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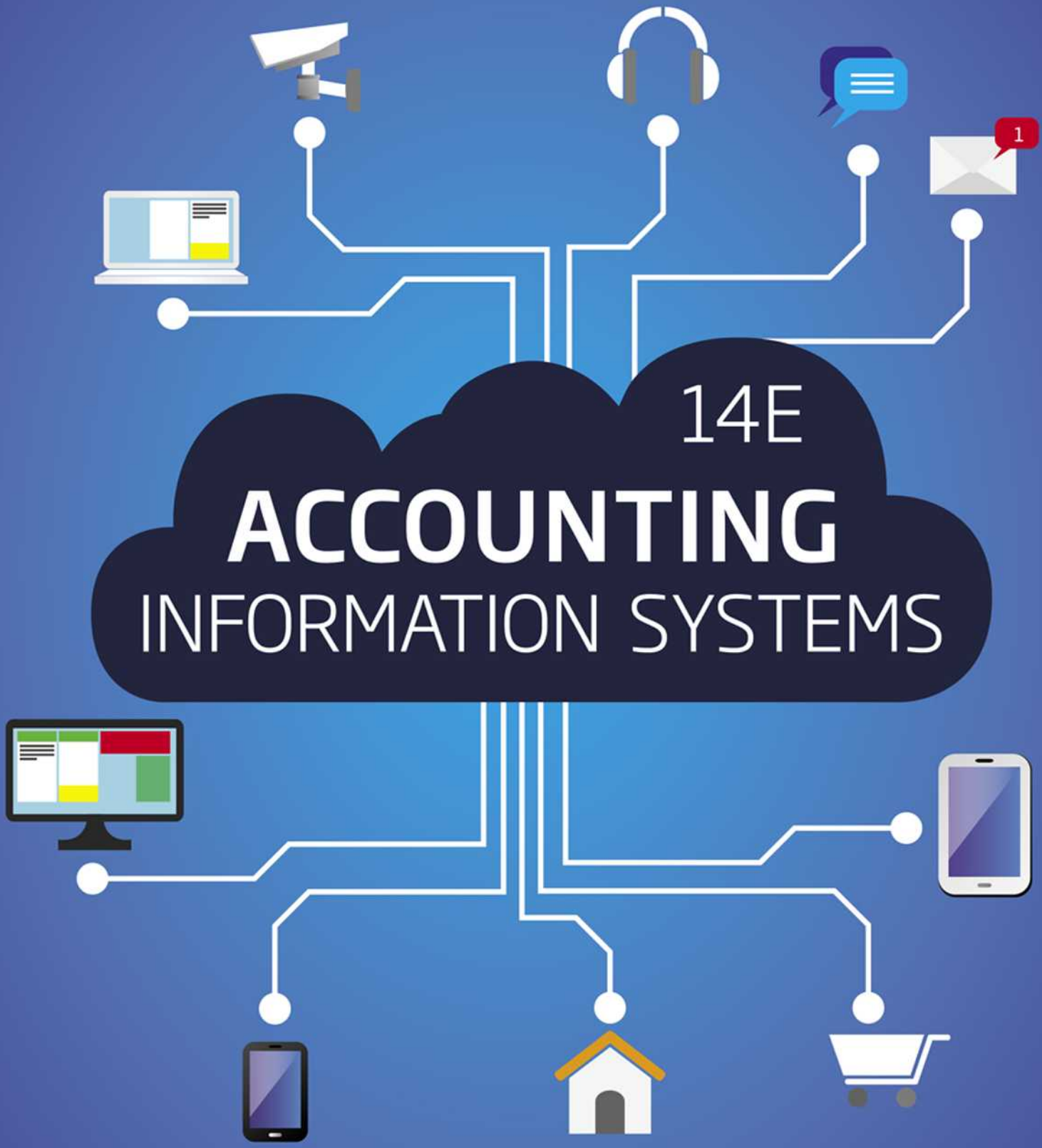

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ACCOUNTING INFORMATION SYSTEMS

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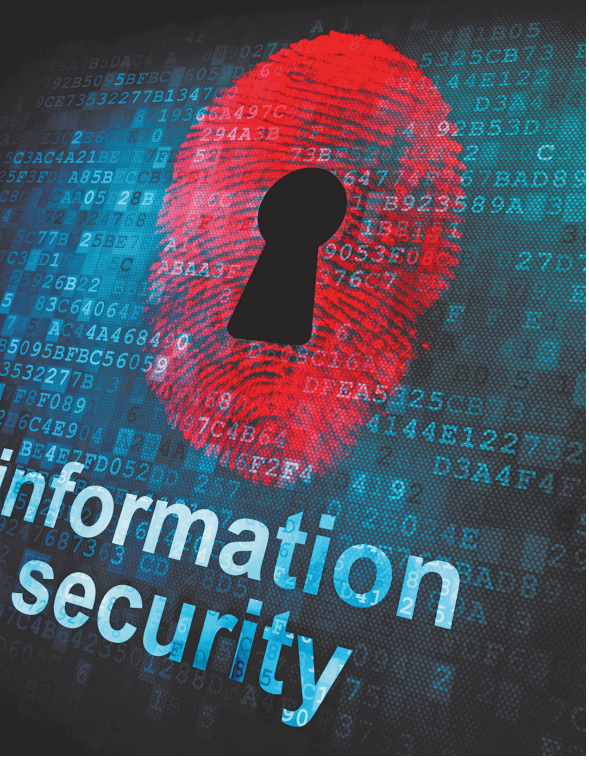

Accounting Information Systems

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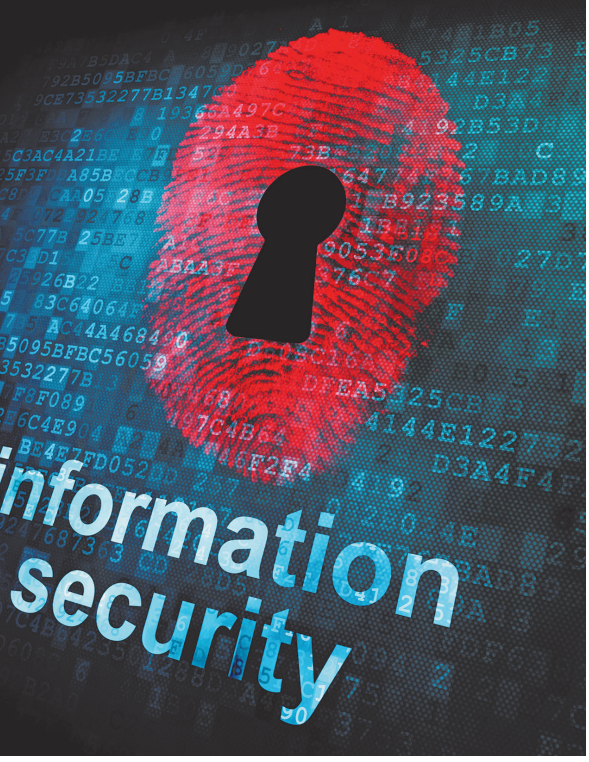

Accounting Information Systems

FOURTEENTH EDITION

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Brief Contents

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Preface

To the Instructor

This book is intended for use in a one-semester course in accounting information systems at either the undergraduate or graduate level. Introductory financial and managerial accounting courses are suggested prerequisites, and an introductory information systems course that covers a computer language or software package is helpful, but not necessary.

The book can also be used as the main text in graduate or advanced undergraduate management information systems courses.

The topics covered in this text provide information systems students with a solid understanding of transaction processing systems that they can then build on as they pursue more in-depth study of specific topics such as databases, data warehouses and data mining, networks, systems analysis and design, cloud computing, virtualization, computer security, and information system controls.

ENHANCEMENTS IN THE FOURTEENTH EDITION

We made extensive revisions to the content of the material to incorporate recent developments, while retaining the features that have made prior editions easy to use. Every chapter has been updated to include up-to-date examples of important concepts. Specific changes include:

1. We discuss the new revision to the COSO framework and have updated the discussion of IT controls to reflect the new distinction between governance and management that was introduced in COBIT 5.
2. Updated discussion of information security countermeasures, including the security and control implications associated with virtualization and cloud computing.
3. Updated end-of-chapter discussion questions and problems, including Excel exercises that are based on articles from the *Journal of Accountancy* so that students can develop the specific skills used by practitioners. Most chapters also include a problem that consists of multiple-choice questions that we have used in our exams to provide students with an additional chance to check how well they understand the chapter material.
4. Many new computer fraud and abuse techniques have been added to help students understand the way systems are attacked.
5. Chapter 21 includes a new section on agile development technologies that discusses scrum development, extreme programming, and unified process development.

CUSTOMIZING THIS TEXT

Pearson Custom Library can help you customize this textbook to fit how you teach the course. You can select just the chapters from this text that you plan to cover and arrange them in the sequence you desire. You even have the option to add your own material or third party content.

In addition, you may choose an alternate version of the REA material presented in Chapters 17–19 that uses the Batini style notation instead of the crows feet notation featured in this book.

To explore how to create a customized version of the book you can contact your Pearson representative.

SUPPLEMENTAL RESOURCES

As with prior editions, our objective in preparing this fourteenth edition has been to simplify the teaching of AIS by enabling you to concentrate on classroom presentation and discussion, rather than on locating, assembling, and distributing teaching materials. To assist you in this process, the following supplementary materials are available to adopters of the text:

- *Solutions Manual* prepared by Marshall Romney at Brigham Young University and Paul John Steinbart at Arizona State University
- *Instructors Manual* prepared by Robyn Raschke at University of Nevada–Las Vegas
- *Test Item File* prepared by Lawrence Chui at University of St. Thomas
- *TestGen testing software*, a computerized test item file
- *PowerPoint Presentation* slides developed by Robyn Raschke at University of Nevada–Las Vegas

The fourteenth edition includes an entirely new set of PowerPoint slides that make extensive use of high-quality graphics to illustrate key concepts. The slides do not merely consist of bullet points taken verbatim from the text, but instead are designed to help students notice and understand important relationships among concepts. The large number of slides provides instructors a great deal of flexibility in choosing which topics they wish to emphasize in class.

In addition, you can access all these supplements from the protected instructor area of www.pearsonhighered.com.

We recognize that you may also wish to use specific software packages when teaching the AIS course. Contact your Pearson representative to learn about options for bundling this text (or a customized version) with software packages or other texts such as *Computerized Practice Set for Comprehensive Assurance & System Tool (CAST); Manual Practice Set for Comprehensive Assurance and Systems Tool (CAST); Comprehensive Assurance & System Tools (CAST): An Integrated Practice Set; or Assurance Practice Set for Comprehensive Assurance & System Tool (CAST)*, all written by Laura R. Ingraham and J. Gregory Jenkins, both at North Carolina State University.

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To the Student

As did previous editions, the fourteenth edition of *Accounting Information Systems* is designed to prepare you for a successful accounting career whether you enter public practice, industry, or government. All of you will be users of accounting information systems. In addition to being users, some of you will become managers. Others will become internal and external auditors, and some of you will become consultants. Regardless of your role, you will need to understand how accounting information systems work in order to effectively measure how cost-effectively

they perform, to assess their reliability and that of the information produced, or to lead the redesign and implementation of new and better systems. Mastering the material presented in this text will give you the foundational knowledge you need in order to excel at all those tasks.

This text discusses important new IT developments, such as virtualization and the move to cloud computing, because such developments affect business processes and often cause organizations to redesign their accounting systems to take advantage of new capabilities. The focus, however, is not on IT for the sake of IT, but on how IT affects business processes and controls. Indeed, new IT developments not only bring new capabilities, but also often create new threats and affect the overall level of risk. This text will help you understand these issues so that you can properly determine how to modify accounting systems controls to effectively address those new threats and accurately assess the adequacy of controls in those redesigned systems. We also discuss the effect of recent regulatory developments, such as the SEC mandate to use XBRL and the pending switch from GAAP to IFRS, on the design and operation of accounting systems.

In addition to technology- and regulatory-driven changes, companies are responding to the increasingly competitive business environment by reexamining every internal activity in an effort to reap the most value at the least cost. As a result, accountants are being asked to do more than simply report the results of past activities. They must take a more proactive role in both providing and interpreting financial and nonfinancial information about the organization's activities. Therefore, throughout this text we discuss how accountants can improve the design and functioning of the accounting information system (AIS) so that it truly adds value to the organization by providing management with the information needed to effectively run an organization.

Key Learning Objectives

When you finish reading this text, you should understand the following key concepts:

- The basic activities performed in the major business cycles
- What data needs to be collected to enable managers to plan, evaluate, and control the business activities in which an organization engages
- How IT developments can improve the efficiency and effectiveness of business processes
- How to design an AIS to provide the information needed to make key decisions in each business cycle
- The risk of fraud and the motives and techniques used to perpetrate fraud
- The COSO and COSO-ERM models for internal control and risk management, as well as the specific controls used to achieve those objectives
- The Control Objectives for Information and Related Technology (COBIT) Framework for the effective governance and control of information systems and how IT affects the implementation of internal controls
- The AICPA's Trust Services framework for ensuring systems reliability by developing procedures to protect the confidentiality of proprietary information, maintain the privacy of personally identifying information collected from customers, assure the availability of information resources, and provide for information processing integrity
- Fundamentals of information security
- Goals, objectives, and methods for auditing information systems
- Fundamental concepts of database technology and data modeling and their effect on an AIS
- The tools for documenting AIS work, such as REA diagrams, data flow diagrams, business processing diagrams, and flowcharts
- The basic steps in the system development process to design and improve an AIS

Features to Facilitate Learning

To help you understand these concepts the text includes the following features:

1. **Each chapter begins with an integrated case that introduces that chapter's key concepts and topics and identifies several key issues or problems that you should be able**

to solve after mastering the material presented in that chapter. The case is referenced throughout the chapter and the chapter summary presents solutions to the problems and issues raised in the case.

2. **Focus Boxes and real-world examples** to help you understand how companies are using the latest IT developments to improve their AIS.
3. **Hands-on Excel exercises in many chapters** to help you hone your computer skills. Many of these exercises are based on "how-to" tutorials that appeared in recent issues of the *Journal of Accountancy*.
4. **Numerous problems in every chapter** provide additional opportunities for you to demonstrate your mastery of key concepts. Many problems were developed from reports in current periodicals. Other problems were selected from the various professional examinations, including the CPA, CMA, CIA, and SMAC exams. One problem consists of a set of multiple-choice questions in order to provide practice in answering exam-style questions. **Each chapter also has one or more cases** that require more extensive exploration of specific topics.
5. **Chapter quizzes** at the end of each chapter enable you to self-assess your understanding of the material. We also provide detailed explanations about the correct answer to each quiz question.
6. **Extensive use of Full-Color Graphics.** The text contains hundreds of figures, diagrams, flowcharts, and tables that illustrate the concepts taught in the chapters. Color is used to highlight key points.
7. Definitions of key terms are repeated in the **glossary margins** in each chapter. In addition, a **comprehensive glossary** located at the back of the book makes it easy to look up the definition of the various technical terms used in the text.
8. **Extensive on-line support** at Pearson's content-rich, text-supported Companion Website at www.pearsonhighered.com/romney/.

Excel Homework Problems

Accountants need to become proficient with Excel because it is a useful tool for tasks related to every business process. That is why each of the chapters in the business process section contains several homework problems that are designed to teach you new Excel skills in a context related to one of the business processes discussed in the chapter.

As with any software, Microsoft regularly releases updates to Microsoft Office, but not everyone always immediately switches. Eventually, however, during your career you will periodically move to a newer version of Excel. When you do, you will find that sometimes you need make only minor changes to existing spreadsheets, but other times you may have to make more significant changes because the newer version of Excel now incorporates different features and functions.

So how do you keep abreast of changes? And how can you learn new Excel skills "on the job" to simplify tasks that you now find yourself doing repeatedly? You could pay to take a course, but that can be costly, time-consuming and may not always be timely. Alternatively, you can develop life-long learning skills to continuously update your knowledge. One important way to do this is to begin now to save copies of two types of articles that regularly appear in the *Journal of Accountancy*. The first is the monthly column titled "Technology Q&A," which often contains answers to questions about how do you do something in a newer version of Excel that you know how to do in an older version. The second type of article is a complete tutorial about a powerful way to use one or more Excel functions to automate a recurring task. Often, this second type of article has an online spreadsheet file that you can download and use to follow along with the example and thereby teach yourself a new skill.

The *Journal of Accountancy* web site maintains an archive of these articles that you can search to see if there is one that addresses a task that is new for you. Even if the article explains how to do something (such as create a pivot table) in an older version of Excel, in most cases you will find that many of the steps have not changed. For those that have, if you read

the old way to do it as described in the article, you can then use Excel's built-in help feature to see how to do the same task in the newer version that you are now using.

The Excel homework problems in the five business process chapters in this textbook let you practice using *Journal of Accountancy* articles to help you develop new skills with Excel. Many of the problems reference a *Journal of Accountancy* tutorial article. Some are written for the version of Excel that you currently use, in which case it will be straightforward to follow the article to solve the problem. Others, however, were written for earlier versions of Excel, which gives you an opportunity to practice learning how to use Excel's help functions to update the steps in the tutorial.

Content and Organization

This text is divided into five parts, each focused on a major theme.

PART I: CONCEPTUAL FOUNDATIONS OF ACCOUNTING INFORMATION SYSTEMS

Part I consists of four chapters which present the underlying concepts fundamental to an understanding of AIS. Chapter 1 introduces basic terminology and provides an overview of AIS topics. It discusses how an AIS can add value to an organization and how it can be used to help organizations implement corporate strategy. It also discusses the types of information companies need to successfully operate and introduces the basic business processes that produce that information. It concludes by describing the role of the AIS in an organization's value chain.

Chapter 2 introduces transaction processing in automated systems, presenting basic information input/output, processing, and data storage concepts. You will see the wide range of data that must be collected by the AIS. This information helps you to understand what an AIS does; as you read the remainder of the book, you will see how advances in IT affect the manner in which those functions are performed. Chapter 2 also introduces you to Enterprise Resource Planning (ERP) systems and discusses their importance and uses in modern business.

Chapter 3 covers three of the most important tools and techniques used to understand, evaluate, design, and document information systems: data flow diagrams, business process diagrams, and flowcharts. You will learn how to read, critique, and create systems documentation using these tools.

Chapter 4 introduces the topic of databases, with a particular emphasis on the relational data model and creating queries in Microsoft Access. The chapter also introduces the concept of business intelligence.

PART II: CONTROL AND AUDIT OF ACCOUNTING INFORMATION SYSTEMS

The seven chapters in Part II focus on threats to the reliability of AIS and applicable controls for addressing and mitigating the risks associated with those threats. Chapter 5 introduces students to the different kinds of threats faced by information systems, primarily focusing on the threat of fraud. The chapter describes the different types of fraud and explains how fraud is perpetrated, who perpetrates it, and why it occurs.

Chapter 6 discusses computer fraud and abuse techniques. Three major types of computer fraud are discussed: computer attacks and abuse, social engineering, and malware. The chapter explains the dozens of ways computer fraud and abuse can be perpetrated.

Chapter 7 uses the COSO framework, including the expanded enterprise risk management (COSO-ERM) model, to discuss the basic concepts of internal control. It also introduces the COBIT framework which applies those concepts to IT, thereby providing a foundation for effective governance and control of information systems.

Chapter 8 focuses on information security. It introduces the fundamental concepts of defense-in-depth and the time-based approach to security. The chapter provides a broad survey of a variety of security topics including access controls, firewalls, encryption, and incident detection and response.

Chapter 9 discusses the many specific computer controls used in business organizations to achieve the objectives of ensuring privacy and confidentiality, and includes a detailed explanation of encryption.

Chapter 10 addresses the controls necessary to achieve the objectives of accurate processing of information and ensuring that information is available to managers whenever and wherever they need it.

Chapter 11 describes principles and techniques for the audit and evaluation of internal control in a computer-based AIS and introduces the topic of computer-assisted auditing.

PART III: ACCOUNTING INFORMATION SYSTEMS APPLICATIONS

Part III focuses on how a company's AIS provides critical support for its fundamental business processes. Most large and many medium-sized organizations use enterprise resource planning (ERP) systems to collect, process, and store data about their business processes, as well as to provide information reports designed to enable managers and external parties to assess the organization's efficiency and effectiveness. To make it easier to understand how an ERP system functions, Part III consists of five chapters, each focusing on a particular business process.

Chapter 12 covers the revenue cycle, describing all the activities involved in taking customer orders, fulfilling those orders, and collecting cash.

Chapter 13 covers the expenditure cycle, describing all the activities involved in ordering, receiving, and paying for merchandise, supplies, and services.

Chapter 14 covers the production cycle, with a special focus on the implications of recent cost accounting developments, such as activity-based costing, for the design of the production cycle information system.

Chapter 15 covers the human resources management/payroll cycle, focusing primarily on the activities involved in processing payroll.

Chapter 16 covers the general ledger and reporting activities in an organization, discussing topics such as XBRL, the balanced scorecard, the switch from GAAP to IFRS, and the proper design of graphs to support managerial decision making.

Each of these five chapters explains the three basic functions performed by the AIS: efficient transaction processing, provision of adequate internal controls to safeguard assets (including data), and preparation of information useful for effective decision making.

PART IV: THE REA DATA MODEL

Part IV consists of three chapters that focus on the REA data model, which provides a conceptual tool for designing and understanding the database underlying an AIS. Chapter 17 introduces the REA data model and how it can be used to design an AIS database. The chapter focuses on modeling the revenue and expenditure cycles. It also demonstrates how the REA model can be used to develop an AIS that can not only generate traditional financial statements and reports but can also more fully meet the information needs of management.

Chapter 18 explains how to implement an REA data model in a relational database system. It also shows how to query a relational database in order to produce various financial statements and management reports.

Chapter 19 explains how to develop REA data models of the production, HR/payroll, and financing cycles. It also discusses a number of advanced modeling issues, such as the acquisition and sale of intangible products and services and rental transactions.

PART V: THE SYSTEMS DEVELOPMENT PROCESS

Part V consists of three chapters that cover various aspects of the systems development process. Chapter 20 introduces the systems development life cycle and discusses the introductory steps of this process (systems analysis, feasibility, and planning). Particular emphasis is placed on the behavioral ramifications of change.

Chapter 21 discusses an organization's many options for acquiring or developing an AIS (e.g., purchasing software, writing software, end-user-developed software, and outsourcing) and for speeding up or improving the development process (business process reengineering, prototyping, agile methodologies, and computer-assisted software engineering).

Chapter 22 covers the remaining stages of the systems development life cycle (conceptual design, physical design, implementation, and operation and maintenance) and emphasizes the interrelationships among the phases.

Acknowledgments

We wish to express our appreciation to all supplements authors for preparing the various supplements that accompany this edition. We thank Martha M. Eining of the University of Utah and Carol F. Venable of San Diego State University for preparing the comprehensive cases included on our Web site. We are also grateful to Iris Vessey for her contributions to the problem material. We thank Bill Heninger of Brigham Young University for allowing us to use portions of his database normalization tutorial to create the Appendix to Chapter 4.

