTEMS Information systems that are integrated organization-wide (enterprise-wide) that help companies in the coordination of critical organizational processes. (2)

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. (13)

ENVIRONMENT Anything external to an organization. Multiple environments exist, such as the physical, economic, legal, and social environments. (2)

EXPLORATION PHASE The beginning phase of agile development, where an analyst asserts his or her conviction that the agile approach is the correct one and then assembles a development team and assesses their skills. This phase 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) A systems development approach that accepts what we know as good systems development practices and takes them to the extreme. The genesis of agile approaches. (6)

FAVICON A small icon displayed next to a 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 The way that HCI elements of a human, a computer, and a task that needs to be performed work together to improve performance and well-being. (14)

FLAT WEB DESIGN Flat Web design means the use of two-dimensional images to portray objects on a website without shadowing. *See also* skeuomorphic design for a contrast in design approaches. (11)

FOLKLORE A system documentation technique based on traditional methods used in gathering information about people and legends. (16)

FORECASTING System analysts' predictions about 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 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)

GESTURES A variety of movements for a finger or a capacitive device such as a stylus across a touch-sensitive screen on a smartphone or tablet that enables the user to change screens, enlarge or shrink content with a pinch, zoom in or out of a page, or rotate or scroll content. Used with apps for smartphones and tablets. (14)

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. (4)

HYPERLINK A highlighted word in a hypertext system that will display another document when clicked on by the user. (11)

ICON A 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)

INFOGRAPHICS The term infographic can mean any graph, chart, or picture that communicates the data better than words or tables. To the designer, it means visually displaying data for the user to see and choosing which type of graph, chart, or even which numbers are most appropriate. (11)

IMPLEMENTATION The last phase of the systems development life cycle, in which an analyst ensures that the system is in operation and then allows users to take over its operation and evaluation. (6)

INHERITANCE The capacity of a derived class to inherit all the attributes and behaviors of the base class 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. (10)

INPUT Any data, either text or numbers, 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 an 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.

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)

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)

KANBAN A concept widely used in software development that emphasizes visualizing the workflow, keeping work-in-progress (WIP) as small as possible, reevaluating the workflow, reassigning priorities if need be, and striving for continual improvement, eliminating bottlenecks and evaluating WIP limits. (6)

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 a context-level data flow diagram that shows from three to nine major processes, important data flows, and data stores of the system under study. (7)

LINUX KERNEL One of the largest open source projects in the world, the Linux kernel is a monolithic kernel encompassing the software that can be most easily replaced that interfaces with all applications that run in user mode such as CPU, memory, and inter-process communication. (1)

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). (16)

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 that analysts use to generate computer source code, eliminating the need for programming the system. (1) *See also* CASE tools.

MAINTENANCE PHASE A phase of the SDLC in which maintaining the information system to improve it or to fix problems begins. Maintenance continues through the life of a system. Some maintenance can be done automatically through connecting to the vendor's website. (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)

MASHUP A new application created by combining two or more Web-based APIs together. (14)

MNEMONIC A device (often using a combination of letters and symbols) that helps a 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 a user to interact with a computer by speaking or writing in human language. (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, a computer representation of some real-world thing or event; can have both attributes and behaviors. (10)

OBJECT ORIENTED An approach to programming as well as analysis and design that differs from traditional procedural programming by examining the objects that are part of a system. Each object is a computer representation of an actual thing or event. Key object-oriented concepts include objects, classes, and inheritance. The Universal Modeling Language (UML) is the standard diagramming tool for object oriented modeling. (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 liberating software from certain licensing restrictions and publishing its source code, which can then be studied, shared, and modified by users and programmers, sometimes in proprietary ways for profit. 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 an information system by way of intranets, extranets, or the Web, on printed reports, on displays, or via audio. (11)

PACKAGE In UML, a grouping of things that can be considered physical subsystems. Systems are implemented and deployed in packages. (10)

PAIR PROGRAMMING A core practice of the agile approach in which two programmers who choose to work together both do programming, run 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. PERT 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.

PICKER A way to allow users to pick a choice from a predetermined list, available for developing drop down lists for Apple products. A picker includes one or more scrollable list where the selected value appears in darker text in the center of the view. (12)

PLANNING GAME A game used in agile development that spells out rules that can help formulate an agile development team's relationship with its business customers. (1)

PLUG-IN Additional software (often developed by a third party) that can be used with another program; for example, RealNetworks's Real Player and Adobe 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)

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 a 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 that describes the expected results of a 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 project. Frequently, it is a role played by a systems analyst. (3)

PROTOTYPE The word prototype means a model or mock up of a document, system, interface, or display, rather than the actual thing. There are four kinds or prototypes we can use in systems design, patched-up prototype, nonoperational prototype, first-of-a series prototype, and selected features prototype. (6) *See also* prototyping.

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 SDLC for requirements determination or as an alternative to the SDLC. (6) *See also* rapid application development.

PULL-DOWN MENU A GUI design element 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 a database concerning data within it. Each query involves an entity, an attribute, and a value. (14)

QUICK RESPONSE CODE (QR CODE) A popular type of about 30 two-dimensional code (2D) bar codes in existence. Microsoft Tags are another example of a 2D bar code. They are optical and machine-readable codes that appear in print and on the Web and can direct users to encoded websites. (15)

RADIO BUTTON A GUI design element 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. (12)

RECORD A collection of data items that have something in common with the entity described. (13)

RELATIONAL DATABASE MODEL A model that represents data in a 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 An 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 a data structure. (8) *See also* data structure.