Perhaps most importantly, we are indebted to the numerous faculty members throughout the world who have adopted the earlier editions of this book and who have been generous with their suggestions for improvement. We are especially grateful to the following faculty who participated in reviewing the fourteenth edition throughout various stages of the revision process:

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A. Ruth Prato, *University of Alaska Fairbanks*
Srinivasan Ragothaman, *University of South Dakota*
Ankita Singhvi, *Suffolk University*

We are grateful for permission received from four professional accounting organizations to use problems and unofficial solutions from their past professional examinations in this book. Thanks are extended to the American Institute of Certified Public Accountants for use of the CPA Examination materials, to the Institute of Certified Management Accountants for use of CMA Examination materials, to the Institute of Internal Auditors for use of CIA Examination materials, and to the Society of Management Accountants of Canada for use of SMAC Examination materials. We also wish to thank Netsuite, Inc., for providing permission to use screenshots of their software throughout the text.

Of course, any errors in this book remain our responsibility. We welcome your comments and suggestions for further improvement.

Finally, we want to thank our wives and families for their love, support, and encouragement. We also want to thank God for giving us the ability to start and complete this book.

— Marshall B. Romney
Provo, Utah
—Paul John Steinbart
Tempe, Arizona

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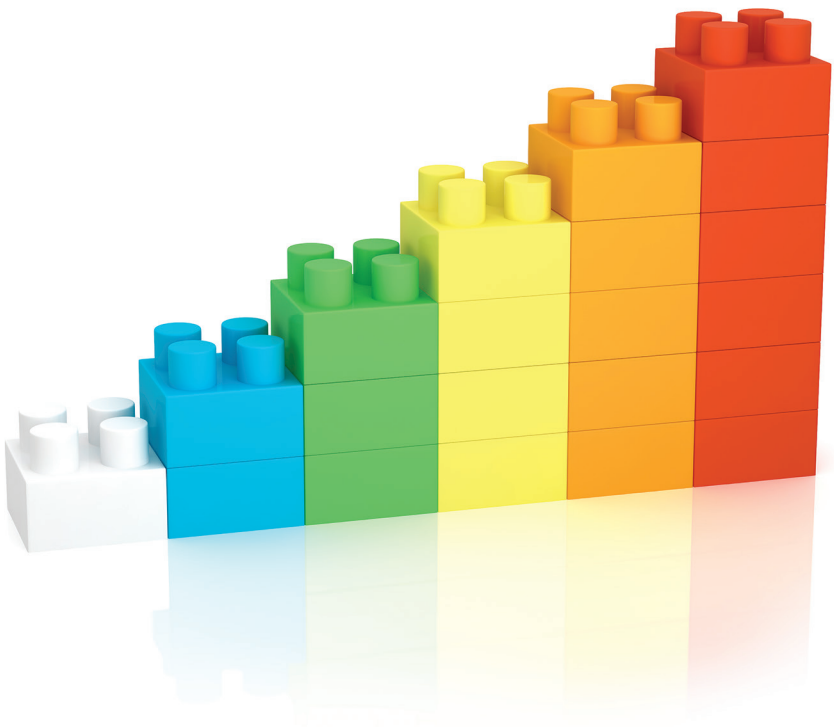
Conceptual Foundations of Accounting Information Systems

PART

I



CHAPTER

1

Accounting Information Systems: An Overview

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

1. Distinguish data from information, discuss the characteristics of useful information, and explain how to determine the value of information.
2. Explain the decisions an organization makes, the information needed to make them, and the major business processes present in most companies.
3. Explain how an AIS adds value to an organization, how it affects and is affected by corporate strategy, and its role in a value chain.

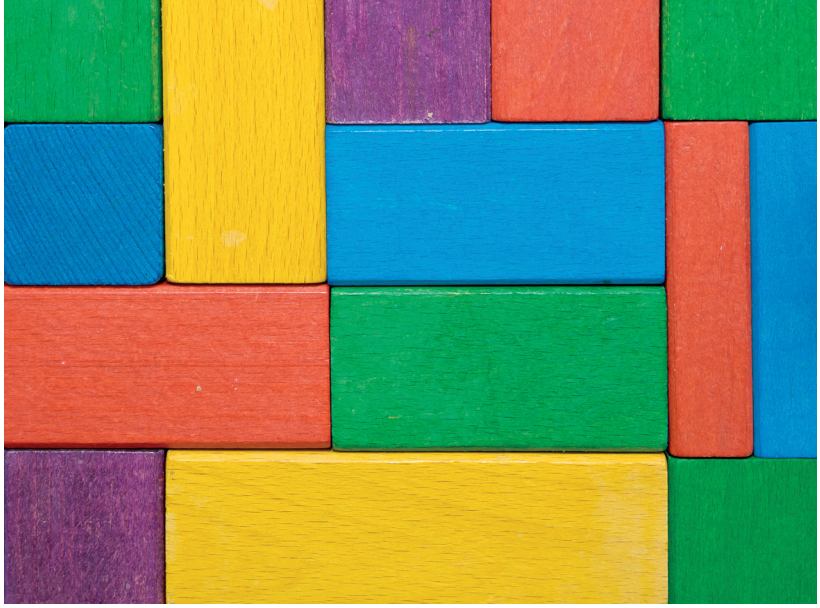
INTEGRATIVE CASE S&S

After working for years as a regional manager for a retail organization, Scott Parry opened his own business with Susan Gonzalez, one of his district managers, as his partner. They formed S&S to sell appliances and consumer electronics. Scott and Susan pursued a "clicks and bricks" strategy by renting a building in a busy part of town and adding an electronic storefront.

Scott and Susan invested enough money to see them through the first six months. They will hire 15 employees within the next two weeks—three to stock the shelves, four sales representatives, six checkout clerks, and two to develop and maintain the electronic storefront.

Scott and Susan will host S&S's grand opening in five weeks. To meet that deadline, they have to address the following important issues:

1. What decisions do they need to make to be successful and profitable? For example:
   a. How should they price products to be competitive yet earn a profit?
   b. Should they extend credit, and, if so, on what terms? How can they accurately track what customers owe and pay?
   c. How should they hire, train, and supervise employees? What compensation and benefits package should they offer? How should they process payroll?
   d. How can they track cash inflows and outflows to avoid a cash squeeze?
   e. What is the appropriate product mix? What inventory quantities should they carry, given their limited showroom space?



2. What information do Scott and Susan need to make those decisions?
   a. What information do the external entities they interact with need?
   b. What information do management and other employees need?
   c. How can they gather, store, and disseminate that information?
3. What business processes are needed, and how should they be carried out?
4. What functionality should be provided on the website?

Although Scott and Susan could use an educated guess or "gut feeling" to make these decisions, they know they can make better decisions if they obtain additional information. A well-designed AIS can solve these issues and provide the information they need to make any remaining decisions.

Introduction

We begin this chapter by explaining important terms and discussing the kinds of information that organizations need and the business processes used to produce that information. We continue with an exploration of what an accounting information system (AIS) is, how an AIS adds value to an organization, how an AIS and corporate strategy affect each other, and the role of the AIS in the value chain.

A **system** is a set of two or more interrelated components that interact to achieve a goal. Most systems are composed of smaller subsystems that support the larger system. For example, a college of business is a system composed of various departments, each of which is a subsystem. Moreover, the college itself is a subsystem of the university.

Each subsystem is designed to achieve one or more organizational goals. Changes in subsystems cannot be made without considering the effect on other subsystems and on the system as a whole. **Goal conflict** occurs when a subsystem's goals are inconsistent with the goals of another subsystem or with the system as a whole. **Goal congruence** occurs when a subsystem achieves its goals while contributing to the organization's overall goal. The larger the organization and the more complicated the system, the more difficult it is to achieve goal congruence.

Data are facts that are collected, recorded, stored, and processed by an information system. Businesses need to collect several kinds of data, such as the activities that take place, the resources affected by the activities, and the people who participate in the activity. For example, the business needs to collect data about a sale (date, total amount), the resource sold (good or service, quantity sold, unit price), and the people who participated (customer, salesperson).

Information is data that have been organized and processed to provide meaning and improve the decision-making process. As a rule, users make better decisions as the quantity and quality of information increase.

system - Two or more interrelated components that interact to achieve a goal, often composed of subsystems that support the larger system.

goal conflict - When a subsystem's goals are inconsistent with the goals of another subsystem or the system as a whole.

goal congruence - When a subsystem achieves its goals while contributing to the organization's overall goal.

data - Facts that are collected, recorded, stored, and processed by an information system.

information - Data that have been organized and processed to provide meaning and improve decision making.

TABLE 1-1 Characteristics of Useful Information

Relevant	Reduces uncertainty, improves decision making, or confirms or corrects prior expectations.
Reliable	Free from error or bias; accurately represents organization events or activities.
Complete	Does not omit important aspects of the events or activities it measures.
Timely	Provided in time for decision makers to make decisions.
Understandable	Presented in a useful and intelligible format.
Verifiable	Two independent, knowledgeable people produce the same information.
Accessible	Available to users when they need it and in a format they can use.

information overload - Exceeding the amount of information a human mind can absorb and process, resulting in a decline in decision-making quality and an increase in the cost of providing information.

Information technology (IT) - The computers and other electronic devices used to store, retrieve, transmit, and manipulate data.

value of information - The benefit provided by information less the cost of producing it.

However, there are limits to the amount of information the human mind can absorb and process. **Information overload** occurs when those limits are passed, resulting in a decline in decision-making quality and an increase in the cost of providing that information. Information system designers use **information technology (IT)** to help decision makers more effectively filter and condense information. For example, Walmart has over 500 terabytes (trillions of bytes) of data in its data warehouse. That is equivalent to 2,000 miles of bookshelves, or about 100 million digital photos. Walmart has invested heavily in IT so it can effectively collect, store, analyze, and manage data to provide useful information.

The **value of information** is the benefit produced by the information minus the cost of producing it. Benefits of information include reduced uncertainty, improved decisions, and improved ability to plan and schedule activities. The costs include the time and resources spent to produce and distribute the information. Information costs and benefits can be difficult to quantify, and it is difficult to determine the value of information before it has been produced and utilized. Nevertheless, the expected value of information should be calculated as effectively as possible so that the costs of producing the information do not exceed its benefits.

To illustrate the value of information, consider the case of 7-Eleven. When a Japanese company licensed the very successful 7-Eleven name from Southland Corporation, it invested heavily in IT. However, the U.S. stores did not. Each 7-Eleven store in Japan was given a computer that:

- Keeps track of the 3,000 items sold in each store and determines what products are moving, at what time of day, and under what weather conditions.
- Keeps track of what and when customers buy to make sure it has in stock the products most frequently purchased.
- Orders sandwiches and rice dishes from suppliers automatically. Orders are placed and filled three times a day so that stores always have fresh food. In addition, suppliers can access 7-Eleven sales data electronically so that they can forecast demand.
- Coordinates deliveries with suppliers. This reduces deliveries from 34 to 12 a day, resulting in less clerical receiving time.
- Prepares a color graphic display that indicates which store areas contribute the most to sales and profits.

Average daily sales of 7-Eleven Japan were 30% higher and its operating margins almost double those of its closest competitor. What happened to Southland and its 7-Eleven stores in the United States? Profits declined, and Southland eventually had to file for bankruptcy. 7-Eleven Japan came to the company's rescue and purchased 64% of Southland.

Table 1-1 presents seven characteristics that make information useful and meaningful.

Information Needs and Business Processes

business process - A set of related, coordinated, and structured activities and tasks, performed by a person, a computer, or a machine, that help accomplish a specific organizational goal.

All organizations need information in order to make effective decisions. In addition, all organizations have certain business processes in which they are continuously engaged. A **business process** is a set of related, coordinated, and structured activities and tasks that are performed by a person, a computer, or a machine, and that help accomplish a specific organizational goal.

To make effective decisions, organizations must decide what decisions they need to make, what information they need to make the decisions, and how to gather and process the data needed to produce the information. This data gathering and processing is often tied to the basic business processes in an organization. To illustrate the process of identifying information needs and business processes, let's return to our S&S case study.

INFORMATION NEEDS

Scott and Susan decide they must understand how S&S functions before they can identify the information they need to manage S&S effectively. Then they can determine the types of data and procedures they will need to collect and produce that information. They created Table 1-2

TABLE 1-2 Overview of S&S's Business Processes, Key Decisions, and Information Needs

BUSINESS PROCESSES	KEY DECISIONS	INFORMATION NEEDS
Acquire capital	How much	Cash flow projections
	Find investors or borrow funds	Pro forma financial statements
	If borrowing, obtain best terms	Loan amortization schedule
Acquire building and equipment	Size of building	Capacity needs
	Amount of equipment	Building and equipment prices
	Rent or buy	Market study
	Location	Tax tables and depreciation regulations
	How to depreciate	
Hire and train employees	Experience requirements	Job descriptions
	How to assess integrity and competence of applicants	Applicant job history and skills
	How to train employees	
Acquire inventory	What models to carry	Market analyses
	How much to purchase	Inventory status reports
	How to manage inventory (store, control, etc.)	Vendor performance
	Which vendors	
Advertising and marketing	Which media	Cost analyses
	Content	Market coverage
Sell merchandise	Markup percentage	Pro forma income statement
	Offer in-house credit	Credit card costs
	Which credit cards to accept	Customer credit status
Collect payments from customers	If offering credit, what terms	Customer account status
	How to handle cash receipts	Accounts receivable aging report
		Accounts receivable records
Pay employees	Amount to pay	Sales (for commissions)
	Deductions and withholdings	Time worked (hourly employees)
	Process payroll in-house or use outside service	W-4 forms
		Costs of external payroll service
Pay taxes	Payroll tax requirements	Government regulations
	Sales tax requirements	Total wage expense
		Total sales
Pay vendors	Whom to pay	Vendor invoices
	When to pay	Accounts payable records
	How much to pay	Payment terms

to summarize part of their analysis. It lists S&S's basic business processes, some key decisions that need to be made for each process, and information they need to make the decisions.

Scott and Susan realize that the list is not exhaustive, but they are satisfied that it provides a good overview of S&S. They also recognize that not all the information needs listed in the right-hand column will be produced internally by S&S. Information about payment terms for merchandise purchases, for example, will be provided by vendors. Thus, S&S must effectively integrate external data with internally generated data so that Scott and Susan can use both types of information to run S&S.

S&S will interact with many external parties, such as customers, vendors, and governmental agencies, as well as with internal parties such as management and employees. To get a better handle on the more important interactions with these parties, they prepared Figure 1-1.

transaction - An agreement between two entities to exchange goods or services, such as selling inventory in exchange for cash; any other event that can be measured in economic terms by an organization.

transaction processing - Process of capturing transaction data, processing it, storing it for later use, and producing information output, such as a managerial report or a financial statement.

give-get exchange - Transactions that happen a great many times, such as giving up cash to get inventory from a supplier and giving employees a paycheck in exchange for their labor.

business processes or transaction cycles - The major give-get exchanges that occur frequently in most companies.

revenue cycle - Activities associated with selling goods and services in exchange for cash or a future promise to receive cash.

BUSINESS PROCESSES

Scott decides to reorganize the business processes listed in Table 1-2 into groups of related transactions. A **transaction** is an agreement between two entities to exchange goods or services or any other event that can be measured in economic terms by an organization. Examples include selling goods to customers, buying inventory from suppliers, and paying employees. The process that begins with capturing transaction data and ends with informational output, such as the financial statements, is called **transaction processing**. Transaction processing is covered in more depth in Chapter 2.

Many business activities are pairs of events involved in a **give-get exchange**. Most organizations engage in a small number of give-get exchanges, but each type of exchange happens many times. For example, S&S will have thousands of sales to customers every year in exchange for cash. Likewise, S&S will continuously buy inventory from suppliers in exchange for cash.

These exchanges can be grouped into five major **business processes or transaction cycles**:

- The **revenue cycle**, where goods and services are sold for cash or a future promise to receive cash. This cycle is discussed in Chapter 12.

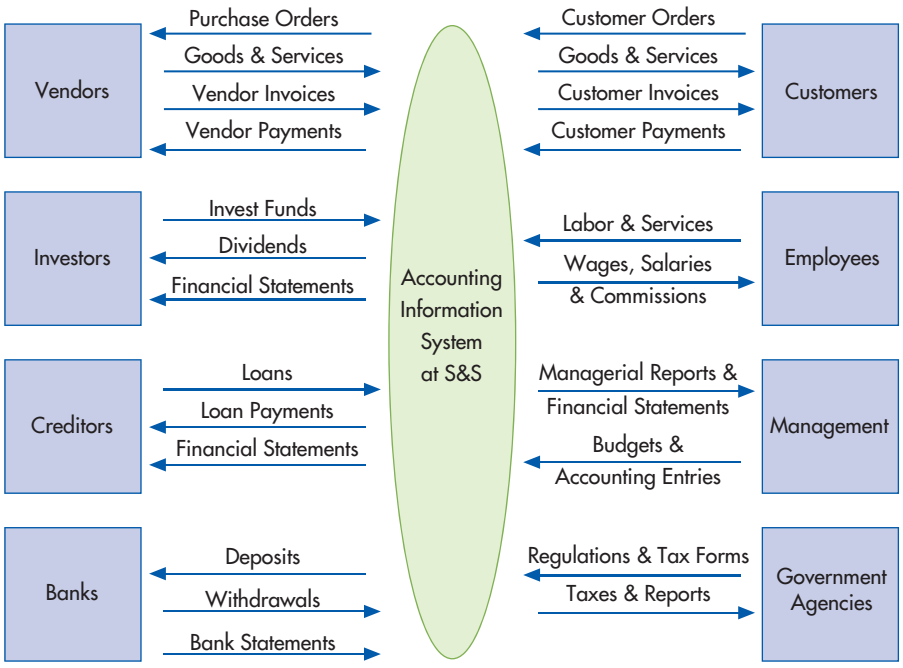


FIGURE 1-1
Interactions between S&S and External and Internal Parties

- The **expenditure cycle**, where companies purchase inventory for resale or raw materials to use in producing products in exchange for cash or a future promise to pay cash. This cycle is discussed in Chapter 13.
- The **production or conversion cycle**, where raw materials are transformed into finished goods. This cycle is discussed in Chapter 14.
- The **human resources/payroll cycle**, where employees are hired, trained, compensated, evaluated, promoted, and terminated. This cycle is discussed in Chapter 15.
- The **financing cycle**, where companies sell shares in the company to investors and borrow money, and where investors are paid dividends and interest is paid on loans.

expenditure cycle - Activities associated with purchasing inventory for resale or raw materials in exchange for cash or a future promise to pay cash.

production or conversion cycle - Activities associated with using labor, raw materials, and equipment to produce finished goods.

human resources/payroll cycle - Activities associated with hiring, training, compensating, evaluating, promoting, and terminating employees.

financing cycle - Activities associated with raising money by selling shares in the company to investors and borrowing money as well as paying dividends and interest.

These cycles process a few related transactions repeatedly. For example, most revenue cycle transactions are either selling goods or services to customers or collecting cash for those sales. Figure 1-2 shows the main transaction cycles and the give-get exchange inherent in each cycle.

These basic give-get exchanges are supported by a number of other business activities. For example, S&S may need to answer a number of customer inquiries and check inventory levels before it can make a sale. Likewise, it may have to check customer credit before a credit sale is made. Accounts receivable will have to be increased each time a credit sale is made

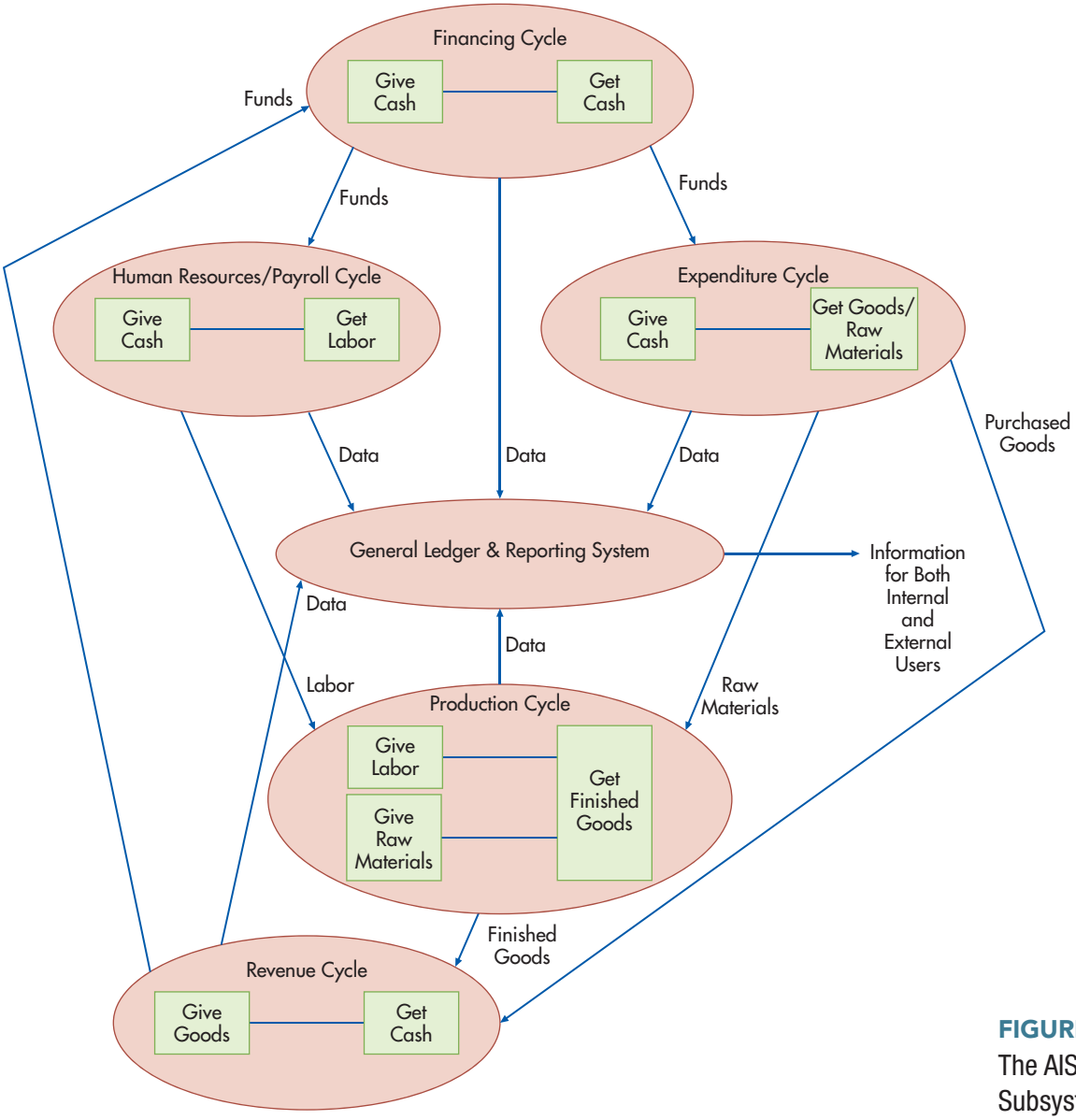


FIGURE 1-2
The AIS and Its Subsystems

and decreased each time a customer payment is received. Table 1-3 lists the major activities in each transaction cycle.

Notice that the last activity listed in Table 1-3 for each transaction cycle is "Send appropriate information to the other cycles." Figure 1-2 shows how these various transaction cycles relate to one another and interface with the **general ledger and reporting system**, which is used to generate information for both management and external parties. The general ledger and reporting system is discussed in more depth in Chapter 16.

general ledger and reporting system - Information-processing operations involved in updating the general ledger and preparing reports for both management and external parties.

In many accounting software packages, the various transaction cycles are implemented as separate modules. Not every organization needs to implement every module. Retail stores like S&S, for example, do not have a production cycle and would not implement that

TABLE 1-3 Common Cycle Activities

TRANSACTION CYCLE	MAJOR ACTIVITIES IN THE CYCLE
Revenue	Receive and answer customer inquiries
	Take customer orders and enter them into the AIS
	Approve credit sales
	Check inventory availability
	Initiate back orders for goods out of stock
	Pick and pack customer orders
	Ship goods to customers or perform services
	Bill customers for goods shipped or services performed
	Update (increase) sales and accounts receivable
	Receive customer payments and deposit them in the bank
	Update (reduce) accounts receivable
	Handle sales returns, discounts, allowances, and bad debts
	Prepare management reports
	Send appropriate information to the other cycles
Expenditure	Request goods and services be purchased
	Prepare, approve, and send purchase orders to vendors
	Receive goods and services and complete a receiving report
	Store goods
	Receive vendor invoices
	Update (increase) accounts payable
	Approve vendor invoices for payment
	Pay vendors for goods and services
	Update (reduce) accounts payable
	Handle purchase returns, discounts, and allowances
	Prepare management reports
	Send appropriate information to the other cycles
Human Resources/Payroll	Recruit, hire, and train new employees
	Evaluate employee performance and promote employees
	Discharge employees
	Update payroll records
	Collect and validate time, attendance, and commission data
	Prepare and disburse payroll
	Calculate and disburse taxes and benefit payments

TABLE 1-3 Continued

TRANSACTION CYCLE	MAJOR ACTIVITIES IN THE CYCLE
	Prepare employee and management reports
	Send appropriate information to the other cycles
Production	Design products
	Forecast, plan, and schedule production
	Request raw materials for production
	Manufacture products
	Store finished products
	Accumulate costs for products manufactured
	Prepare management reports
	Send appropriate information to the other cycles
Financing	Forecast cash needs
	Sell stock/securities to investors
	Borrow money from lenders
	Pay dividends to investors and interest to lenders
	Retire debt
	Prepare management reports
	Send appropriate information to the other cycles

module. Moreover, some organizations have unique requirements. Financial institutions, for example, have demand deposit and installment-loan cycles that relate to transactions involving customer accounts and loans. In addition, the nature of a given transaction cycle differs across different types of organizations. For example, the expenditure cycle of a service company, such as a public accounting or a law firm, does not normally involve processing transactions related to the purchase, receipt, and payment for merchandise that will be resold to customers.

Each transaction cycle can include many different business processes or activities. Each business process can be relatively simple or quite complex. Focus 1-1 shows how Toyota's attention to continuously improving its business processes has helped it become the largest and most profitable automobile manufacturer in the world.

FOCUS 1-1 Improving Business Processes Helps Drive Toyota's Success

Toyota's Georgetown, Kentucky, manufacturing plant, its largest in North America, is the size of 156 football fields, employs 7,000 people, and produces a new car every 55 seconds. Because Toyota produces a high-quality car at a lower cost than its competitors, it is the largest automobile manufacturer in the world, a title General Motors had for almost 100 years.

A major factor in its success is the Toyota Production System (TPS), which is a set of philosophies, principles, and business processes supported by IT. Its goal is to improve continually so Toyota has the most effective and most efficient manufacturing and business processes possible. Toyota willingly shares TPS and its manufacturing and business processes with its suppliers to help them improve their quality and efficiency. It also shares TPS with its competitors, knowing that by the time they duplicate it Toyota will have greatly improved TPS.

The following are some of the principles and business processes on which TPS is built and which Toyota's information systems must support and enable:

- Performance-monitoring software warns assembly line workers of equipment problems. Workers stop production whenever necessary to prevent or correct defects.

continued

FOCUS 1-1 Continued

- Their just-in-time (JIT) inventory system is one of the most sophisticated in the world. Driverless carts take parts to assembly stations when they are needed so inventory does not pile up. Suppliers must meet rigid delivery standards. Four hours before they are needed, Toyota software electronically tells Johnson Controls exactly what car seats are needed for each car and the exact order in which they must be shipped.
- Continuous improvement is a critical and ongoing process. No process or detail is too small or insignificant to improve. Technology is especially important in the continuous improvement process. This emphasis on continuous improvement creates a culture that values continuous learning and embraces change.
- Electronic displays connected to the manufacturing equipment help workers monitor the assembly line. Information is communicated by light colors (green means the process is operating correctly, yellow means a problem is being investigated, and red means the assembly line has stopped) and by printed messages (which machine malfunctioned, its speed and temperature when it broke down, and who was operating the machine).
- Electronic quality control devices, such as an electronic sensor on a tool or a beam of light, monitor a process. These devices let a computer know when a tool is not used or a required part is not picked up and used at the appropriate time.
- More than half of Toyota's information systems employees work in operations at its plants so they can accompany executives, team leaders, and factory workers when they go to solve assembly line problems.

In summary, Toyota has a clear and in-depth understanding of the business processes that make it successful, continuously improves those processes, and understands the role information systems play in managing, supporting, and facilitating those processes.

Source: Mel Duvall, "What's Driving Toyota?" *Baseline Magazine*, September 5, 2006.

After preparing Tables 1-2 and 1-3 and Figures 1-1 and 1-2, Scott and Susan believe they understand S&S well enough to begin shopping for an information system. Susan recalled a previous employer that had several separate information systems because their software was not designed to accommodate the information needs of all managers. She also vividly recalled attending one meeting where she witnessed the negative effects of having multiple systems. The head of marketing had one report on year-to-date sales by product, the production manager had a different report that contained different sales figures, and the controller's report, which was produced by the general ledger system, had yet a third version of year-to-date sales. Over an hour was wasted trying to reconcile those different reports! Susan vowed that she would make sure that S&S did not ever find itself in such a mess. She would make sure that any system selected would have the capability to integrate both financial and nonfinancial data about S&S's various business processes so that everyone could pull information from the same system.

Accounting Information Systems

accounting information system - A system that collects, records, stores, and processes data to produce information for decision makers. It includes people, procedures and instructions, data, software, information technology infrastructure, and internal controls and security measures.

It has often been said that accounting is the language of business. If that is the case, then an **accounting information system (AIS)** is the intelligence—the information-providing vehicle—of that language.

Accounting is a data identification, collection, and storage process as well as an information development, measurement, and communication process. By definition, accounting is an information system, since an AIS collects, records, stores, and processes accounting and other data to produce information for decision makers. This is illustrated in Figure 1-3.

An AIS can be a paper-and-pencil manual system, a complex system using the latest in IT, or something in between. Regardless of the approach taken, the process is the same. The AIS must collect, enter, process, store, and report data and information. The paper and pencil or the computer hardware and software are merely the tools used to produce the information.

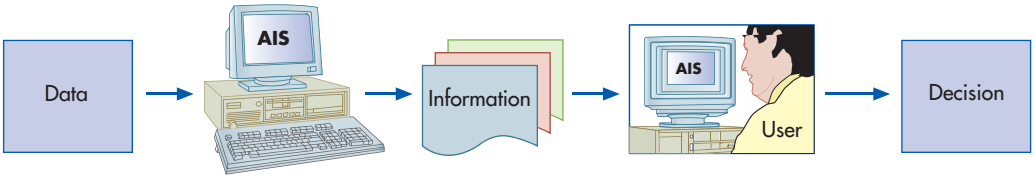


FIGURE 1-3
An AIS Processes Data to Produce Information for Decision Makers

This text does not distinguish an AIS from other information systems. Instead, our viewpoint is that the AIS can and should be the organization's primary information system and that it provides users with the information they need to perform their jobs.

There are six components of an AIS:

1. The *people* who use the system
2. The *procedures and instructions* used to collect, process, and store data
3. The *data* about the organization and its business activities
4. The *software* used to process the data
5. The *information technology infrastructure*, including the computers, peripheral devices, and network communications devices used in the AIS
6. The *internal controls and security measures* that safeguard AIS data

These six components enable an AIS to fulfill three important business functions:

1. Collect and store data about organizational activities, resources, and personnel. Organizations have a number of business processes, such as making a sale or purchasing raw materials, which are repeated frequently.
2. Transform data into information so management can plan, execute, control, and evaluate activities, resources, and personnel. Decision making is discussed in detail later in this chapter.
3. Provide adequate controls to safeguard the organization's assets and data. Control concepts are discussed in detail in Chapters 5–11.

Since accounting data comes from an AIS, AIS knowledge and skills are critical to an accountant's career success. Interacting with an AIS is one of the most important activities that accountants perform. Other important AIS-related activities include designing information systems and business process improvements, as discussed in Chapters 20 to 22. Focus 1-2 explains a specialty to designate that certain CPAs (Certified Public Accountants) have an in-depth knowledge of AIS topics.

HOW AN AIS CAN ADD VALUE TO AN ORGANIZATION

A well-designed AIS can add value to an organization by:

1. ***Improving the quality and reducing the costs of products or services.*** For example, an AIS can monitor machinery so operators are notified immediately when performance falls outside acceptable quality limits. This helps maintain product quality, reduces waste, and lowers costs.
2. ***Improving efficiency.*** For example, timely information makes a just-in-time manufacturing approach possible, as it requires constant, accurate, up-to-date information about raw materials inventories and their locations.
3. ***Sharing knowledge.*** Sharing knowledge and expertise can improve operations and provide a competitive advantage. For example, CPA firms use their information systems to share best practices and to support communication between offices. Employees can search the corporate database to identify experts to provide assistance for a particular client; thus, a CPA firm's international expertise can be made available to any local client.
4. ***Improving the efficiency and effectiveness of its supply chain.*** For example, allowing customers to directly access inventory and sales order entry systems can reduce sales and marketing costs, thereby increasing customer retention rates.

FOCUS 1-2 CITP—An IT Specialty Designation for CPAs

The American Institute of Certified Public Accountants (AICPA) offers several specialty designations for CPAs. The CITP (Certified Information Technology Professional) designation reflects the AICPA's recognition of the importance of IT and its interrelationship with accounting. A CITP possesses a broad range of business, managerial, and technological knowledge, making it possible for the CITP to understand how organizations use IT to achieve their business objectives. To obtain a CITP certification, a person must demonstrate a mastery of the following topics: information system management, business intelligence, fraud, risk assessment, internal control concepts, and how to test and evaluate an information system.

There are many reasons to earn the CITP certification:

- Because only CPAs can be CITPs, this certification further differentiates you from others in the marketplace.
- It affirms your value as an IT specialist and increases your value to your employer or clients.
- It is a great "calling card" for IT people who want to be leaders in industry, public practice, government, or academia.
- It opens the doors to new technology-related roles and opportunities.
- Automatic membership in the IT Section, which allows you to meet, share best practices, network, and communicate with other CITPs. You can also receive CITP newsletters and other communications, attend CITP Webinars, receive CITP member discounts, and access exclusive CITP resources and content on the CITP website.

To qualify for the CITP designation, you must:

- Be a CPA and a member of the AICPA
- Pass the CITP exam
- In the five years preceding your application, meet the 1,000 hour experience and the 75-hour continuing professional education requirements

Based on information from http://www.aicpa.org.

5. ***Improving the internal control structure.*** An AIS with the proper internal control structure can help protect systems from fraud, errors, system failures, and disasters.
6. ***Improving decision making.*** Improved decision making is vitally important and is discussed below in more detail.

Decision making is a complex, multistep activity: identify the problem, collect and interpret information, evaluate ways to solve the problem, select a solution methodology, and implement the solution. An AIS can provide assistance in all phases of decision making. Reports can help to identify potential problems. Decision models and analytical tools can be provided to users. Query languages can gather relevant data to help make the decision. Various tools, such as graphical interfaces, can help the decision maker interpret decision model results, evaluate them, and choose among alternative courses of action. In addition, the AIS can provide feedback on the results of actions.

An AIS can help improve decision making in several ways:

- It can identify situations requiring management action. For example, a cost report with a large variance might stimulate management to investigate and, if necessary, take corrective action.
- It can reduce uncertainty and thereby provide a basis for choosing among alternative actions.
- It can store information about the results of previous decisions, which provides valuable feedback that can be used to improve future decisions. For example, if a company tries a particular marketing strategy and the information gathered indicates that it did not succeed, the company can use that information to select a different marketing strategy.
- It can provide accurate information in a timely manner. For example, Walmart has an enormous database that contains detailed information about sales transactions at each of its stores. It uses this information to optimize the amount of each product carried at each store.
- It can analyze sales data to discover items that are purchased together, and it can use such information to improve the layout of merchandise or to encourage additional sales of related items. For example, Amazon uses its sales database to suggest additional books for customers to purchase.

THE AIS AND CORPORATE STRATEGY

Since most organizations have limited resources, it is important to identify the AIS improvements likely to yield the greatest return. Making a wise decision requires an understanding of the organization's overall business strategy. To illustrate, consider the results of a *CIO* magazine survey of 500 Chief Information Officers. Asked to identify the three most important skill sets for a CIO, over 75% put strategic thinking and planning on their list.

Figure 1-4 shows three factors that influence the design of an AIS: developments in IT, business strategy, and organizational culture. It is also important to recognize that the design of the AIS can also influence the organization's culture by controlling the flow of information within the organization. For example, an AIS that makes information easily accessible and widely available is likely to increase pressures for more decentralization and autonomy.

IT developments can affect business strategy. For example, the Internet has profoundly affected the way many activities are performed, significantly affecting both strategy and strategic positioning. The Internet dramatically cuts costs, thereby helping companies to implement a low-cost strategy. If every company used the Internet to adopt a low-cost strategy, then the effects might be problematic. Indeed, one possible outcome may be intense price competition among firms, with the likely result that most of the cost savings provided by the Internet get passed on to the industry's customers, rather than being retained in the form of higher profits. Moreover, because every company can use the Internet to streamline its activities, a company is unlikely to gain a sustainable long-term competitive advantage.

Many other technological advances affect company strategy and provide an opportunity to gain a competitive advantage. An example is **predictive analysis**, which uses data warehouses and complex algorithms to forecast future events, based on historical trends and calculated probabilities. Predictive analysis provides an educated guess of what one may expect to see in the near future, allowing companies to make better business decisions and improve their processes. FedEx uses predictive analysis to predict, with 65% to 90% accuracy, how customers respond to price changes and new services. Blue Cross Blue Shield of Tennessee uses a neural-based predictive model to predict the health care that specific patients will need, the severity of illnesses, and organ failures. Stock market analysts are using predictive analysis to predict short-term trends in the stock market.

predictive analysis - The use of data warehouses and complex algorithms to forecast future events, based on historical trends and calculated probabilities.

An organization's AIS plays an important role in helping it adopt and maintain a strategic position. Achieving a close fit among activities requires that data be collected about each activity. It is also important that the information system collect and integrate both financial and nonfinancial data about the organization's activities.

value chain - Linking together of all the primary and support activities in a business. Value is added as a product passes through the chain.

THE ROLE OF THE AIS IN THE VALUE CHAIN

To provide value to their customers, most organizations perform a number of different activities. Figure 1-5 shows that those activities can be conceptualized as forming a **value chain** consisting of five **primary activities** that directly provide value to customers:

primary activities - Value chain activities that produce, market, and deliver products and services to customers and provide post-delivery service and support.

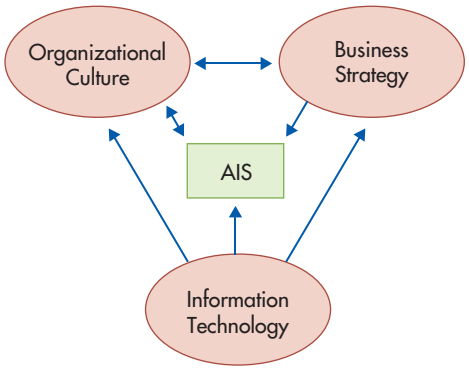
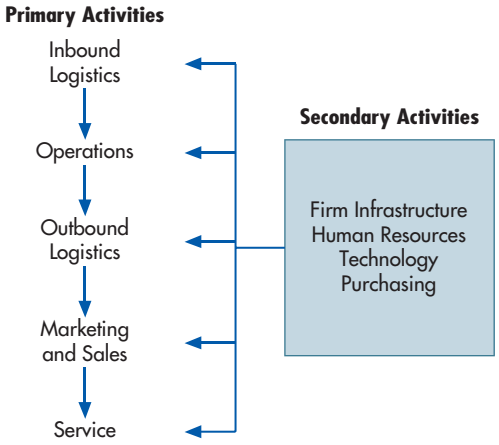


FIGURE 1-4
Factors Influencing Design of the AIS

FIGURE 1-5
The Value Chain



support activities - Value chain activities such as firm infrastructure, technology, purchasing, and human resources that enable primary activities to be performed efficiently and effectively.

supply chain - An extended system that includes an organization's value chain as well as its suppliers, distributors, and customers.

1. ***Inbound logistics*** consists of receiving, storing, and distributing the materials an organization uses to create the services and products it sells. For example, an automobile manufacturer receives, handles, and stores steel, glass, and rubber.
2. ***Operations*** activities transform inputs into final products or services. For example, assembly line activities convert raw materials into a finished car and retailers remove goods from packing boxes and place the individual items on shelves for customers to purchase.
3. ***Outbound logistics*** activities distribute finished products or services to customers. An example is shipping automobiles to car dealers.
4. ***Marketing and sales*** activities help customers buy the organization's products or services. Advertising is an example of a marketing and sales activity.
5. ***Service*** activities provide post-sale support to customers. Examples include repair and maintenance services.

Support activities allow the five primary activities to be performed efficiently and effectively. They are grouped into four categories:

1. ***Firm infrastructure*** is the accounting, finance, legal, and general administration activities that allow an organization to function. The AIS is part of the firm infrastructure.
2. ***Human resources*** activities include recruiting, hiring, training, and compensating employees.
3. ***Technology*** activities improve a product or service. Examples include research and development, investments in IT, and product design.
4. ***Purchasing*** activities procure raw materials, supplies, machinery, and the buildings used to carry out the primary activities.

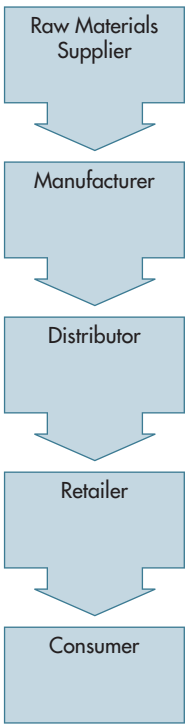


FIGURE 1-6
The Supply Chain

Using IT to redesign supply chain systems yields tremendous benefits and cost savings. For example, Tennessee Valley Authority, a power generator, reengineered its supply chain and created an enterprise-wide system that provides up-to-the-minute information, rather than the "current once a day" system that it replaced. The new system replaced 20 smaller and incompatible systems, reduced head count by 89 people, and saved $270 million in its first five years.

An organization's value chain is a part of a larger system called a **supply chain**. As shown in Figure 1-6, a manufacturing organization interacts with its suppliers and distributors. By paying attention to its supply chain, a company can improve its performance by helping the others in the supply chain to improve their performance. For example, S&S can improve its purchasing and inbound logistics activities by implementing a more efficient just-in-time inventory management system that reduces its costs and minimizes the capital tied up in inventory. S&S can reap additional benefits if it links its new systems with its suppliers so they can perform their primary value chain activities more efficiently. For example, by providing more detailed and timely information about its inventory needs, S&S suppliers can more efficiently plan their production schedules. Part of the resultant cost reduction can be passed on to S&S in the form of lower product costs.

The problems created by an ineffective supply chain are illustrated by Limited Brands. Limited experienced explosive growth, including acquisitions of other retail companies such as Victoria's Secret and Abercrombie & Fitch. These acquisitions left Limited with a tangled web of over 60 incompatible information systems. The problems came to a head one night when 400 trailers converged on a distribution center parking lot that could fit only 150 trailers. The trailers blocked traffic along all the highways around the distribution center and caused countless traffic and community problems. No one in Limited knew where all the trailers came from, what the merchandise was, or where it was to be sent. Chaos reigned for some time, until the merchandise could be routed to stores and other distribution centers. Limited solved many of its problems by installing a new, integrated system that greatly improved its supply chain processes and technologies. Developing the new system was not easy. Limited has over 1,000 suppliers and sells its merchandise using various platforms, including retail stores, the Internet, catalogs, and third-party retailers.

Summary and Case Conclusion

Susan and Scott reflected on what they had done to try and understand what decisions S&S would need to make and the information needed to make them. They began by obtaining an understanding of S&S's basic business processes and of the key decisions that must be made to operate the business effectively. They followed that with an analysis of the internal and external parties that the AIS would have to interact with and the information the AIS would have to provide them.

Since S&S is a retail merchandising company, its business processes could be described in terms of four basic transaction cycles:

1. The *revenue cycle* encompasses all transactions involving sales to customers and the collection of cash receipts for those sales.
2. The *expenditure cycle* encompasses all transactions involving the purchase and payment of merchandise sold by S&S, as well as other services it consumes, such as rent and utilities.
3. The *human resources/payroll cycle* encompasses all the transactions involving the hiring, training, and payment of employees.
4. The *financing cycle* encompasses all transactions involving the investment of capital in the company, borrowing money, payment of interest, and loan repayments.

These four cycles interface with the *general ledger and reporting system*, which consists of all activities related to the preparation of financial statements and other managerial reports.

Scott and Susan will need a well-designed AIS to provide the information they need to effectively plan, manage, and control their business. Their AIS must be able to process data about sales and cash receipts, purchasing and paying for merchandise and services, payroll and tax-related transactions, and acquiring and paying for fixed assets. The company's AIS must also provide the information needed to prepare financial statements.

Fortunately, there are many computer-based accounting packages available for the retail industry. As they begin looking at various software packages, however, Scott and Susan quickly learn that considerable accounting knowledge is required to choose the one that will best fit their business. Because neither has an accounting background, Scott and Susan decide that their next task will be to hire an accountant.

KEY TERMS

system 3
goal conflict 3
goal congruence 3
data 3
information 3
information overload 4
information technology (IT) 4
value of information 4
business process 4
transaction 6
transaction processing 6
give-get exchange 6
business processes or transaction cycles 6
revenue cycle 6
expenditure cycle 7
production (conversion) cycle 7
human resources/payroll cycle 7
financing cycle 7
general ledger and reporting system 8
accounting information system (AIS) 10
predictive analysis 13
value chain 13
primary activities 13
support activities 14
supply chain 14

AIS in Action

CHAPTER QUIZ

1. Data differ from information in which way?
a. Data are output, and information is input.
b. Information is output, and data are input.
c. Data are meaningful bits of information.
d. There is no difference.

2. Which of the following is NOT a characteristic that makes information useful?
a. It is reliable.
b. It is timely.
c. It is inexpensive.
d. It is relevant.

3. Which of the following is a primary activity in the value chain?
a. purchasing
b. accounting
c. post-sales service
d. human resource management

4. Which transaction cycle includes interactions between an organization and its suppliers?
a. revenue cycle
b. expenditure cycle
c. human resources/payroll cycle
d. general ledger and reporting system

5. Which of the following is NOT a means by which information improves decision making?
a. increases information overload
b. reduces uncertainty
c. provides feedback about the effectiveness of prior decisions
d. identifies situations requiring management action

6. In the value chain concept, upgrading IT is considered what kind of activity?
a. primary activity
b. support activity
c. service activity
d. structured activity

7. In which cycle does a company ship goods to customers?
a. production cycle
b. financing cycle
c. revenue cycle
d. expenditure cycle

8. Which of the following is a function of an AIS?
a. reducing the need to identify a strategy and strategic position
b. transforming data into useful information
c. allocating organizational resources
d. automating all decision making

9. A firm, its suppliers, and its customers collectively form which of the following?
a. supply chain
b. value chain
c. ERP system
d. AIS

10. A report telling how well all approved vendors have performed in the prior 12 months is information that is MOST needed in which business process?
a. paying vendors
b. acquiring inventory
c. selling merchandise
d. paying employees

DISCUSSION QUESTIONS

1.1. The value of information is the difference between the benefits realized from using that information and the costs of producing it. Would you, or any organization, ever produce information if its expected costs exceeded its benefits? If so, provide some examples. If not, why?