SAMPLING Systematically selecting representative elements of a population. Analysts sample hard data, archival data, and people during information requirements determination. (5)

SCRUM Development teams begin a project with a high-level plan that can be changed on the fly as the "game" progresses. Scrum is an agile software development method suitable for complex projects. A limited number of features or tasks are selected for completion in a sprint, typically lasting two to four weeks. The result of is a potentially shippable product. Once the sprint ends, the process begins again with new priorities and features to be finished in the next sprint. (6) *See also* sprint and sprint cycle.

SECOND NORMAL FORM (2NF) A stage of data normalization in which an 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 diagram that 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) An architecture in which individual software services that are unassociated or only loosely coupled to one another are 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)

SKEUOMORPHIC WEB DESIGN Web design featuring 3-D, realistic images with shadows (see in contrast FLAT WEB DESIGN). (6)

SLACK A social media platform for the workplace that incorporates email, chatrooms, and direct messaging. Each work team has channels that are like big chatrooms that can be public or semipublic. (2)

SOFTWARE AS A SERVICE One of the components of cloud computing. It is software distributed by a third-party that hosts applications for users and makes them accessible over the Internet. (3)

SPRINT and SPRINT CYCLE In agile software development methodology, a sprint cycle has development teams working on limited features, lasts two to four weeks, with the result of a potentially shippable product. (6) *See also* Scrum

STATECHART DIAGRAM In UML, a diagram that enables further refinement of requirements. (10)

STICKINESS A property of Web pages, particularly discussed in ecommerce, that indicates how well the pages draw and hold customers. 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)

STORYBOARDING In developing a website (or any app, for that matter), a storyboard could be used to show the differences between screens. It can show, screen by screen, how a visitor to a website would use it to find the information desired. Storyboards can be developed using Microsoft PowerPoint and many other applications. (11)

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 a system's programming and overall development that points out problems and allows a programmer or an analyst to make suitable changes. (16)

SUPPLY CHAIN MANAGEMENT An organization's effort to integrate its 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 A 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 a systems analyst's work in a business up to the current 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 an organization through the use of information systems. (3) *See also* intangible benefits, intangible costs, tangible costs.

TANGIBLE COSTS The costs in dollars that can be accurately projected by a 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.

THINGS In UML, 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) A language that 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)

USE CASE SCENARIO This scenario is a verbal articulation of exceptions to the main behavior described in the primary use case when developing UML diagrams. (10)

USER EXPERIENCE (UX) DESIGN A customer-first method for designing software that observes the behavior of customers and enhances customer satisfaction and loyalty by improving usability and ease of use. UX is also a design culture that emphasizes a good experience for the user over maximizing short-term profit. (14)

USER STORIES Part of the agile approach, a user story captures a requirement from an end user perspective. It is a brief story that is short and easy to comprehend, and services as reminder to developers to hold conversations about the user requirements in user stories. (6)

WEB 2.0 TECHNOLOGIES Collaborative technologies such as blogs, email, and chat rooms that can be added to websites to improve interaction and collaboration. (11)

WEBMASTER The person responsible for updating and maintaining a website; often initially the systems analyst during development of ecommerce applications. (11)

WORK BREAKDOWN STRUCTURE (WBS) A system of breaking down a project into simpler tasks, usually by decomposition. A WBS can be either product or process oriented. Information systems projects tend to be process oriented. (3)

XML SCHEMAS A tool for precisely defining 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* extreme programming. (6)

ACRONYMS

1:1	one-to-one
1:M	one-to-many
1NF	first normal form
2NF	second normal form
3NF	third normal form
AC	actual cost
Ajax	Asynchronous JavaScript and XML
API	application programming interface
AR	augmented reality
AWS	Amazon Web Services
BA	business analytics
BAC	budget at completion
BI	business intelligence
BYOD	bring your own device
BYOT	bring your own technology
CASE	Computer-Aided Software Engineering
CMS	content management system
COCOMO II	Constructive Cost Model
COSYSMO	Construct of Systems Engineering Cost Model
COTS	commercial off-the-shelf
CPI	cost performance index
CRUD	Create, Read, Update, Delete
CV	cost variance
DBMS	database management system
DFD	data flow diagram
DSS	decision support system
DTD	document type definition
E-R	entity-relationship
ERP	enterprise resource planning
EULA	end-user license agreement
EV	earned value
EVM	earned value management
GPL	general public license
GUI	graphical user interface
HCI	human-computer interaction
HTML	hypertext markup language
IaaS	Infrastructure as a Service
ISO	International Organization for Standardization
JAD	joint application design
KDD	knowledge data discovery
LAN	local area network
MICR	magnetic ink character recognition
NFC	near field communication
OCLC	Online Computer Library Center
OCR	optical character recognition
OID	object identifier
OLAP	online analytical processing
O-O	object-oriented
OOA	object-oriented approach
OSS	open source software
OSs	operating systems
PaaS	Platform as a Service
PERT	Program Evaluation and Review Technique
QBE	query by example
QR	Quick Response
RFID	radio frequency identification
RSS	Real Simple Syndication
SaaS	Software as a Service
SAN	storage area network
SDLC	systems development life cycle
SEO	search engine optimization
SOA	service-oriented architecture
SPI	schedule performance index
SQL	Structured Query Language
STROBE	structured observation of the environment
SV	schedule variance
TQM	total quality management
UIs	user interfaces
UML	unified modeling language
UPC	universal product code
UX	user experience
VA	Visible Analyst
VR	virtual reality
WAN	wide area network
WLAN	wireless local area network

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