1.2. Can the characteristics of useful information listed in Table 1-1 be met simultaneously? Or does achieving one mean sacrificing another?

1.3. You and a few of your classmates decided to become entrepreneurs. You came up with a great idea for a new mobile phone application that you think will make lots of money. Your business plan won second place in a local competition, and you are using the $10,000 prize to support yourselves as you start your company.
a. Identify the key decisions you need to make to be successful entrepreneurs, the information you need to make them, and the business processes you will need to engage in.
b. Your company will need to exchange information with various external parties. Identify the external parties, and specify the information received from and sent to each of them.

1.4. How do an organization's business processes and lines of business affect the design of its AIS? Give several examples of how differences among organizations are reflected in their AIS.

1.5. Figure 1-4 shows that organizational culture and the design of an AIS influence one another. What does this imply about the degree to which an innovative system developed by one company can be transferred to another company?

1.6. Figure 1-4 shows that developments in IT affect both an organization's strategy and the design of its AIS. How can a company determine whether it is spending too much, too little, or just enough on IT?

1.7. Apply the value chain concept to S&S. Explain how it would perform the various primary and support activities.

1.8. IT enables organizations to easily collect large amounts of information about employees. Discuss the following issues:
a. To what extent should management monitor employees' e-mail?
b. To what extent should management monitor which websites employees visit?
c. To what extent should management monitor employee performance by, for example, using software to track keystrokes per hour or some other unit of time? If such information is collected, how should it be used?
d. Should companies use software to electronically "shred" all traces of e-mail?
e. Under what circumstances and to whom is it appropriate for a company to distribute information it collects about the people who visit its website?

PROBLEMS

1.1. IT is continually changing the nature of accounting and the role of accountants. Write a two-page report describing what you think the nature of the accounting function and the AIS in a large company will be like in the year 2030.

1.2. The annual report is considered by some to be the single most important printed document that companies produce. In recent years, annual reports have become large documents. They now include such sections as letters to the stockholders, descriptions of the business, operating highlights, financial review, management discussion and analysis, a discussion of company internal controls, segment reporting, inflation data, and the basic financial statements. The expansion has been due in part to a general increase in the degree of sophistication and complexity in accounting standards and disclosure requirements for financial reporting.

The expansion also is reflective of the change in the composition and level of sophistication of users. Current users include not only stockholders but also financial and securities analysts, potential investors, lending institutions, stockbrokers, customers, employees, and—whether the reporting company likes it or not—competitors. Thus, a report that was originally designed as a device for communicating basic financial information now attempts to meet the diverse needs of an ever-expanding audience.

Users hold conflicting views on the value of annual reports. Some argue that they fail to provide enough information, whereas others believe that disclosures in annual reports have expanded to the point where they create information overload. Others argue that the future of most companies depends on acceptance by the investing public and by its customers; therefore, companies should take this opportunity to communicate well-defined corporate strategies.

REQUIRED

a. Identify and discuss the basic factors of communication that must be considered in the presentation of the annual report.
b. Discuss the communication problems a corporation faces in preparing the annual report that result from the diversity of the users being addressed.
c. Select two types of information found in an annual report, other than the financial statements and accompanying footnotes, and describe how they are helpful to the users of annual reports.
d. Discuss at least two advantages and two disadvantages of stating well-defined corporate strategies in the annual report.
e. Evaluate the effectiveness of annual reports in fulfilling the information needs of the following current and potential users: shareholders, creditors, employees, customers, and financial analysts.
f. Annual reports are public and accessible to anyone, including competitors. Discuss how this affects decisions about what information should be provided in annual reports. (*CMA Examination, adapted*)

1.3. United Services Automotive Association (USAA) is one of the largest diversified financial services companies in the United States, with close to $75 billion in assets under management. One reason for its success is the use of IT to lower costs and improve customer service. USAA operates one of the most advanced and successful information systems in the world. It communicates with its widely scattered customers, mostly military officers and their families, primarily by e-mail, phone, and its website.

Early on, USAA made a strategic choice to become one of the more technology-intensive companies in the world. It views IT as a strategic weapon and uses it in several ways, including the following:

- When customers call from their homes, offices, or cell phones, USAA personnel greet them personally by name. Unlike many diversified companies, a customer representative can handle inquires and transactions about all of USAA's products using a highly integrated database.

- USAA uses its extensive database to keep track of minute details, such as which auto parts are fixed most frequently. It also uses its database to find ways to reduce claims costs. For example, USAA discovered that repair shops would rather charge up to $300 to replace a windshield with punctures than to charge $40 to repair it. USAA began offering to waive the deductible if the owners would repair the windshield rather than replace it.
- USAA spent extensively to develop an image-processing system that digitizes all paper documents sent in by claimants (over 25 million a year). It takes only a few keystrokes for a policy service representative to retrieve pictures of all the documents in a customer's file. The system can sort and prioritize documents so that employees are always working on the most important and urgent tasks.
- USAA offers its customers remote deposit capture using scanning technology. It was the first U.S. bank to implement a remote deposit capture application for the iPhone. The iPhone application allows customers to take pictures of the front and back of each check and submit them electronically for deposit.
- USAA is a world leader in mobile banking. Customers can use their cell phones and other mobile devices to access and execute banking, investment, stock trading, and insurance applications such as filing claims. Customers can also use USAA's two-way text messaging system to send messages and receive text alerts and real-time information. They can also access person-to-person payment applications as well as social networking and personal financial management tools connected to bank accounts. Over 70% of USAA's logins are from cell phone users.

REQUIRED

a. Why should USAA collect data on which auto parts are fixed most frequently? What could it do with this data?
b. Even though USAA offered to waive the deductible, the repair shops still managed to convince 95% of the owners to replace rather than repair their damaged windshields. How could USAA use its AIS to persuade more shop owners to repair rather than replace their windshields?
c. How does the image-processing system at USAA add value to the organization?
d. How do the remote deposit capture and mobile banking system at USAA add value to the organization?
e. Do an Internet search and find out what other advancements USAA has introduced. Write a brief paragraph on each new application or other newsworthy item you find (maximum limit of three applications or items).

1.4. Matching

Match the description listed in the right column with the information characteristic listed in the left column.

1. Relevant		a.	The report was carefully designed so that the data contained in the report became information to the reader.
2. Reliable		b.	The manager was working one weekend and needed to find some information about production requests for a certain customer. He was able to find the report on the company's network.
3. Complete		c.	The data in a report was checked by two clerks working independently.
4. Timely		d.	An accounts receivable aging report included all customer accounts.
5. Understandable		e.	A report was checked by three different people for accuracy.
6. Verifiable		f.	An accounts receivable aging report is used in credit-granting decisions.
7. Accessible		g.	An accounts receivable aging report was received before the credit manager had to make a decision whether to extend credit to a customer.

1.5. The Howard Leasing Company is a privately held, medium-sized business that purchases school buses and leases them to school districts, churches, charitable organizations, and other businesses. To better serve its customers and, more important, to protect its investment in the buses, Howard operates a large maintenance facility to maintain and repair leased vehicles. Howard's annual sales for last year were $37 million, with a net income of $2.9 million. Howard employs approximately 150 people.

You were recently hired by Howard, and you are eager to prove your worth to the company. Your supervisor just called you into her office and asked you to prepare an accounts receivable aging report as of the end of the year for use in the upcoming audit of the company's financial statements.

REQUIRED

a. What is an accounts receivable aging report?
b. Why is an accounts receivable aging report needed for an audit?
c. What is an accounts receivable aging report used for in normal company operations?
d. What data will you need to prepare the report?
e. Where will you collect the data you need to prepare the report?
f. How will you collect the necessary data for the report?
g. What will the report look like (i.e., how will you organize the data collected to create the information your supervisor needs for the audit)? Prepare an accounts receivable aging report in Excel or another spreadsheet package.
h. How will you distribute the report? How many copies will you make? Who should receive the copies? What security features will you implement?

1.6. Based on Walmart's success in the United States, many expected the company to quickly dominate the British market after it bought the Asda grocery chain in 1999. That did not happen; Walmart's market share in groceries grew to a little more than half that of its biggest competitor, Tesco. Initially, Tesco's sales and net income rose significantly while Walmart's sales and net income increased at a much slower rate. More recently, Walmart has made small gains in market share, and Tesco has had small decreases.

Walmart found out that Tesco is a formidable worldwide competitor. Tesco operates almost 2,400 stores in Britain in four different formats. It has a very successful operation in Central Europe, and it expanded to the United States with Fresh & Easy stores. In Korea, Tesco's 174 stores thrived while Walmart gave up after an eight-year effort to succeed and sold its 16 stores.

One of the biggest reasons for Tesco's success is its use of technology. In 1995, Tesco started a loyalty card program, called Clubcard, and over 80% of its shoppers are members. Shoppers fill out an application in the store and receive a plastic card and a key fob in the mail that is scanned before they make a purchase. Tesco gathers massive amounts of data about its customers' 15 million purchases each week. Sales data are analyzed and turned into information that provides Tesco with a significant competitive advantage.

As traditional advertising loses effectiveness, these large stores of data allow Tesco to find new and creative ways to market its products.

REQUIRED

a. What kind of information do you think Tesco gathers?
b. How do you think Tesco has motivated over 22 million customers to sign up for its Clubcard program?
c. What can Tesco accomplish with the Clubcard data it collects? Think in terms of strategy and competitive advantage.
d. What are some of the disadvantages to the Clubcard program?
e. Do an Internet search to find out how Tesco is doing in comparison to Walmart and other grocers and retailers. Write a few paragraphs explaining your findings.

1.7. Have you ever imagined having one electronic device that does everything you would ever need? Mobile phone makers in Japan have gone beyond the imagining phase. Cell phones in Japan are becoming more versatile than ever. Newer models of cell phones contain a myriad of applications and can do many of the things that a personal computer (PC) can do. PCs are also able to function as phones. A growing number of professionals are trading in their laptops for handheld computers. Cell phone manufacturers in the United States and elsewhere are quickly catching up to their Japanese counterparts.

REQUIRED

a. What commercial activities can be done with a cell phone? With a cell phone/PC combination device? What do you do when you're on your cell phone? What do you expect to be doing in five years?
b. How can businesses utilize this technology to attract more customers, sell more products, advertise their products, facilitate the sale of products, and conduct and manage their businesses more efficiently and effectively?
c. What are some problems or drawbacks you can see with using these devices in business?

1.8. Classify each of the following items as belonging in the revenue, expenditure, human resources/payroll, production, or financing cycle.

a. Purchase raw materials
b. Pay off mortgage on a factory
c. Hire a new assistant controller
d. Establish a $10,000 credit limit for a new customer
e. Pay for raw materials
f. Disburse payroll checks to factory workers
g. Record goods received from a vendor
h. Update the allowance for doubtful accounts
i. Decide how many units to make next month
j. Complete a picking ticket for a customer order
k. Record factory employee timecards
l. Sell concert tickets
m. Draw on line of credit
n. Send new employees to a business ethics course
o. Pay utility bills
p. Pay property taxes on an office building
q. Pay federal payroll taxes
r. Sell a DVD player
s. Collect payments on customer accounts
t. Obtain a bank loan
u. Pay sales commissions
v. Send an order to a vendor
w. Put purchased goods into the warehouse

AIS in Action Solutions

QUIZ KEY

1. Data differ from information in which way?
a. Data are output, and information is input. [Incorrect. Data are facts and figures that, once organized, can become information. Therefore, data are inputs, and information is output.]
► **b.** Information is output, and data are input. [Correct.]
c. Data are meaningful bits of information. [Incorrect. Information is organized and processed data that provide meaning.]
d. There is no difference. [Incorrect. There is a difference. Data are unorganized facts and figures. Information is meaningful, organized, and processed data.]

2. Which of the following is NOT a characteristic that makes information useful?
a. It is reliable. [Incorrect. This is one of the information characteristics listed in Table 1-1 on page 4.]
b. It is timely. [Incorrect. This is one of the information characteristics listed in Table 1-1 on page 4.]
► **c.** It is inexpensive. [Correct. This is NOT one of the information characteristics listed in Table 1-1 on page 4.]
d. It is relevant. [Incorrect. This is one of the information characteristics listed in Table 1-1 on page 4.]

3. Which of the following is a primary activity in the value chain?
a. purchasing [Incorrect. This is a support activity.]
b. accounting [Incorrect. This is a firm infrastructure support activity.]
► **c.** post-sales service [Correct. Service is a primary activity.]
d. human resource management [Incorrect. This is a support activity.]

4. Which transaction cycle includes interactions between an organization and its suppliers?
a. revenue cycle [Incorrect. The revenue cycle involves interactions between an organization and its customers.]
► **b.** expenditure [Correct.]
c. human resources/payroll cycle [Incorrect. The human resources/payroll cycle involves interactions between an organization and its employees, government, and potential hires.]
d. general ledger and reporting system [Incorrect. The general ledger and reporting system receives summary information from all cycles.]

5. Which of the following is NOT a means by which information improves decision making?
► **a.** increases information overload [Correct. Decision makers receiving too much information have difficulty incorporating all of the information into their decision framework, and, as a result, decision quality can be reduced rather than improved.]
b. reduces uncertainty [Incorrect. More reliable information leads to less uncertainty and thus better decisions.]
c. provides feedback about the effectiveness of prior decisions [Incorrect. Knowledge of effective and ineffective decisions can lead to better decisions in the future.]
d. identifies situations requiring management action [Incorrect. Identifying the need for management action can lead to improved decision making.]

6. In the value chain concept, upgrading IT is considered what kind of activity?
a. primary activity [Incorrect. Investing in IT is a support activity.]
► **b.** support activity [Correct. Technology activities, including investing in IT, are considered a support activity.]

c. service activity [Incorrect. The value chain includes only primary and support activities. A service activity is a type of primary activity.]
d. structured activity [Incorrect. The value chain includes only primary and support activities. A structured activity is neither a primary nor a secondary activity.]

7. In which cycle does a company ship goods to customers?
a. production cycle [Incorrect. The production cycle involves the transformation of raw materials into finished goods.]
b. financing cycle [Incorrect. The financing cycle deals with interactions between an organization and its lenders and owners.]
► **c.** revenue cycle [Correct. The revenue cycle involves interactions between an organization and its customers, such as shipping them goods.]
d. expenditure cycle [Incorrect. The expenditure cycle involves interactions between an organization and its suppliers.]

8. Which of the following is a function of an AIS?
a. reducing the need to identify a strategy and strategic position [Incorrect. An AIS does not reduce the need to identify a strategy. It provides information to executives for the purpose of making strategic decisions.]
► **b.** transforming data into useful information [Correct. This is one of the primary functions of an AIS.]
c. allocating organizational resources [Incorrect. Decision makers allocate resources, and the purpose of the AIS is to provide information to the decision makers so that they can make the allocation.]
d. automating all decision making [Incorrect. The AIS provides information to decision makers; it is not designed to automate all decision making.]

9. A firm, its suppliers, and its customers collectively form which of the following?
► **a.** supply chain [Correct. The supply chain is made up of the firm, its suppliers, and customers.]
b. value chain [Incorrect. The value chain is made up of primary and support activities within the firm.]
c. ERP system [Incorrect. An ERP system integrates all aspects of an organization's activities into one system.]
d. AIS [Incorrect. The AIS is made up of the human and capital resources within an organization that are responsible for collecting and processing transactions and preparing financial information.]

10. A report telling how well all approved vendors have performed in the prior 12 months is information that is MOST needed in which business process?
a. paying vendors [Incorrect. To pay a vendor, a company needs to know whether merchandise ordered was received in good condition. They do not need a 12-month history of vendor performance.]
► **b.** acquiring inventory [Correct. Companies want to acquire inventory from companies that have performed well in the past. A vendor performance report would disclose whether the vendor shipped inventory on time, whether the inventory was of the requested quality, whether the prices were as agreed upon, etc.]
c. selling merchandise [Incorrect. A 12-month history of vendor performance is usually not very helpful in trying to sell products to customers. More important would be customer tastes and preferences, customer credit status, etc.]
d. paying employees [Incorrect. It is very rare for an employee's pay to be based on a 12-month history of vendor performance. More important are hours worked, annual salary, sales figures to calculate commissions, etc.]

CHAPTER

2

Overview of Transaction Processing and Enterprise Resource Planning Systems

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

1. Describe the data processing cycle used to process transactions, including how data is input, stored, and processed and how information is output.
2. Discuss how organizations use enterprise resource planning (ERP) systems to process transactions and provide information.

INTEGRATIVE CASE S&S

The grand opening of S&S is two weeks away. Scott Parry and Susan Gonzalez are working long hours to make the final arrangements for the store opening. Most of the employees have already been hired; training is scheduled for next week.

Susan has ordered inventory for the first month. The store is being remodeled and will have a bright, cheery decor. All seems to be in order—all, that is, except the accounting records.

Like many entrepreneurs, Scott and Susan have not given as much thought to their accounting records as they have to other parts of their business. Recognizing they need qualified accounting help, they hired a full-time accountant, Ashton Fleming. Scott and Susan think Ashton is perfect for the job because of his three years of experience with a national CPA (Certified Public Accountants) firm. Ashton is looking forward to working for S&S because he has always wanted to be involved in building a company from the ground up.

During Ashton's first day on the job, Susan gives him the invoices for the inventory she purchased and a folder with their bank loan documentation, with the first payment due after the grand opening. She also hands him a folder containing information on rental payments, utilities, and other expenses. Susan tells Ashton that she and Scott know little about accounting and he will run the accounting end of S&S. She adds that the only thing they have done so far is to open a checking account for S&S and that they have kept the check register updated to monitor their cash flow.

Scott explains that the sales staff is paid a fixed salary and commissions and that all other employees are paid hourly rates. Employees are paid every two weeks, with their first paychecks due next week. Ashton asks Scott what accounting software the company is using. Scott replies that he and Susan have not had time to tackle that aspect yet. Scott and Susan looked at some of the popular packages but quickly realized that they did not know enough about accounting to make an intelligent choice. Scott then tells Ashton that his first task should be to purchase whatever accounting software he thinks will be best for S&S.

After Scott leaves, Ashton feels both excited and a little nervous about his responsibility for creating an accounting information system (AIS) for S&S. Although Ashton has audited many companies, he has never organized a company's books and is unsure how to go about it. A million questions run through his head. Here are just a few of them:

1. How should I organize the accounting records so that financial statements can be easily produced?
2. How am I going to collect and process data about all of S&S's transactions?
3. How do I organize all the data that will be collected?
4. How should I design the AIS so that the information provided is reliable and accurate?
5. How can I design procedures to ensure that they meet all government obligations, such as remitting sales, income, and payroll taxes?

Introduction

This chapter is divided into two major sections. The first section discusses the data processing cycle and its role in organizing business activities and providing information to users. It explains how organizations capture and enter data about business activities into their accounting information system (AIS) and how companies process data and transform it into useful information. It also discusses basic data storage concepts, showing how data are stored for further use. Finally, information output is discussed, including the different ways information is provided to users.

The second section discusses the role of the information system in modern organizations and introduces the concept of an enterprise resource planning (ERP) system. An ERP can help integrate all aspects of a company's operations with its traditional AIS. This section also describes the significant advantages of an ERP as well as significant challenges that must be overcome to implement an ERP system.

Transaction Processing: The Data Processing Cycle

Accountants and other system users play a significant role in the data processing cycle. For example, they interact with systems analysts to help answer questions such as these: What data should be entered and stored by the organization, and who should have access to them? How should data be organized, updated, stored, accessed, and retrieved? How can scheduled and unanticipated information needs be met? To answer these and related questions, the data processing concepts explained in this chapter must be understood.

One important AIS function is to process company transactions efficiently and effectively. In manual (non-computer-based) systems, data are entered into journals and ledgers maintained on paper. In computer-based systems, data are entered into computers and stored in files and databases. The operations performed on data to generate meaningful and relevant information are referred to collectively as the **data processing cycle**. As shown in Figure 2-1, this process consists of four steps: data input, data storage, data processing, and information output.

data processing cycle - The four operations (data input, data storage, data processing, and information output) performed on data to generate meaningful and relevant information.

DATA INPUT

The first step in processing input is to capture transaction data and enter them into the system. The data capture process is usually triggered by a business activity. Data must be collected about three facets of each business activity:

1. Each activity of interest
2. The resource(s) affected by each activity
3. The people who participate in each activity

For example, the most frequent revenue cycle transaction is a sale, either for cash or on credit. S&S may find it useful to collect the following data about a sales transaction:

- Date and time the sale occurred
- Employee who made the sale and the checkout clerk who processed the sale
- Checkout register where the sale was processed
- Item(s) sold
- Quantity of each item sold
- List price and actual price of each item sold
- Total amount of the sale
- Delivery instructions
- For credit sales: customer name, customer bill-to and ship-to addresses

source documents - Documents used to capture transaction data at its source – when the transaction takes place. Examples include sales orders, purchase orders, and employee time cards.

Historically, most businesses used paper **source documents** to collect data about their business activities. They later transferred that data into the computer. When the data is entered using computer screens, they often retain the same name and basic format as the paper source document it replaced. Table 2-1 lists some common transaction cycle activities and the source document or form used to capture data about that event. Examples of many of these documents can be found in Chapters 12 through 16. For example, a purchase order, used to request merchandise from suppliers, is shown in Chapter 13.

turnaround documents - Records of company data sent to an external party and then returned to the system as input. Turnaround documents are in machine-readable form to facilitate their subsequent processing as input records. An example is a utility bill.

Turnaround documents are company output sent to an external party, who often adds data to the document, and then are returned to the company as an input document. They are in machine-readable form to facilitate their subsequent processing as input records. An example is a utility bill that is sent to the customer, returned with the customer's payment, and read by a special scanning device when it is returned.

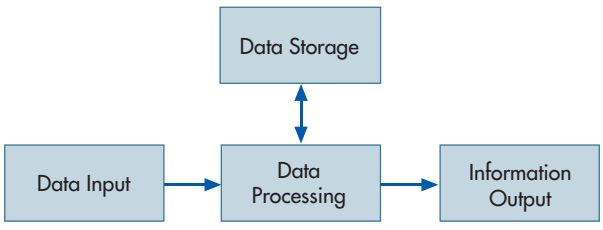


FIGURE 2-1
The Data Processing Cycle

TABLE 2-1 Common Business Activities and Source Documents

BUSINESS ACTIVITY	SOURCE DOCUMENT
Revenue Cycle	
Take customer order	Sales order
Deliver or ship order	Delivery ticket or bill of lading
Receive cash	Remittance advice or remittance list
Deposit cash receipts	Deposit slip
Adjust customer account	Credit memo
Expenditure Cycle	
Request items	Purchase requisition
Order items	Purchase order
Receive items	Receiving report
Pay for items	Check or electronic funds transfer
Human Resources Cycle	
Collect employee withholding data	W-4 form
Record time worked by employees	Time cards
Record time spent on specific jobs	Job time tickets or time sheet

Source data automation devices capture transaction data in machine-readable form at the time and place of their origin. Examples include ATMs used by banks, point-of-sale (POS) scanners used in retail stores, and bar code scanners used in warehouses.

source data automation - The collection of transaction data in machine-readable form at the time and place of origin. Examples are point-of-sale terminals and ATMs.

The second step in processing input is to make sure captured data are accurate and complete. One way to do this is to use source data automation or well-designed turnaround documents and data entry screens. Well-designed documents and screens improve accuracy and completeness by providing instructions or prompts about what data to collect, grouping logically related pieces of information close together, using checkoff boxes or pull-down menus to present the available options, and using appropriate shading and borders to clearly separate data items. Data input screens usually list all the data the user needs to enter. Sometimes these screens resemble source documents, and users fill out the screen the same way they would a paper source document.

Users can improve control either by using prenumbered source documents or by having the system automatically assign a sequential number to each new transaction. Prenumbering simplifies verifying that all transactions have been recorded and that none of the documents has been misplaced. (Imagine trying to balance a checkbook if the checks were not prenumbered.)

The third step in processing input is to make sure company policies are followed, such as approving or verifying a transaction. For example, S&S would not want to sell goods to a customer who was not paying his bills or to sell an item for immediate delivery that was out of stock. These problems are prevented by programming the system to check a customer's credit limit and payment history, as well as inventory status, before confirming a customer sale.

DATA STORAGE

A company's data are one of its most important resources. However, the mere existence of relevant data does not guarantee that they are useful. To function properly, an organization must have ready and easy access to its data. Therefore, accountants need to understand how data are organized and stored in an AIS and how they can be accessed. In essence, they need to know how to manage data for maximum corporate use.

Imagine how difficult it would be to read a textbook if it were not organized into chapters, sections, paragraphs, and sentences. Now imagine how hard it would be for S&S to find an invoice if all documents were randomly dumped into file cabinets. Fortunately, information in an AIS is organized for easy and efficient access. This section explains basic data storage concepts and definitions.

general ledger - A ledger that contains summary-level data for every asset, liability, equity, revenue, and expense account of the organization.

subsidiary ledger - A ledger used to record detailed data for a general ledger account with many individual subaccounts, such as accounts receivable, inventory, and accounts payable.

control account - A title given to a general ledger account that summarizes the total amounts recorded in a subsidiary ledger. For example, the accounts receivable control account in the general ledger represents the total amount owed by all customers. The balances in the accounts receivable subsidiary ledger indicate the amount owed by each specific customer.

coding - The systematic assignment of numbers or letters to items to classify and organize them.

sequence codes - Items are numbered consecutively so that gaps in the sequence code indicate missing items that should be investigated. Examples include prenumbered checks, invoices, and purchase orders.

block code - Blocks of numbers that are reserved for specific categories of data, thereby helping to organize the data. An example is a chart of accounts.

group codes - Two or more subgroups of digits that are used to code an item. A group code is often used in conjunction with a block code.

mnemonic code - Letters and numbers that are interspersed to identify an item. The mnemonic code is derived from the description of the item and is usually easy to memorize.

LEDGERS Cumulative accounting information is stored in general and subsidiary ledgers. A **general ledger** contains summary-level data for every asset, liability, equity, revenue, and expense account. A **subsidiary ledger** contains detailed data for any general ledger account with many individual subaccounts. For example, the general ledger has an accounts receivable account that summarizes the total amount owed to the company by all customers. The subsidiary accounts receivable ledger has a separate record for each individual customer, with detailed information such as name, address, purchases, payments, account balance, and credit limit. Subsidiary ledgers are often used for accounts receivable, inventory, fixed assets, and accounts payable.

The general ledger account corresponding to a subsidiary ledger is called a **control account**. The relationship between the general ledger control account and the total of individual subsidiary ledger account balances helps maintain the accuracy of AIS data. Specifically, the sum of all subsidiary ledger account balances should equal the amount in the corresponding general ledger control account. Any discrepancy between them indicates that a recording error has occurred.

CODING TECHNIQUES Data in ledgers is organized logically using coding techniques. **Coding** is the systematic assignment of numbers or letters to items to classify and organize them.

- With **sequence codes**, items are numbered consecutively to account for all items. Any missing items cause a gap in the numerical sequence. Examples include prenumbered checks, invoices, and purchase orders.
- With a **block code**, blocks of numbers are reserved for specific categories of data. For example, S&S reserved the following numbers for major product categories:

PRODUCT CODE	PRODUCT TYPE
1000000–1999999	Electric range
2000000–2999999	Refrigerator
3000000–3999999	Washer
4000000–4999999	Dryer

Users can identify an item's type and model using the code numbers. Other examples include ledger account numbers (blocked by account type), employee numbers (blocked by department), and customer numbers (blocked by region).

- **Group codes**, which are two or more subgroups of digits used to code items, are often used in conjunction with block codes. If S&S uses a seven-digit product code number, the group coding technique might be applied as follows.

DIGIT POSITION	MEANING
1–2	Product line, size, style
3	Color
4–5	Year of manufacture
6–7	Optional features

There are four subcodes in the product code, each with a different meaning. Users can sort, summarize, and retrieve information using one or more subcodes. This technique is often applied to general ledger account numbers.

- With **mnemonic codes**, letters and numbers are interspersed to identify an item. The mnemonic code is derived from the description of the item and is usually easy to memorize. For example, Dry300W05 could represent a low end (300), white (W) dryer (Dry) made by Sears (05).

The following guidelines result in a better coding system. The code should:

- Be consistent with its intended use, which requires that the code designer determine desired system outputs prior to selecting the code.
- Allow for growth. For example, don't use a three-digit employee code for a fast-growing company with 950 employees.

- Be as simple as possible to minimize costs, facilitate memorization and interpretation, and ensure employee acceptance.
- Be consistent with the company's organizational structure and across the company's divisions.

CHART OF ACCOUNTS A great example of coding is the **chart of accounts**, which is a list of the numbers assigned to each general ledger account. These account numbers allow transaction data to be coded, classified, and entered into the proper accounts. They also facilitate the preparation of financial statements and reports, because data stored in individual accounts can easily be summed for presentation.

chart of accounts - A listing of all the numbers assigned to balance sheet and income statement accounts. The account numbers allow transaction data to be coded, classified, and entered into the proper accounts. They also facilitate financial statement and report preparation.

However, data stored in summary accounts cannot be easily analyzed and reported in more detail. Consequently, it is important that the chart of accounts contain sufficient detail to meet an organization's information needs. To illustrate, consider the consequences if S&S were to use only one general ledger account for all sales transactions. It would be easy to produce reports showing the total amount of sales for a given time period, but it would be very difficult to prepare reports separating cash and credit sales. Indeed, the only way to produce these latter reports would be to go back to original sales records to identify the nature of each sales transaction. If S&S used separate general ledger accounts for cash and credit sales, then reports showing both types of sales could be easily produced. Total sales could also be easily reported by summing each type of sale.

Table 2-2 shows the chart of accounts Ashton developed for S&S. Each account number is three digits long. The first digit represents the major account category and indicates where

TABLE 2-2 Sample Chart of Accounts for S&S

ACCOUNT CODE	ACCOUNT NAME
100–199	**Current Assets**
101	Checking Account
102	Savings Account
103	Petty Cash
120	Accounts Receivable
125	Allowance for Doubtful Accounts
130	Notes Receivable
150	Inventory
160	Supplies
170	Prepaid Rent
180	Prepaid Insurance
200–299	**Noncurrent Assets**
200	Land
210	Buildings
215	Accumulated Depreciation—Buildings
230	Equipment
235	Accumulated Depreciation—Equipment
240	Furniture & Fixtures
245	Accumulated Depreciation—Furniture & Fixtures
250	Other Assets
300–399	**Liabilities**
300	Accounts Payable
310	Wages Payable
321	Employee Income Tax Payable
322	FICA Tax Payable
323	Federal Unemployment Tax Payable
324	State Unemployment Tax Payable
330	Accrued Interest Payable
360	Other Liabilities
400–499	**Equity Accounts**
400	Common Stock
410	Retained Earnings
500–599	**Revenues**
501	Cash Sales
502	Credit Sales
510	Sales Returns & Allowances
511	Sales Discounts
520	Interest Revenue
530	Miscellaneous Revenue
600–799	**Expenses**
600	Cost of Goods Sold
611	Wages Expense
612	Commissions Expense
613	Payroll Tax Expense
620	Rent Expense
630	Insurance Expense
640	Supplies Expense
650	Bad Debt Expense
701	Depreciation Expense—Buildings
702	Depreciation Expense—Equipment
703	Depreciation Expense—Furniture & Fixtures
710	Income Tax Expense
900–999	**Summary Accounts**
910	Income Summary

it appears on S&S's financial statements. Thus, all current assets are numbered in the 100s, noncurrent assets are numbered in the 200s, and so on.

The second digit represents the primary financial subaccounts within each category. Again, the accounts are assigned numbers to match the order of their appearance in financial statements (in order of decreasing liquidity). Thus, account 120 represents accounts receivable, and account 150 represents inventory.

The third digit identifies the specific account to which the transaction data will be posted. For example, account 501 represents cash sales, and account 502 represents credit sales. Similarly, accounts 101 through 103 represent the various cash accounts used by S&S.

A chart of accounts is tailored to the nature and purpose of an organization. For example, the chart of accounts for S&S indicates that the company is a corporation. In contrast, a partnership would include separate capital and drawing accounts for each partner, instead of common stock and retained earnings. Likewise, because S&S is a retail organization, it has only one type of general ledger inventory account. A manufacturing company, in contrast, would have separate general ledger accounts for raw materials, work in process, and finished goods inventories.

Ashton left gaps in S&S's chart of accounts to allow for additional accounts. For example, when S&S has excess cash to invest in marketable securities, a new general ledger account can be created and assigned the number 110. When S&S opens stores in the future, he will add three digits to the chart of accounts to represent each store in the chain, so that S&S can track items in each store.

Subsidiary ledger accounts often have longer account codes than general ledger accounts. At S&S, each account receivable will have a seven-digit code. The first three digits are 120, the code for accounts receivable. The next four digits identify up to 10,000 individual customers.

general journal - A journal used to record infrequent or nonroutine transactions, such as loan payments and end-of-period adjusting and closing entries.

specialized journal - A journal used to record a large number of repetitive transactions such as credit sales, cash receipts, purchases, and cash disbursements.

JOURNALS Transaction data are often recorded in a journal before they are entered into a ledger. A journal entry shows the accounts and amounts to be debited and credited. A **general journal** is used to record infrequent or nonroutine transactions, such as loan payments and end-of-period adjusting and closing entries. A **specialized journal** records large numbers of repetitive transactions such as sales, cash receipts, and cash disbursements.

Table 2-3 is a sample sales journal. All transaction information is recorded in one line, with every entry a debit to accounts receivable and a credit to sales. There is no need to write an explanation of each entry, as is the case with general journal entries. Given the high number of daily sales transactions, the time saved by recording these transactions in a sales journal, rather than in the general journal, is considerable.

The Post Ref column indicates when transactions are posted to the appropriate ledger. In a manual system, ledgers are books; hence, the phrase "keeping the books" refers to the process of maintaining the ledgers.

Figure 2-2 shows how to journalize and post sales transactions. First, each credit sale is recorded in the sales journal. Then each sales journal entry is posted to the appropriate customer account in the accounts receivable subsidiary ledger (note the arrow linking the $1,876.50 sale to KDR Builders in the sales journal to the debit for $1,876.50 in the accounts

TABLE 2-3 Sample Sales Journal

SALES JOURNAL					PAGE 5
DATE	INVOICE NUMBER	ACCOUNT DEBITED	ACCOUNT NUMBER	POST REF	AMOUNT
Oct. 15	151	Brown Hospital Supply	120–035	✓	798.00
15	152	Greenshadows Hotel Suites	120–122	✓	1,267.00
15	153	Heathrow Apartments	120–057	✓	5,967.00
15	154	LMS Construction	120–173	✓	2,312.50
15	155	Gardenview Apartments	120–084	✓	3,290.00
15	156	KDR Builders	120–135	✓	1,876.50
		TOTAL	120/502		15,511.00

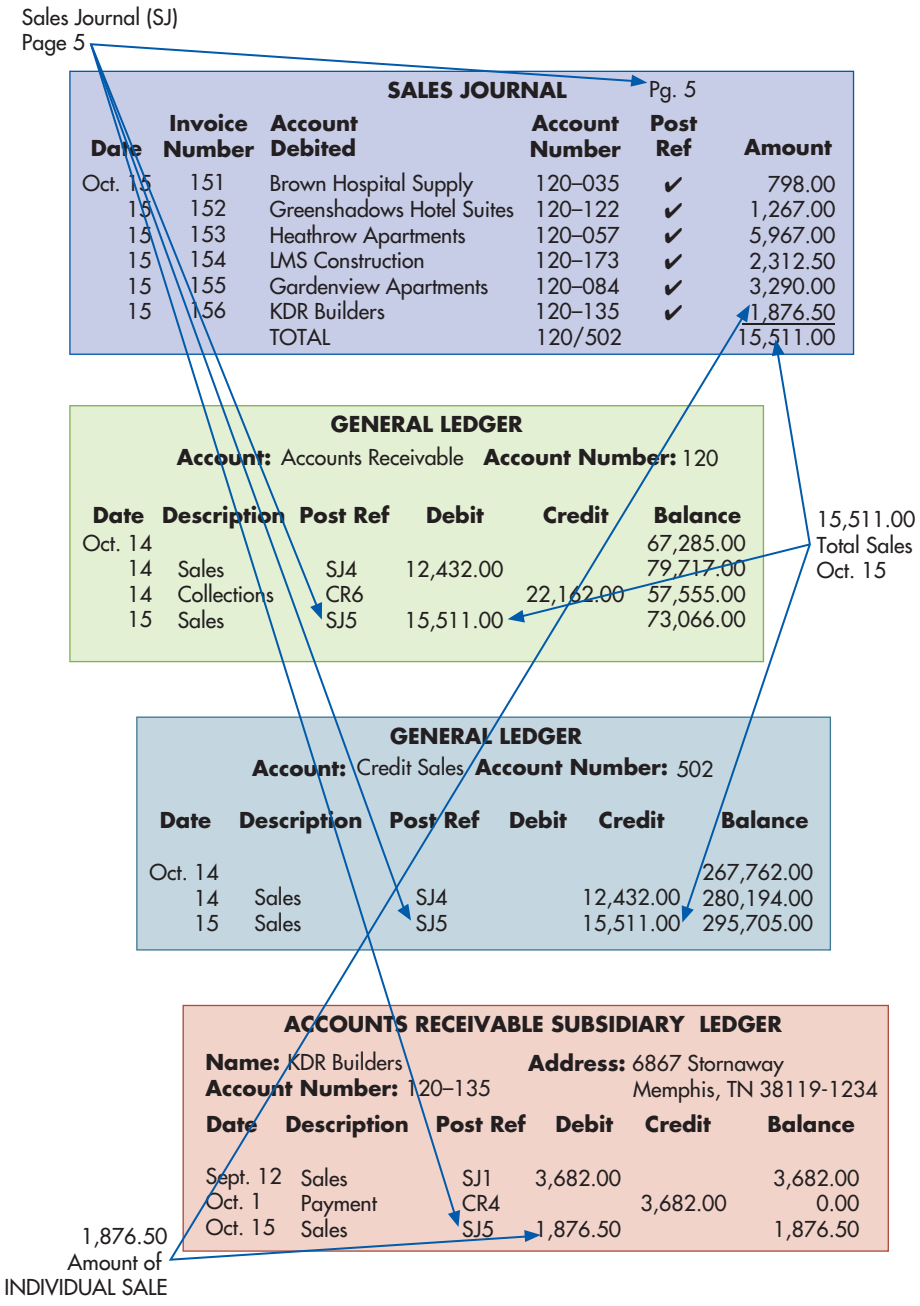


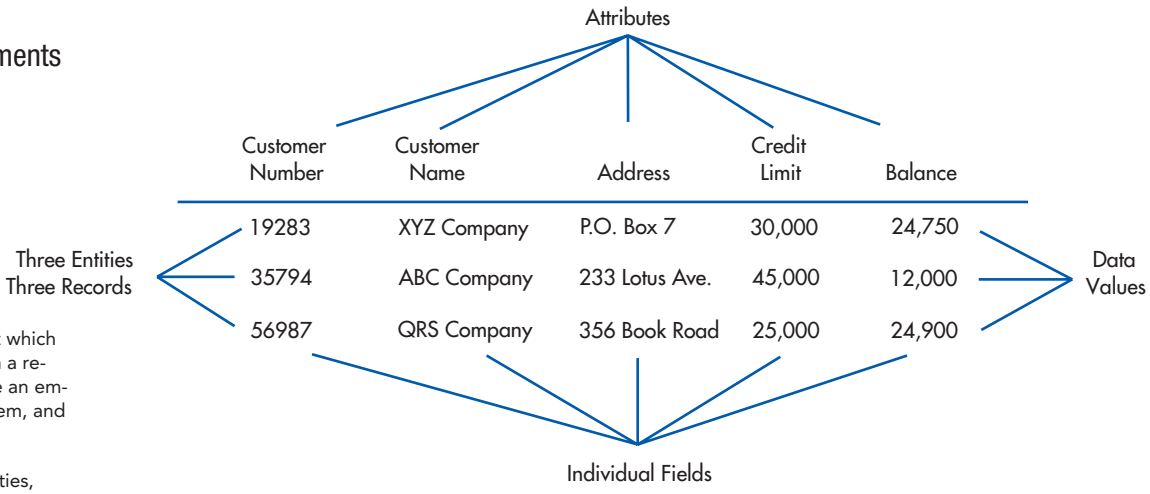
FIGURE 2-2
Recording and Posting a Credit Sale

receivable subsidiary ledger). Periodically, the total of all sales journal entries is posted to the general ledger (note the arrow showing the daily sales journal total of $15,511.00 posted to both the Accounts Receivable and the Credit Sales general ledger accounts).

AUDIT TRAIL Figure 2-2 shows how the posting references and document numbers provide an audit trail. An **audit trail** is a traceable path of a transaction through a data processing system from point of origin to final output, or backward from final output to point of origin. It is used to check the accuracy and validity of ledger postings. Observe that the SJ5 posting reference for the $15,511 credit to the sales account in the general ledger refers to page 5 of the sales journal. By checking page 5 of the sales journal, it is possible to verify that $15,511 represents the total credit sales recorded on October 15. Similarly, the posting reference for the $1,876.50 debit to the KDR Builders' account in the subsidiary accounts receivable ledger also refers to page 5 of the sales journal as the source of that entry. Furthermore, note that the sales journal lists the invoice numbers for each individual entry. This provides the means for

audit trail - A path that allows a transaction to be traced through a data processing system from point of origin to output or backwards from output to point of origin. It is used to check the accuracy and validity of ledger postings and to trace changes in general ledger accounts from their beginning balance to their ending balance.

FIGURE 2-3
Data Storage Elements



This accounts receivable file stores information about three separate entities: XYZ Company, ABC Company, and QRS Company. As a result, there are three records in the file. Five separate attributes are used to describe each customer: customer number, customer name, address, credit limit, and balance. There are, therefore, five separate fields in each record. Each field contains a data value that describes an attribute of a particular entity (customer). For example, the data value 19283 is the customer number for the XYZ Company.

entity - The item about which information is stored in a record. Examples include an employee, an inventory item, and a customer.

attributes - The properties, identifying numbers, and characteristics of interest of an entity that is stored in a database. Examples are employee number, pay rate, name, and address.

field - The portion of a data record where the data value for a particular attribute is stored. For example, in a spreadsheet each row might represent a customer and each column is an attribute of the customer. Each cell in a spreadsheet is a field.

record - A set of fields whose data values describe specific attributes of an entity, such as all payroll data relating to a single employee. An example is a row in a spreadsheet.

data value - The actual value stored in a field. It describes a particular attribute of an entity. For example, the customer name field would contain "ZYX Company" if that company was a customer.

file - A set of logically related records, such as the payroll records of all employees.

master file - A permanent file of records that stores cumulative data about an organization. As transactions take place, individual records within a master file are updated to keep them current.

transaction file - A file that contains the individual business transactions that occur during a specific fiscal period. A transaction file is conceptually similar to a journal in a manual AIS.

database - A set of interrelated, centrally controlled data files that are stored with as little data redundancy as possible. A database consolidates records previously stored in separate files into a common pool and serves a variety of users and data processing applications.

locating and examining the appropriate source documents in order to verify that the transaction occurred and it was recorded accurately.

COMPUTER-BASED STORAGE CONCEPTS An **entity** is something about which information is stored, such as employees, inventory items, and customers. Each entity has **attributes**, or characteristics of interest, that are stored, such as a pay rate and address. Each type of entity possesses the same set of attributes. For example, all employees possess an employee number, pay rate, and home address. The specific values for those attributes will differ. For example, one employee's pay rate might be $12.00 an hour, whereas another's might be $12.25.

Figure 2-3 shows that computers store data in a **field**. The fields containing data about entity attributes constitute a **record**. In Figure 2-3, each row represents a different record, and each column represents an attribute. Each intersecting row and column in Figure 2-3 is a field within a record, the contents of which are called a **data value**.

A **file** is a group of related records. A **master file**, like a ledger in a manual AIS, stores cumulative information about an organization. The inventory and equipment master files store information about important organizational resources. The customer, supplier, and employee master files store information about important agents with whom the organization interacts.

Master files are permanent; they exist across fiscal periods. However, individual master file records may change frequently. For example, individual customer accounts balances are updated to reflect new sales transactions and payments received. Periodically, new records are added to or removed from a master file, for example, when a new customer is added or a former customer deleted.

A **transaction file** contains records of individual business transactions that occur during a specific time. It is similar to a journal in a manual AIS. For example, S&S will have a daily sales transaction file and a cash receipts file. Both files will update individual customer account balances in the customer master file. Transaction files are not permanent and may not be needed beyond the current fiscal period. However, they are usually maintained for a specified period for backup purposes.

A set of interrelated, centrally coordinated files is referred to as a **database**. For example, the accounts receivable file might be combined with customer, sales analysis, and related files to form a customer database. Chapter 4 discusses database technology.

DATA PROCESSING

Once business activity data have been entered into the system, they must be processed to keep the databases current. The four different types of data processing activities, referred to as CRUD, are as follows:

1. ***Creating*** new data records, such as adding a newly hired employee to the payroll database.
2. ***Reading***, retrieving, or viewing existing data.
3. ***Updating*** previously stored data. Figure 2-4 depicts the steps required to update an accounts receivable record with a sales transaction. The two records are matched using the account number. The sale amount ($360) is added to the account balance ($1,500) to get a new current balance ($1,860).
4. ***Deleting*** data, such as purging the vendor master file of all vendors the company no longer does business with.

Updating done periodically, such as daily, is referred to as **batch processing**. Although batch processing is cheaper and more efficient, the data are current and accurate only immediately after processing. For that reason, batch processing is used only for applications, such as payroll, that do not need frequent updating and that naturally occur or are processed at fixed time periods.

batch processing - Accumulating transaction records into groups or batches for processing at a regular interval such as daily or weekly. The records are usually sorted into some sequence (such as numerically or alphabetically) before processing.

Most companies update each transaction as it occurs, referred to as **online, real-time processing** because it ensures that stored information is always current, thereby increasing its decision-making usefulness. It is also more accurate because data input errors can be corrected in real time or refused. It also provides significant competitive advantages. For example, FedEx updated its mission statement to include the phrase "Positive control of each package will be maintained by utilizing real-time electronic tracking and tracing systems." With FedEx's system, employees and customers can track the exact location of each package and estimate its arrival time.

online, real-time processing - The computer system processes data immediately after capture and provides updated information to users on a timely basis.

A combination of the two approaches is online batch processing, where transaction data are entered and edited as they occur and stored for later processing. Batch processing and online, real-time processing are summarized in Figure 2-5.

INFORMATION OUTPUT

The final step in the data processing cycle is information output. When displayed on a monitor, output is referred to as "soft copy." When printed on paper, it is referred to as "hard copy." Information is usually presented in one of three forms: a document, a report, or a query response.

Documents are records of transaction or other company data. Some, such as checks and invoices, are transmitted to external parties. Others, such as receiving reports and purchase

document - A record of a transaction or other company data. Examples include checks, invoices, receiving reports, and purchase requisitions.

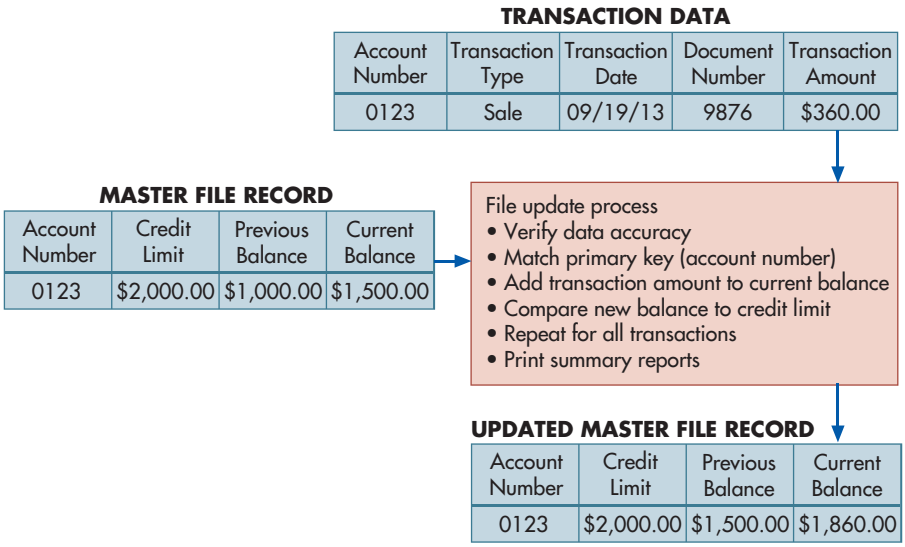
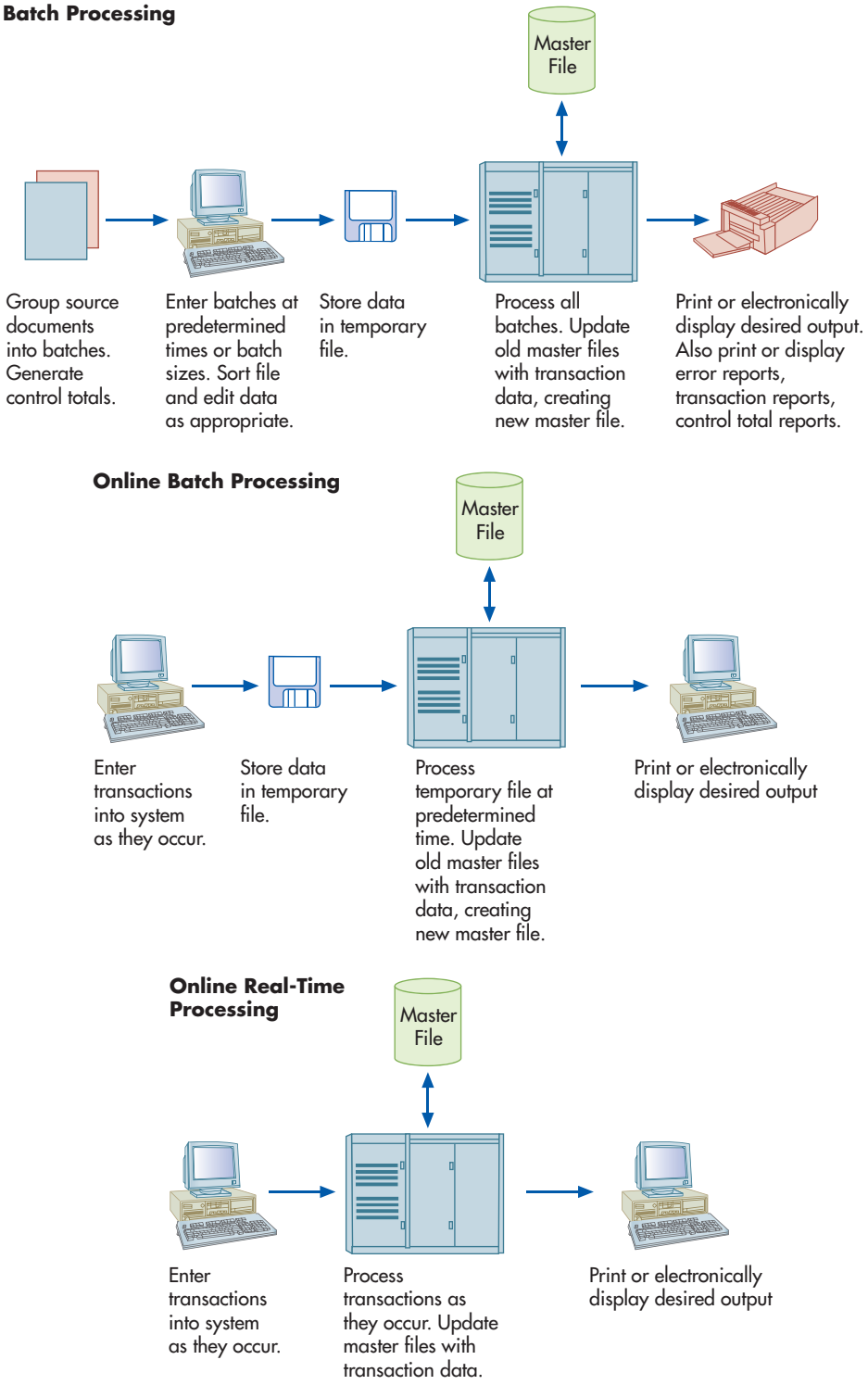


FIGURE 2-4
The Accounts Receivable File Update Process

FIGURE 2-5
Batch and Online Processing



reports - System output, organized in a meaningful fashion, that is used by employees to control operational activities, by managers to make decisions and design strategies, and by investors and creditors to understand a company's business activities.

requisitions, are used internally. Documents can be printed out, or they can be stored as electronic images in a computer. For example, Toys 'R' Us uses electronic data interchange to communicate with its suppliers. Every year it processes over half a million invoices electronically, thereby eliminating paper documents and dramatically reducing costs and errors. This has resulted in higher profits and more accurate information.

Reports are used by employees to control operational activities and by managers to make decisions and to formulate business strategies. External users need reports to evaluate

company profitability, judge creditworthiness, or comply with regulatory requirements. Some reports, such as financial statements and sales analyses, are produced on a regular basis. Others are produced on an exception basis to call attention to unusual conditions. For example, S&S could have its system produce a report to indicate when product returns exceed a certain percentage of sales. Reports can also be produced on demand. For example, Susan could produce a report to identify the salesperson who sold the most items during a specific promotional period.

The need for reports should be periodically assessed, because they are often prepared long after they are needed, wasting time, money, and resources. For example, NCR Corporation reduced the number of reports from 1,200 to just over 100. Another company eliminated 6 million pages of reports, a stack four times higher than its 41-story headquarters building. One 25-page report took five days to prepare and sat unread.

A database **query** is used to provide the information needed to deal with problems and questions that need rapid action or answers. A user enters a request for a specific piece of information; it is retrieved, displayed, or analyzed as requested. Repetitive queries are often developed by information systems specialists. One-time queries are often developed by users. Some companies, such as Walmart, allow suppliers to access their databases to help them better serve Walmart's needs. Suppliers can gauge how well a product is selling in every Walmart store in the world and maximize sales by stocking and promoting items that are selling well.

query - A request for the database to provide the information needed to deal with a problem or answer a question. The information is retrieved, displayed or printed, and/or analyzed as requested.

Additional information about system output is contained in Chapters 12 to 16.

Enterprise Resource Planning (ERP) Systems

Traditionally, the AIS has been referred to as a transaction processing system because its only concern was financial data and accounting transactions. For example, when a sale took place, the AIS would record a journal entry showing only the date of the sale, a debit to either cash or accounts receivable, and a credit to sales. Other potentially useful nonfinancial information about the sale, such as the time of day that it occurred, would traditionally be collected and processed outside the AIS. Consequently, many organizations developed additional information systems to collect, process, store, and report information not contained in the AIS. Unfortunately, the existence of multiple systems creates numerous problems and inefficiencies. Often the same data must be captured and stored by more than one system, which not only results in redundancy across systems but also can lead to discrepancies if data are changed in one system but not in others. In addition, it is difficult to integrate data from the various systems.

Enterprise resource planning (ERP) systems overcome these problems as they integrate all aspects of a company's operations with a traditional AIS. Most large and many medium-sized organizations use ERP systems to coordinate and manage their data, business processes, and resources. The ERP system collects, processes, and stores data and provides the information managers and external parties need to assess the company.

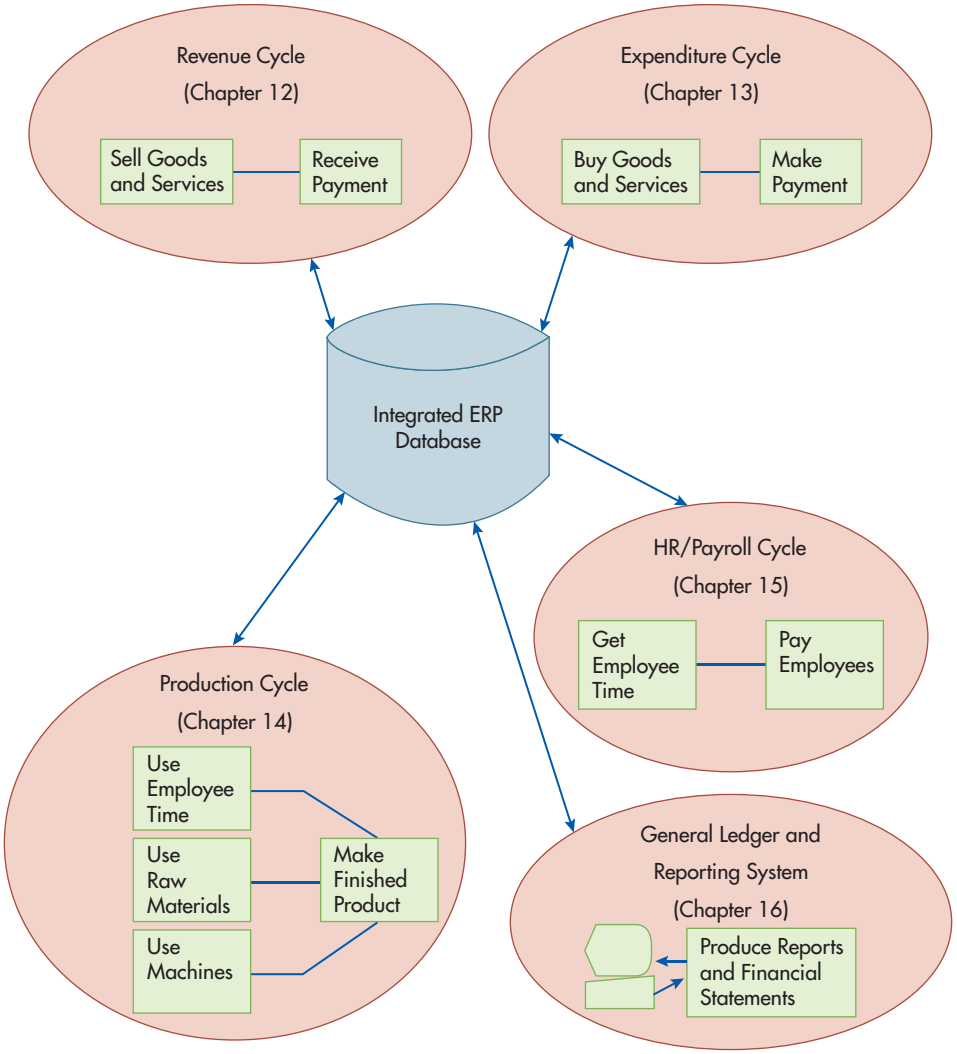
enterprise resource planning (ERP) system - A system that integrates all aspects of an organization's activities—such as accounting, finance, marketing, human resources, manufacturing, inventory management—into one system. An ERP system is modularized; companies can purchase the individual modules that meet their specific needs. An ERP facilitates information flow among the company's various business functions and manages communications with outside stakeholders.

As shown in Figure 2-6, a properly configured ERP system uses a centralized database to share information across business processes and coordinate activities. This is important because an activity that is part of one business process often triggers a complex series of activities throughout many different parts of the organization. For example, a customer order may necessitate scheduling additional production to meet the increased demand. This may trigger an order to purchase more raw materials. It may also be necessary to schedule overtime or hire temporary help. Well-designed ERP systems provide management with easy access to up-to-date information about all of these activities in order to plan, control, and evaluate the organization's business processes more effectively.

ERP systems are modular, with each module using best business practices to automate a standard business process. This modular design allows businesses to add or delete modules as needed. Typical ERP modules include:

- Financial (general ledger and reporting system)—general ledger, accounts receivable, accounts payable, fixed assets, budgeting, cash management, and preparation of managerial reports and financial statements

FIGURE 2-6
Integrated ERP System



- Human resources and payroll—human resources, payroll, employee benefits, training, time and attendance, benefits, and government reporting
- Order to cash (revenue cycle)—sales order entry, shipping, inventory, cash receipts, commission calculation
- Purchase to pay (disbursement cycle)—purchasing, receipt and inspection of inventory, inventory and warehouse management, and cash disbursements
- Manufacturing (production cycle)—engineering, production scheduling, bill of materials, work-in-process, workflow management, quality control, cost management, and manufacturing processes and projects
- Project management—costing, billing, time and expense, performance units, activity management
- Customer relationship management—sales and marketing, commissions, service, customer contact, and call center support
- System tools—tools for establishing master file data, specifying flow of information, access controls, and so on

An ERP system, with its centralized database, provides significant advantages:

- An ERP provides an integrated, enterprise-wide, single view of the organization's data and financial situation. Storing all corporate information in a single database breaks down barriers between departments and streamlines the flow of information.
- Data input is captured or keyed once, rather than multiple times, as it is entered into different systems. Downloading data from one system to another is no longer needed.

- Management gains greater visibility into every area of the enterprise and greater monitoring capabilities. Employees are more productive and efficient because they can quickly gather data from both inside and outside their own department.
- The organization gains better access control. An ERP can consolidate multiple permissions and security models into a single data access structure.
- Procedures and reports are standardized across business units. This standardization can be especially valuable with mergers and acquisitions because an ERP system can replace the different systems with a single, unified system.
- Customer service improves because employees can quickly access orders, available inventory, shipping information, and past customer transaction details.
- Manufacturing plants receive new orders in real time, and the automation of manufacturing processes leads to increased productivity.

ERP systems also have significant disadvantages:

- Cost. ERP hardware, software, and consulting costs range from $50 to $500 million for a Fortune 500 company and upgrades can cost $50 million to $100 million. Midsized companies spend between $10 and $20 million.
- Amount of time required. It can take years to select and fully implement an ERP system, depending on business size, number of modules to be implemented, degree of customization, the scope of the change, and how well the customer takes ownership of the project. As a result, ERP implementations have a very high risk of project failure.
- Changes to business processes. Unless a company wants to spend time and money customizing modules, they must adapt to standardized business processes as opposed to adapting the ERP package to existing company processes. The failure to map current business processes to existing ERP software is a main cause of ERP project failures.
- Complexity. This comes from integrating many different business activities and systems, each having different processes, business rules, data semantics, authorization hierarchies, and decision centers.
- Resistance. Organizations that have multiple departments with separate resources, missions, profit and loss, and chains of command may believe that a single system has few benefits. It also takes considerable training and experience to use an ERP system effectively, and employee resistance is a major reason why many ERP implementations do not succeed. It is not easy to convince employees to change how they do their jobs, train them in new procedures, master the new system, and persuade them to share sensitive information. Resistance, and the blurring of company boundaries, can cause problems with employee morale, accountability, and lines of responsibility.

Reaping the potential benefits of ERP systems and mitigating their disadvantages requires conscious effort and involvement by top management. Top management's commitment to and support for the necessary changes greatly increase the chances of success.

Because ERP systems are complex and expensive, choosing one is not an easy task. In doing so, you must take great care to ensure that the ERP system has a module for every critical company process and that you are not paying for software modules that you do not need. One way to choose a suitable system is to select a package designed for your industry. Although cost is a huge concern, buying too cheaply can cost more in the long run if the system does not meet your needs, because modification costs can be quite high. You can minimize the risk of buying the wrong package by researching the best ERP vendors. There are many ERP vendors, the two largest being SAP and Oracle. Other leading vendors are The Sage Group, Microsoft, and Infor.

Because it is too difficult for most companies to implement ERP software by themselves, they often hire an ERP vendor or a consulting company to do it for them. These firms usually provide three types of services: consulting, customization, and support. For most midsized companies, implementation costs range from the list price of the ERP user licenses to twice that amount. Large companies with multiple sites often spend three to five times the cost of the user license.

Because many processes automatically trigger additional actions in other modules, proper configuration is essential. This requires a sound understanding of all major business processes and their interactions so they can be defined. Examples include setting up cost/profit centers,

credit approval policies, and purchase approval rules. In the configuration process, companies balance the way they want the system to operate with the way it lets them operate. If the way an ERP module operates is unacceptable, the company can modify the module. Alternatively, it can use an existing system and build interfaces between it and the ERP system. Both options are time consuming, costly, and result in fewer system integration benefits. In addition, the more customized a system becomes, the more difficult it is to communicate with suppliers and customers. To make configuration easier, ERP vendors are developing built-in "configuration" tools to address most customers' needs for system changes.

The importance of sound internal controls in an ERP cannot be overstated. The integrated nature of ERP systems means that unless every data item is validated and checked for accuracy at the time of initial entry, errors will automatically propagate throughout the system. Thus, data entry controls and access controls are essential. Most managers and employees see and have access to only a small portion of the system. This segregation of duties provides sound internal control. It is important to separate responsibility for custody of assets, authorization of activities that affect those assets, and recording information about activities and the status of organizational assets.

Summary and Case Conclusion

Ashton is aware that Scott and Susan plan to open additional stores in the near future and want to develop a website to conduct business over the Internet. Based on this information, Ashton will select an accounting package that will satisfy S&S's current and anticipated future needs. The software should be able to take care of all data processing and data storage tasks. Ashton will also make sure that the software can interface with the source data automation devices he wants to use to capture most data input. The software must be capable of producing a full set of financial reports and be flexible enough to produce other useful information the company will need to be successful. Finally, Ashton realized his next step would be to select the software and produce some documentation of how the system worked.

KEY TERMS

data processing cycle 26
source documents 26
turnaround documents 26
source data automation 27
general ledger 28
subsidiary ledger 28
control account 28
coding 28
sequence code 28
block code 28
group code 28
mnemonic code 28
chart of accounts 29
general journal 30
specialized journal 30
audit trail 31
entity 32
attributes 32
field 32
record 32
data value 32
file 32
master file 32
transaction file 32
database 32
batch processing 33
online, real-time processing 33
document 33
report 34
query 35
enterprise resource planning (ERP) system 35

AIS in Action

CHAPTER QUIZ

1. Which of the following is NOT a step in the data processing cycle?
a. data collection
b. data input
c. data storage
d. data processing

2. All of the information (name, GPA, major, etc.) about a particular student is stored in the same
a. file
b. record
c. attribute
d. field

3. Which of the following would contain the total value of all inventory owned by an organization?
a. source document
b. general ledger
c. cash budget

4. Which of the following is most likely to be a general ledger control account?
a. accounts receivable
b. petty cash
c. prepaid rent
d. retained earnings

5. Which of the following documents is most likely to be used in the expenditure cycle?
a. sales orders
b. credit memo
c. receiving report
d. job time ticket

6. Which of the following is LEAST likely to be a specialized journal?
a. sales journal
b. cash receipts journal
c. prepaid insurance journal
d. cash disbursements journal

7. How does the chart of accounts list general ledger accounts?
a. alphabetical order
b. chronological order
c. size order
d. the order in which they appear in financial statements

8. Which of the following is NOT an advantage of an ERP system?
a. better access control
b. standardization of procedures and reports
c. improved monitoring capabilities
d. simplicity and reduced costs

9. Records of company data sent to an external party and then returned to the system as input are called
a. turnaround documents
b. source data automation documents
c. source documents
d. external input documents

10. Recording and processing information about a transaction at the time it takes place is referred to as which of the following?
a. batch processing
b. online, real-time processing
c. captured transaction processing
d. chart of accounts processing

DISCUSSION QUESTIONS

2.1 Table 2-1 lists some of the documents used in the revenue, expenditure, and human resources cycle. What kinds of input or output documents or forms would you find in the production (also referred to as the conversion) cycle?

2.2 With respect to the data processing cycle, explain the phrase "garbage in, garbage out." How can you prevent this from happening?

2.3 What kinds of documents are most likely to be turnaround documents? Do an Internet search to find the answer and to find example turnaround documents.

2.4 The data processing cycle in Figure 2-1 is an example of a basic process found throughout nature. Relate the basic input/process/store/output model to the functions of the human body.

2.5 Some individuals argue that accountants should focus on producing financial statements and leave the design and production of managerial reports to information systems specialists. What are the advantages and disadvantages of following this advice? To what extent should accountants be involved in producing reports that include more than just financial measures of performance? Why?

PROBLEMS

2.1 The chart of accounts must be tailored to an organization's specific needs. Discuss how the chart of accounts for the following organizations would differ from the one presented for S&S in Table 2-2.

a. university
b. bank
c. government unit (city or state)
d. manufacturing company
e. expansion of S&S to a chain of two stores

2.2 Ollie Mace is the controller of SDC, an automotive parts manufacturing firm. Its four major operating divisions are heat treating, extruding, small parts stamping, and machining. Last year's sales from each division ranged from $150,000 to $3 million. Each division is physically and managerially independent, except for the constant surveillance of Sam Dilley, the firm's founder.

The AIS for each division evolved according to the needs and abilities of its accounting staff. Mace is the first controller to have responsibility for overall financial management. Dilley wants Mace to improve the AIS before he retires in a few years so that it will be easier to monitor division performance. Mace decides to redesign the financial reporting system to include the following features:

- It should give managers uniform, timely, and accurate reports of business activity. Monthly reports should be uniform across divisions and be completed by the fifth day of the following month to provide enough time to take corrective actions to affect the next month's performance. Company-wide financial reports should be available at the same time.
- Reports should provide a basis for measuring the return on investment for each division. Thus, in addition to revenue and expense accounts, reports should show assets assigned to each division.
- The system should generate meaningful budget data for planning and decision-making purposes. Budgets should reflect managerial responsibility and show costs for major product groups.

Mace believes that a new chart of accounts is required to accomplish these goals. He wants to divide financial statement accounts into major categories, such as assets, liabilities, and equity. He does not foresee a need for more than 10 control accounts within each of these categories. From his observations to date, 100 subsidiary accounts are more than adequate for each control account.

No division has more than five major product groups. Mace foresees a maximum of six cost centers within any product group, including both the operating and nonoperating groups. He views general divisional costs as a non-revenue-producing product group. Mace estimates that 44 expense accounts plus 12 specific variance accounts would be adequate.

REQUIRED

Design a chart of accounts for SDC. Explain how you structured the chart of accounts to meet the company's needs and operating characteristics. Keep total account code length to a minimum, while still satisfying all of Mace's desires. *(CMA Examination, adapted)*

2.3 An audit trail enables a person to trace a source document to its ultimate effect on the financial statements or work back from financial statement amounts to source documents. Describe in detail the audit trail for the following:

a. Purchases of inventory
b. Sales of inventory
c. Employee payroll

2.4 Your nursery sells various types and sizes of trees, bedding plants, vegetable plants, and shrubs. It also sells fertilizer and potting soil. Design a coding scheme for your nursery.

2.5 Match the following terms with their definitions.

Term	Definition
____ a. data processing cycle	**1.** Contains summary-level data for every asset, liability, equity, revenue, and expense account
____ b. source documents	**2.** Items are numbered consecutively to account for all items; missing items cause a gap in the numerical sequence
____ c. turnaround documents	**3.** Path of a transaction through a data processing system from point of origin to final output, or backward from final output to point of origin
____ d. source data automation	**4.** List of general ledger account numbers; allows transaction data to be coded, classified, and entered into proper accounts; facilitates preparation of financial statements and reports
____ e. general ledger	**5.** Contents of a specific field, such as "George" in a name field
____ f. subsidiary ledger	**6.** Portion of a data record that contains the data value for a particular attribute, like a cell in a spreadsheet
____ g. control account	**7.** Company data sent to an external party and then returned to the system as input
____ h. coding	**8.** Used to record infrequent or nonroutine transactions
____ i. sequence code	**9.** Characteristics of interest that need to be stored
____ j. block code	**10.** The steps a company must follow to efficiently and effectively process data about its transactions
____ k. group code	**11.** Something about which information is stored
____ l. mnemonic code	**12.** Stores cumulative information about an organization; like a ledger in a manual AIS
____ m. chart of accounts	**13.** Contains detailed data for any general ledger account with many individual subaccounts
____ n. general journal	**14.** Contains records of individual business transactions that occur during a specific time period
____ o. specialized journal	**15.** Updating each transaction as it occurs
____ p. audit trail	**16.** Devices that capture transaction data in machine-readable form at the time and place of their origin
____ q. entity	**17.** Used to record large numbers of repetitive transactions
____ r. attribute	**18.** Set of interrelated, centrally coordinated files

____ s. field	**19.** Two or more subgroups of digits are used to code items
____ t. record	**20.** Updating done periodically, such as daily
____ u. data value	**21.** Systematic assignment of numbers or letters to items to classify and organize them
____ v. master file	**22.** Letters and numbers, derived from the item description, are interspersed to identify items; usually easy to memorize
____ w. transaction file	**23.** Initial record of a transaction that takes place; usually recorded on preprinted forms or formatted screens
____ x. database	**24.** Fields containing data about entity attributes, like a row in a spreadsheet
____ y. batch processing	**25.** Sets of numbers are reserved for specific categories of data
____ z. online, real-time processing	**26.** The general ledger account corresponding to a subsidiary ledger, where the sum of all subsidiary ledger entries should equal the amount in the general ledger account

2.6 For each of the following scenarios, identify which data processing method (batch or online, real-time) would be the most appropriate.

a. Make an airline reservation
b. Register for a university course
c. Prepare biweekly payroll checks
d. Process an order through an e-commerce website
e. Prepare a daily bank deposit
f. Preparation of customer bills by a local utility
g. Accumulate daily costs from a production run of a single automobile part
h. Identify the replacement drill bit size for a bit broken during a recent production run

2.7 On their websites, you will find several online demonstrations for the SAP and Oracle ERP systems. Visit these websites and explore their content by doing the following:

a. Search the SAP site for corporate videos, and watch two of them. Explore the industries, services, solutions, and platforms that SAP offers. Read several of the articles, such as the ones about customer successes.
b. Explore the Oracle website just as you explored the SAP site.

REQUIRED

After viewing the websites, and based on your reading of the chapter, write a two-page paper that describes how an ERP can connect and integrate the revenue, expenditure, human resources/payroll, and financing cycles of a business.

2.8 Which of the following actions update a master file and which would be stored as a record in a transaction file?

a. Update customer address change
b. Update unit pricing information
c. Record daily sales
d. Record payroll checks
e. Change employee pay rates
f. Record production variances
g. Record sales commissions
h. Change employee office location

i. Update accounts payable balance
j. Change customer credit limit
k. Change vendor payment discount terms
l. Record purchases

2.9 You were hired to assist Ashton Fleming in designing an accounting system for S&S. Ashton has developed a list of the journals, ledgers, reports, and documents that he thinks S&S needs (see Table 2-4). He asks you to complete the following tasks:
a. Specify what data you think should be collected on each of the following four documents: sales invoice, purchase order, receiving report, employee time card.
b. Design a report to manage inventory.
c. Design a report to assist in managing credit sales and cash collections.
d. Visit a local office supply store and identify what types of journals, ledgers, and blank forms for various documents (sales invoices, purchase orders, etc.) are available. Describe how easily they could be adapted to meet S&S's needs.

2.10 Answer the following 10 multiple choice questions.

1. Which of the following statements is (are) true?
a. Turnaround documents are company output sent to an external party and returned as an input document.
b. Data is one of a company's most important resources but, to function properly, most organizations do not have to have the data readily and easily accessible.
c. Each type of entity possesses the same set of attributes or characteristics of interest that are stored, but the specific data values for those attributes will differ depending on the entity.
d. Online data processing is almost always cheaper and more efficient than batch processing,
e. Reaping the potential benefits of ERP systems and mitigating their disadvantages requires conscious effort and involvement by top management.

TABLE 2-4 Documents, Journals, and Ledgers for S&S

TITLE	PURPOSE
Documents	
Sales Invoice	Record cash and credit sales of merchandise
Service Invoice	Record sales of repair services
Delivery Ticket	Record delivery of merchandise to customers
Monthly Statement	Inform customers of outstanding account balances
Credit Memo	Support adjustments to customer accounts for sales returns and allowances and sales discounts; also support write-off of uncollectible accounts
Purchase Order	Order merchandise from vendors
Receiving Report	Record receipt of merchandise from vendors, indicating both quantity and condition of items received
Time Card	Record time worked by employees
Specialized Journals	
Sales	Record all credit sales
Cash Receipts	Record cash sales, payments from customers, and other cash receipts
Purchases	Record all purchases from vendors
Cash Disbursements	Record all cash disbursements
General Journal	Record infrequent, nonroutine transactions; also record adjusting and closing entries
Subsidiary Ledgers	
Accounts Receivable	Maintain details about amounts due from customers
Accounts Payable	Maintain details about amounts due to vendors
Inventory	Maintain details about each inventory item
Fixed Assets	Maintain details about each piece of equipment and other fixed assets
General Ledger	Maintain details about all major asset, liability, equity, revenue, and expense accounts

2. Which of the following statements is (are) true?
   a. The data capture or input process is usually triggered by a top management decision.
   b. With sequence codes, items are numbered consecutively to account for all items, and missing items cause a gap in the numerical sequence.
   c. Cumulative accounting information is stored in general and subsidiary journals.
   d. Computers store data in a field; the fields containing data about entity attributes constitute a record.
   e. Updating done periodically, such as daily or weekly, is referred to as batch processing.

3. Which of the following statements is (are) true?
   a. Source data automation devices capture transaction data in paper form at the time and place of their origin.
   b. General ledgers are often used for accounts receivable, inventory, fixed assets, and accounts payable.
   c. Master files are permanent and exist across fiscal periods; individual master file records may change frequently.
   d. When choosing an ERP system, make sure it has a module for every critical company process and that you are not paying for modules that you do not need.
   e. If an ERP system does not meet your needs, it can almost always be inexpensively modified to meet your unique needs

4. Which of the following statements is (are) true?
   a. Using source data automation or well-designed turnaround documents and data entry screens helps ensure captured data are accurate and complete.
   b. If the sum of all subsidiary ledger account balances does not equal its general ledger control account balance, a recording error has occurred.
   c. Online, real-time processing updates transactions as they occur, helping ensure stored information is current and useful in making decision.
   d. It is usually best to let a user determine what data to input rather than have data input screens list the data the user needs to enter.
   e. A group code is derived from the description of the item and is usually easy to memorize.

5. Which of the following statements is (are) true?
   a. Online batch processing is where transaction data are entered, edited, and processed as they occur.
   b. ERP implementation costs for large companies with multiple sites are usually about half the cost of the ERP user license.
   c. Well-designed documents and screens improve accuracy and completeness by providing instructions or prompts about what data to collect.
   d. Data in ledgers is organized logically using coding techniques that assign numbers or letters to items to classify and organize them.
   e. In an ERP system, data entry controls such as validating data item and checking them for accuracy at the time of initial entry are not needed.

6. Which of the following statements is (are) true?
   a. Input controls are improved by using pre-numbered source documents or by the system automatically assigning a sequential number to each transaction.
   b. With mnemonic codes, blocks of numbers are reserved for specific categories of data.
   c. As ERP modules do not automatically trigger additional actions in other modules, it is less important to understand business processes and their interactions.
   d. In an integrated ERP system, undetected data entry errors can automatically propagate throughout the system.
   e. A purchase to pay ERP module facilitates production scheduling, work-in-process, quality control, cost management, and manufacturing processes.

7. Which of the following statements is (are) true?
   a. To ensure credit sales policies are followed, the system can be programmed to check a customer's credit limit and payment history.
   b. A transaction file contains records of individual business transactions and is similar to a general ledger in a manual AIS.
   c. An ERP system uses a centralized database to share information across business processes and coordinate activities.
   d. It is difficult for an ERP system to provide management with the up-to-date information needed to plan, control, and evaluate an organization's business.
   e. Use of pre-numbered documents makes it harder to verify that all transactions have been recorded and that none has been misplaced.

8. Which of the following statements is (are) true?
   a. A chart of accounts facilitates preparing financial statements because data stored in individual accounts can easily be summed for presentation.
   b. A database query can provide the information needed to deal with problems and questions that need rapid action or answers.
   c. Repetitive and frequently used database queries are usually developed by users; one-time queries are usually developed by information systems specialists.
   d. Transaction files are permanent and must be maintained for several years for backup purposes.
   e. A journal entry shows the accounts and amounts to be debited and credited.

9. Which of the following statements is (are) true?
   a. Transaction data are almost always recorded in a ledger before they are entered into a journal.
   b. Documents are records of transaction or other company data that can be printed out or stored as electronic images in a computer.
   c. ERP systems are not effective in integrating nonfinancial company operations with a traditional accounting system.
   d. Since batch processing data are current and accurate only immediately after processing, it is used for applications that do not need frequent updating.
   e. Well-designed screens improve accuracy and completeness by using checkoff boxes or pull-down menus to present the available options.

10. Which of the following statements is (are) true?
   a. An audit trail is a transaction path through a data processing system from point of origin to final output, but not backward from final output to point of origin.
   b. The need for reports should be periodically assessed, because they are often prepared long after they are needed, wasting time, money, and resources.
   c. An AIS has traditionally been referred to as a transaction processing system because its only concern was financial data and accounting transactions.
   d. Accountants and systems developers do not need to understand how data are captured, organized, stored, processed, or accessed.
   e. A master file, like a ledger in a manual AIS, stores cumulative information about an organization.

CASE 2-1 Bar Harbor Blueberry Farm

The Bar Harbor Blueberry Farm is a family-owned, 200-acre farm that grows and sells blueberries to grocery stores, blueberry wholesalers, and small roadside stands. Bar Harbor has 25 full-time employees and hires 150 to 200 seasonal workers for the harvest.

For the past six summers, you have picked berries for Bar Harbor. When you graduated, you were hired full-time as the accountant/office manager. Until now, Bar Harbor kept most of its accounting records in a big file box. Jack Phillips, the owner, would like a more organized approach to the farm's accounting records. He has asked you to establish a proper set of books. You decide to start by establishing appropriate journals and ledgers for these transactions.

Presented below are a set of vendor invoices and a few partially completed journals and ledgers. Your job is to record these transactions and update the appropriate ledgers. Be sure to leave a proper audit trail. You may also use Excel, Great Plains, Peachtree, QuickBooks, or another accounting software package of your choosing to complete this problem.

VENDOR INVOICES

DATE	SUPPLIER INVOICE	SUPPLIER NAME	SUPPLIER ADDRESS	AMOUNT
March 7	AJ34	Bud's Soil Prep	PO Box 34	$2,067.85
March 11	14568	Osto Farmers Supply	45 Main	$ 67.50
March 14	893V	Whalers Fertilizer	Route 34	$5,000.00
March 21	14699	Osto Farmers Supply	45 Main	$3,450.37
March 21	10102	IFM Wholesale	587 Longview	$4,005.00
March 24	10145	IFM Wholesale	587 Longview	$ 267.88

PURCHASES JOURNAL

PAGE 1

DATE	SUPPLIER	SUPPLIER INVOICE	ACCOUNT NUMBER	POST REF	AMOUNT
March 7	Bud's Soil Prep	AJ34			$2,067.85

GENERAL LEDGER

ACCOUNTS PAYABLE **ACCOUNT NUMBER: 300**

DATE	DESCRIPTION	POST REF	DEBIT	CREDIT	BALANCE
March 1	Balance Forward				$18,735.55

GENERAL LEDGER

PURCHASES **ACCOUNT NUMBER: 605**

DATE	DESCRIPTION	POST REF	DEBIT	CREDIT	BALANCE
March 1	Balance Forward				$54,688.49

ACCOUNTS PAYABLE SUBSIDIARY LEDGER

ACCOUNT NO: 23	BUD'S SOIL PREP	PO BOX 34	TERMS: 2/10, NET 30	
DATE	DESCRIPTION	DEBIT	CREDIT	BALANCE

ACCOUNT NO: 24	OSTO FARMERS SUPPLY	45 MAIN	TERMS: 2/10, NET 30	
DATE	DESCRIPTION	DEBIT	CREDIT	BALANCE

ACCOUNT NO: 36	WHALERS FERTILIZER	ROUTE 34	TERMS: 2/10, NET 30	
DATE	DESCRIPTION	DEBIT	CREDIT	BALANCE

ACCOUNT NO: 38	IFM WHOLESALE	587 LONGVIEW	TERMS: 2/10, NET 30	
DATE	DESCRIPTION	DEBIT	CREDIT	BALANCE

AIS in Action Solutions

QUIZ KEY

1. Which of the following is NOT a step in the data processing cycle?

► **a.** data collection [Correct. Data collection is a part of data input and is therefore not a step in the data processing cycle.]

b. data input [Incorrect. Data input is the first step in the data processing cycle. This is the step where data is captured, collected, and entered into the system.]

c. data storage [Incorrect. Data storage is the data processing cycle step where data is stored for future use by the company.]

d. data processing [Incorrect. Data processing is the data processing cycle step where stored data is updated with new input data.]

2. All of the information (name, GPA, major, etc.) about a particular student is stored in the same _____.

a. file [Incorrect. A file is designed to include information about many students.]

► **b.** record [Correct. A record should include all information maintained by the system about a particular entity, such as a student.]

c. attribute [Incorrect. An attribute is a descriptor or a characteristic of an entity—in this example, the student's major is an attribute.]
d. field [Incorrect. A field represents a data storage space—in this example, an accounting student would have "Accounting" stored in the major field.]

3. Which of the following would contain the total value of all inventory owned by an organization?
a. source document [Incorrect. A source document contains data about a particular event or transaction.]
► **b.** general ledger [Correct. The general ledger maintains summary information on inventory and every other general ledger account.]
c. cash budget [Incorrect. A cash budget provides information only on projected cash inflows and outflows.]

4. Which of the following is most likely to be a general ledger control account?
► **a.** accounts receivable [Correct. Accounts receivable is typically made up of many individual customer accounts maintained in a subsidiary ledger. The total of all individual customer accounts in the subsidiary ledger is maintained in the accounts receivable control account in the general ledger.]
b. petty cash [Incorrect. Petty cash is made up of only one account.]
c. prepaid rent [Incorrect. A subsidiary ledger containing multiple prepaid rent accounts is usually not necessary.]
d. retained earnings [Incorrect. Retained earnings is typically comprised of only one account.]

5. Which of the following documents is most likely to be used in the expenditure cycle?
a. sales order [Incorrect. The sales order is a revenue cycle document that captures the information about a customer's order.]
b. credit memo [Incorrect. A credit memo is a revenue cycle document that is used to give a credit to a customer for damaged or returned goods.]
► **c.** receiving report [Correct. A receiving report is an expenditure cycle document that is used to record the receipt of goods from suppliers. Companies pay their suppliers based on the goods received and recorded on the receiving report.]
d. job time ticket [Incorrect. A job time ticket is a production cycle document that is used to record time spent on specific jobs.]

6. Which of the following is LEAST likely to be a specialized journal?
a. sales journal [Incorrect. A specialized journal is used to record large numbers of repetitive transactions. Most companies have a large number of sales.]
b. cash receipts journal [Incorrect. A specialized journal is used to record large numbers of repetitive transactions. Most companies have a large number of cash receipts.]
► **c.** prepaid insurance journal [Correct. A specialized journal is used to record large numbers of repetitive transactions, and most companies have very few prepaid insurance transactions.]
d. cash disbursements journal [Incorrect. A specialized journal is used to record large numbers of repetitive transactions. Most companies have a large number of cash disbursements.]

7. How does the chart of accounts list general ledger accounts?
a. alphabetical order [Incorrect. General ledger accounts are listed in the order in which they appear in the financial statements, not in alphabetical order.]
b. chronological order [Incorrect. General ledger accounts are listed in the order in which they appear in the financial statements, not according to the date they were created.]
c. size order [Incorrect. General ledger accounts are listed in the order in which they appear in the financial statements, not according to their size.]
► **d.** the order in which they appear in financial statements [Correct.]

8. Which of the following is NOT an advantage of an ERP system?
   a. better access control [Incorrect. Better access control is an advantage because an ERP can consolidate multiple permissions and security models into a single data access structure.]
   b. standardization of procedures and reports [Incorrect. Standardization of procedures and reports is an advantage because procedures and reports can be standardized across business units, and in mergers and acquisitions they can replace the different systems with a single, unified system.]
   c. improved monitoring capabilities [Incorrect. Improved monitoring capabilities are an advantage because management gains greater visibility into every area of the enterprise that allows them to better monitor the organization.]
► **d.** simplicity and reduced costs [Correct. ERP systems are quite complex and costly; they do not offer the advantages of simplicity and reduced costs.]

9. Records of company data sent to an external party and then returned to the system as input are called _____.
► **a.** turnaround documents [Correct. For example, a utility bill is sent to a customer, who then returns the bill with payment.]
   b. source data automation documents [Incorrect. Source data automation is the capturing of input data in machine-readable form.]
   c. source documents [Incorrect. Source documents collect data about business activities.]
   d. external input documents [Incorrect. These documents originate from external sources.]

10. Recording and processing information about a transaction at the time it takes place is referred to as which of the following?
   a. batch processing [Incorrect. Batch processing involves processing transactions in groups or batches all at the same time.]
► **b.** online, real-time processing [Correct. Online, real-time processing involves processing transactions as they occur.]
   c. captured transaction processing [Incorrect. This is not a recognized transaction processing method.]
   d. chart of accounts processing [Incorrect. The chart of accounts, although typically updated every so often, is not a transaction processing method.]

CHAPTER

3

Systems Documentation Techniques

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

1. Prepare and use data flow diagrams to understand, evaluate, and document information systems.
2. Prepare and use flowcharts to understand, evaluate, and document information systems.
3. Prepare and use business process diagrams to understand, evaluate, and document information systems.

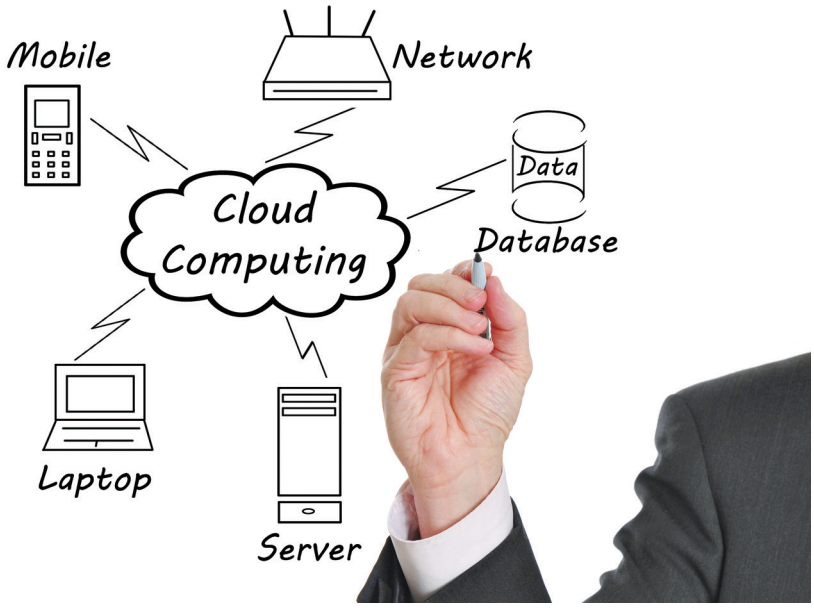
INTEGRATIVE CASE S&S

What a hectic few months it has been for Ashton Fleming! He helped S&S get started, helped get S&S through its weeklong grand opening, and was swamped with processing all the transactions from the highly successful grand opening. Because of its rapid growth, S&S has outgrown the initial rudimentary accounting information system (AIS) that Ashton selected. Lacking time and expertise, Ashton has engaged Computer Applications (CA), a systems consulting firm, to help S&S select and install a new and more powerful AIS.

During Ashton's first meeting with Kimberly Sierra, CA's manager, she asked about S&S's system requirements and management's expectations. Ashton had yet to think through these issues, so he could not answer her specifically. When she asked how S&S's system worked, Ashton plunged into a discussion about the use of various company documents, but Kimberly seemed unable to absorb his detailed explanations. Ashton thought that part of his discussion was helpful, but overall it was irrelevant to the issue at hand.

Ashton came away impressed by CA and Kimberly. He also realized the need to understand S&S's information requirements more clearly. From his days as an auditor, Ashton knew the value of good system documentation in helping unfamiliar users both understand and evaluate a system. Good system documentation would be a big help to him and Kimberly, as well as to Scott and Susan as they evaluate the current and proposed systems.

After sharing his conclusions with Susan and Scott, they enthusiastically approved Ashton's plan to document the current and proposed systems. They supported his taking a



leadership role in moving toward a new system and were especially interested in diagrams or charts that would document their system and help them understand and evaluate it.

Introduction

Documentation explains how a system works, including the who, what, when, where, why, and how of data entry, data processing, data storage, information output, and system controls. Popular means of documenting a system include diagrams, flowcharts, tables, and other graphical representations of data and information. These are supplemented by a **narrative description** of the system, a written step-by-step explanation of system components and interactions. In this chapter, we explain three common systems documentation tools: data flow diagrams, flowcharts, and business process diagrams.

documentation - Narratives, flowcharts, diagrams, and other written materials that explain how a system works.

narrative description - Written, step-by-step explanation of system components and how they interact.

Documentation tools are important on the following levels:

1. At a minimum, you must be able to *read* documentation to determine how a system works.
2. You may need to *evaluate* documentation to identify internal control strengths and weaknesses and recommend improvements as well as to determine if a proposed system meets the company's needs.
3. More skill is needed to *prepare* documentation that shows how an existing or proposed system operates.

This chapter discusses the following documentation tools:

1. ***Data flow diagram (DFD)***, a graphical description of data sources, data flows, transformation processes, data storage, and data destinations
2. ***Flowchart***, which is a graphical description of a system. There are several types of flow charts, including:
   a. ***Document flowchart***, which shows the flow of documents and information between departments or areas of responsibility
   b. ***System flowchart***, which shows the relationship among the input, processing, and output in an information system
   c. ***Program flowchart***, which shows the sequence of logical operations a computer performs as it executes a program.
3. ***Business Process diagrams***, which are graphical descriptions of the business processes used by a company

Accountants use documentation techniques extensively. Auditing standards require that independent auditors understand the automated and manual internal control procedures an entity uses. One good way to gain this understanding is to use business process models or flowcharts to document a system, because such graphic portrayals more readily reveal internal control weaknesses and strengths.

The Sarbanes-Oxley Act (SOX) of 2002 requires an internal control report in public company annual reports that (1) states that management is responsible for establishing and maintaining an adequate internal control structure and (2) assesses the effectiveness of the company's internal controls. SOX also specifies that a company's auditor must evaluate management's assessment of the company's internal control structures and attest to its accuracy. The auditor's attestation should include a specific notation about significant defects or material noncompliance found during internal control tests. This means that both the company and its auditors have to document and test the company's internal controls. To do so, they must be able to prepare, evaluate, and read different types of documentation, such as business process models and flowcharts.

Documentation tools are also used extensively in the systems development process. In addition, the team members who develop information systems applications often change, and documentation tools help the new team members get up to speed quickly.

Documentation is easier to prepare and revise when a software package is used. Once a few basic commands are mastered, users can quickly and easily prepare, store, revise, and print presentation-quality documentation.

The documentation tools in this chapter are used throughout the book.

Data Flow Diagrams

data flow diagram (DFD) - A graphical description of the flow of data within an organization, including data sources/destinations, data flows, transformation processes, and data storage.

A **data flow diagram (DFD)** graphically describes the flow of data within an organization. It uses the first four symbols shown in Figure 3-1 to represent four basic elements: data sources and destinations, data flows, transformation processes, and data stores. For example, Figure 3-2 shows that the input to process C is data flow B, which comes from data source A. The outputs of process C are data flows D and E. Data flow E is sent to data destination J. Process F uses data flows D and G as input and produces data flows I and G as output. Data flow G comes from and returns to data store H. Data flow I is sent to data destination K.

Figure 3-3 assigns specific titles to each of the processes depicted in Figure 3-2. Figures 3-2 and 3-3 will be used to examine the four basic elements of a DFD in more detail.

In Chapters 12 through 16, the basic DFD has been adapted so that it shows internal controls, using the triangle symbol (highway warning symbol) shown in Figure 3-1. The internal controls are numbered and an accompanying table explains the internal control. Users who do not wish to indicate internal controls simply ignore the triangle symbol.

data source - The entity that produces or sends the data that is entered into a system.

data destination - The entity that receives data produced by a system.

A **data source** and a **data destination** are entities that send or receive data that the system uses or produces. An entity can be both a source and a destination. They are represented by squares, as illustrated by items A (customer), J (bank), and K (credit manager) in Figure 3-3.

FIGURE 3-1
Data Flow Diagram Symbols

SYMBOL	NAME	EXPLANATION
	Data sources and destinations	The people and organizations that send data to and receive data from the system are represented by square boxes. Data destinations are also referred to as data sinks.
	Data flows	The flow of the data into or out of a process is represented by curved or straight lines with arrows.
	Transformation processes	The processes that transform data from inputs to outputs are represented by circles. They are often referred to as bubbles.
	Data stores	The storage of data is represented by two horizontal lines.
	Internal Control	An internal control. The internal controls are numbered and explained in an accompanying table. See Chapters 12–16.

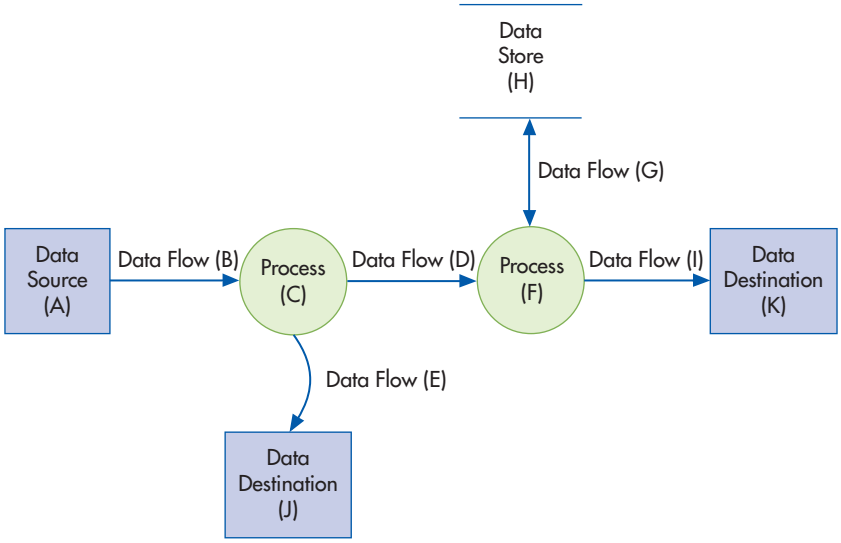


FIGURE 3-2
Basic Data Flow Diagram Elements

A **data flow** is the movement of data among processes, stores, sources, and destinations. Data that pass between data stores and a source or destination must go through a data transformation process. Data flows are labeled to show what data is flowing. The only exception is data flow between a process and a data store, such as data flow G in Figure 3-3, because the data flow is usually obvious. In data flow G, data from the accounts receivable file is retrieved, updated, and stored back in the file. Other data flows in Figure 3-3 are B (customer payment), D (remittance data), E (deposit), and I (receivables data).

data flow - The movement of data among processes, stores, sources, and destinations.

If two or more data flows move together, a single line is used. For example, data flow B (customer payment) consists of a payment and remittance data. Process 1.0 (process payment) splits them and sends them in different directions. The remittance data (D) is used to update accounts receivable records, and the payment (E) is deposited in the bank. If the data flow separately, two lines are used. For example, Figure 3-4 shows two lines because customer inquiries (L) do not always accompany a payment (B). If represented by the same data flow, the separate elements and their different purposes are obscured, and the DFD is more difficult to interpret.

Processes represent the transformation of data. Figure 3-3 shows that process payment (C) splits the customer payment into the remittance data and the check, which

process - The action that transforms data into other data or information.

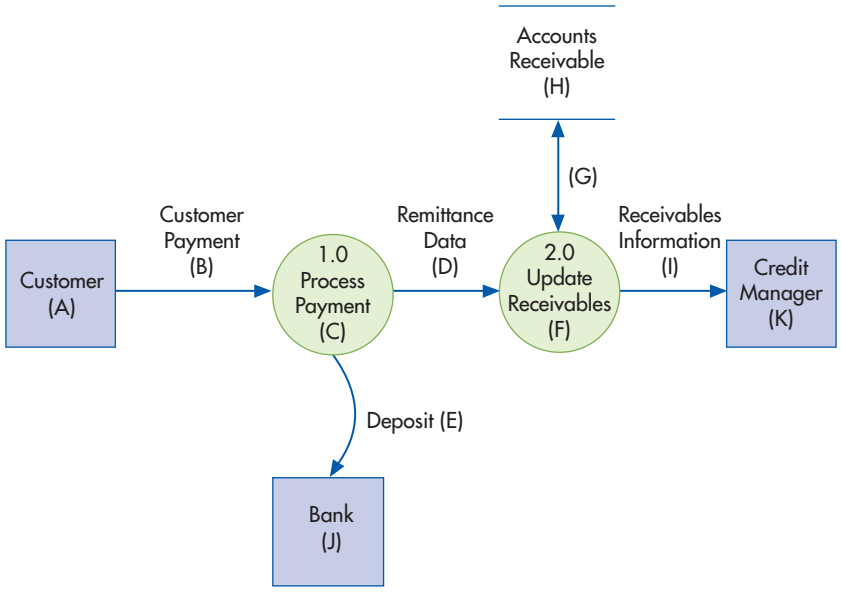
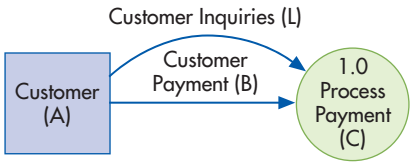


FIGURE 3-3
Data Flow Diagram of Customer Payment Process

FIGURE 3-4
Splitting Customer Payments and Inquiries



is deposited in the bank. The update receivables process (F) uses remittance (D) and accounts receivable (H) data to update receivable records and send receivables data to the credit manager.

data store - The place or medium where system data is stored.

A **data store** is a repository of data. DFDs do not show the physical storage medium (such as a server or paper) used to store the data. As shown in Figure 3-3, data stores (H) are represented by horizontal lines, with the name of the file written inside the lines.

SUBDIVIDING THE DFD

DFDs are subdivided into successively lower levels to provide ever-increasing amounts of detail, because few systems can be fully diagrammed on one sheet of paper. Also, users have differing needs, and a variety of levels can better satisfy differing requirements.

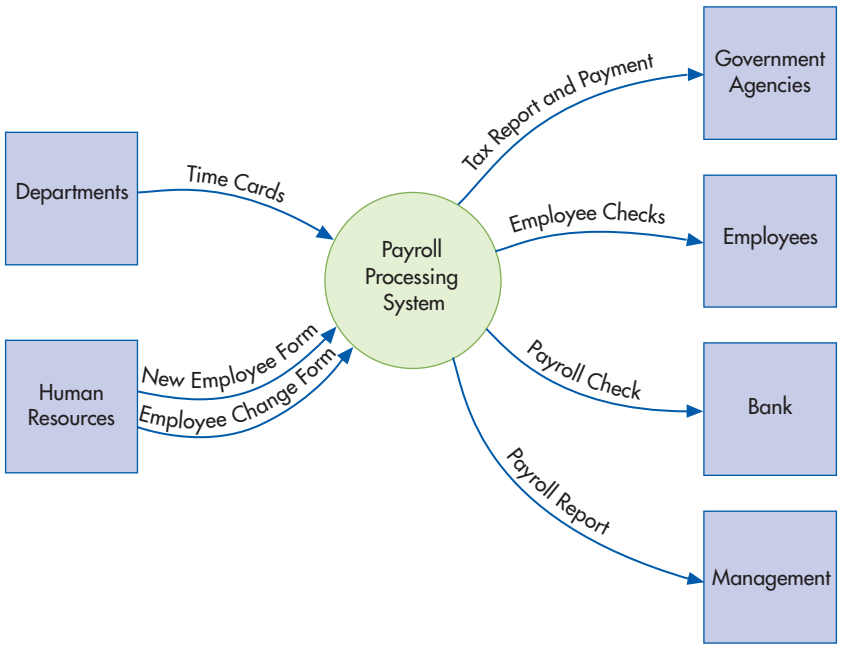
context diagram - Highest-level DFD; a summary-level view of a system, showing the data processing system, its input(s) and output(s), and their sources and destinations.

The highest-level DFD is referred to as a **context diagram** because it provides the reader with a summary-level view of a system. It depicts a data processing system and the entities that are the sources and destinations of system inputs and outputs. For example, Ashton drew Figure 3-5 to document payroll processing procedures at S&S. The payroll processing system receives time card data from different departments and employee data from human resources. The system processes these data and produces (1) tax reports and payments for governmental agencies, (2) employee paychecks, (3) a payroll check deposited in the payroll account at the bank, and (4) payroll information for management.

Ashton used the description of S&S's payroll processing procedures in Table 3-1 to decompose the context diagram into successively lower levels, each with an increasing amount of detail. Read this description and determine the following:

- How many major data processing activities are involved?
- What are the data inputs and outputs of each activity (ignoring all references to people, departments, and document destinations)?

FIGURE 3-5
Context Diagram for S&S Payroll Processing



The narrative in Table 3-1 describes five data processing activities:

1. Updating the employee/payroll master file (first paragraph).
2. Handling employee compensation (second, fifth, and sixth paragraphs). Later in this chapter, you will see a breakdown of this activity into smaller parts in a lower-level DFD.
3. Generating management reports (third paragraph).
4. Paying taxes (fourth paragraph).
5. Posting entries to the general ledger (last paragraph).

The five activities and all data inflows and outflows are shown in Table 3-2.

TABLE 3-1 Narrative Description of Payroll Processing at S&S

When employees are hired, they complete a new-employee form. When a change to an employee's payroll status occurs, such as a raise or a change in the number of exemptions, the human resources department completes an employee change form. A copy of these forms is sent to payroll. These forms are used to create or update the records in the employee/payroll file and are then stored in the file. Employee records are stored alphabetically.

Some S&S employees are paid a salary, but most are hourly workers who record their time on time cards. At the end of each pay period, department managers send the time cards to the payroll department. The payroll clerk uses the time card data, data from the employee file (such as pay rate and annual salary), and the appropriate tax tables to prepare a two-part check for each employee. The clerk also prepares a two-part payroll register showing gross pay, deductions, and net pay for each employee. The clerk updates the employee file to reflect each employee's current earnings. The original copy of the employee paychecks is forwarded to Susan. The payroll register is forwarded to the accounts payable clerk. The time cards and the duplicate copies of the payroll register and paychecks are stored by date in the payroll file.

Every pay period, the payroll clerk uses the data in the employee/payroll file to prepare a payroll summary report for Susan so that she can control and monitor labor expenses. This report is forwarded to Susan, with the original copies of the employee paychecks.

Every month, the payroll clerk uses the data in the employee/payroll file to prepare a two-part tax report. The original is forwarded to the accounts payable clerk, and the duplicate is added to the tax records in the payroll file. The accounts payable clerk uses the tax report to prepare a two-part check for taxes and a two-part cash disbursements voucher. The tax report and the original copy of each document are forwarded to Susan. The duplicates are stored by date in the accounts payable file.

The accounts payable clerk uses the payroll register to prepare a two-part check for the total amount of the employee payroll and a two-part disbursements voucher. The original copy of each document is forwarded to Susan, and the payroll register and the duplicates are stored by date in the accounts payable file.

Susan reviews each packet of information she receives, approves it, and signs the checks. She forwards the cash disbursements vouchers to Ashton, the tax reports and payments to the appropriate governmental agency, the payroll check to the bank, and the employee checks to the employees. She files the payroll report chronologically.

Ashton uses the payroll tax and the payroll check cash disbursement vouchers to update the general ledger. He then cancels the journal voucher by marking it "posted" and files it numerically.

TABLE 3-2 Activities and Data Flows in Payroll Processing at S&S

ACTIVITIES	DATA INPUTS	DATA OUTPUTS
Update employee/payroll file	New-employee form Employee change form	Updated employee/payroll file
Pay employees	Time cards Employee/payroll file Tax rates table	Employee checks Payroll register Updated employee/payroll file Payroll check Payroll cash disbursements voucher
Prepare reports	Employee/payroll file	Payroll report
Pay taxes	Employee/payroll file	Tax report Tax payment Payroll tax cash disbursements voucher Updated employee/payroll file
Update general ledger	Payroll tax cash disbursements voucher Payroll cash disbursements voucher	Updated general ledger

Ashton exploded his context diagram and created the Level 0 DFD (called Level 0 because there are zero meaningful decimal points—1.0, 2.0, etc.) shown in Figure 3-6. Notice that some data inputs and outputs have been excluded from this DFD. For example, in process 2.0, the data inflows and outflows that are not related to an external entity or to another process are not depicted (tax tables and payroll register). These data flows are internal to the "pay employees" activity and are shown on the next DFD level.

Ashton exploded process 2.0 (pay employees) to create a Level 1 DFD (it has one meaningful decimal place—2.1, 2.2, etc.). Figure 3-7 provides more detail about the data processes

FIGURE 3-6
Level 0 DFD for S&S Payroll Processing

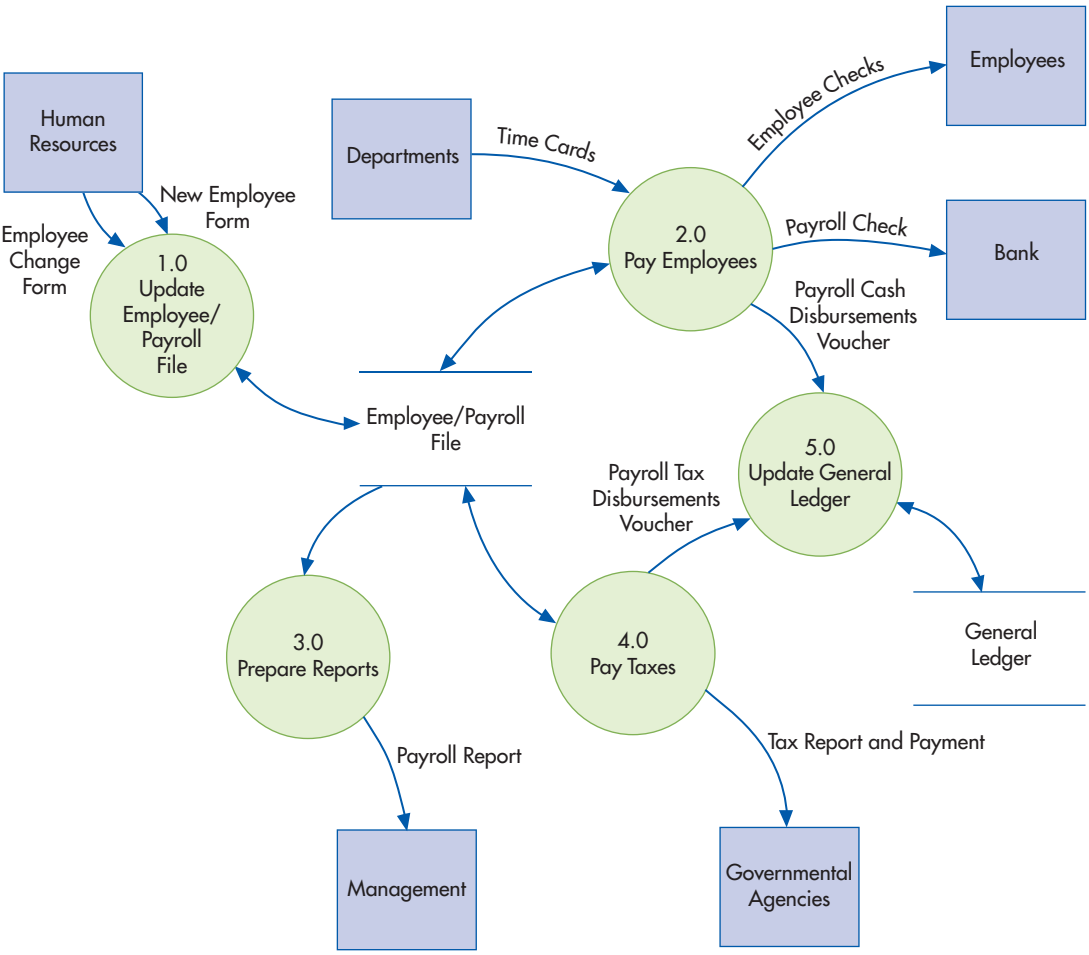
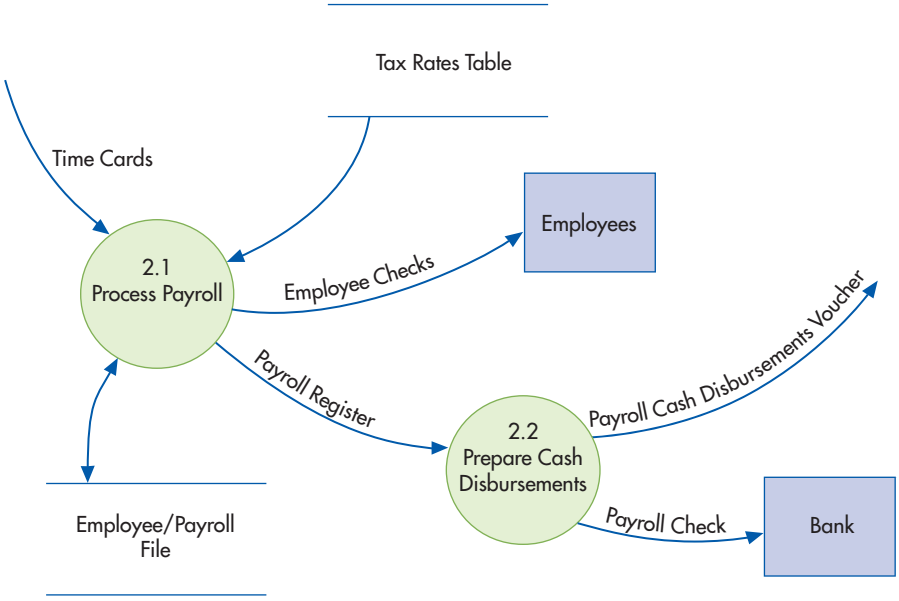


FIGURE 3-7
Level 1 DFD for Process 2.0 in S&S Payroll Processing



involved in paying employees, and it includes the tax rates table and the payroll register data flow omitted from Figure 3-6. In a similar fashion, each of the Figure 3-6 processes could be exploded, using a Level 1 DFD, to show a greater level of detail.

Some general guidelines for developing DFDs are shown in Focus 3-1.

You can practice creating the different levels of a DFD by drawing them for the comprehensive problem, called Accuflow Cash Disbursements Process, at the end of the chapter content (page 67).You can then compare your diagrams to the solution at the very end of the chapter (pages 78–83).You can also read the detailed explanation of how the solution was prepared.

FOCUS 3-1 Guidelines for Drawing a DFD

1. ***Understand the system.*** Develop this understanding by observing organization data flows, observing and interviewing those who use and process the data or having them complete a questionnaire; by reading a narrative description of the system; or by walking through system transactions.
2. ***Ignore certain aspects of the system.*** A DFD is a diagram of the origins, flow, transformation, storage, and destinations of data. Only very important error paths are included; unimportant error paths are ignored. Determining how the system starts and stops is not shown.
3. ***Determine system boundaries.*** Determine what to include and exclude. Include all relevant data elements, because excluded items will not be considered during system development.
4. ***Develop a context diagram.*** A context diagram depicts system boundaries. In the diagram's center is a circle with the name of the system. Outside entities the system interacts with directly are in boxes on either side, connected by data flows depicting the data passed between them. DFDs in successively more detail depict data flows inside the system.
5. ***Identify data flows.*** Identify all data flows (significant movement of data) entering or leaving the system, including where the data originate and their final destination. All data flows come from and go to a transformation process, a data store (file), or a source or destination. Data flows can move in two directions, shown as a line with arrows on both ends (see G in Figure 3-3).
6. ***Group data flows.*** A data flow can consist of one or more pieces of datum. Data elements that always flow together should be grouped together and shown as one data flow until they are separated. If the data do not always flow together, show them as separate data flows.
7. ***Identify transformation processes.*** Place a circle wherever work is required to transform one data flow into another. All transformation processes should have one or more incoming and outgoing data flows.
8. ***Group transformation processes.*** Transformation processes that are logically related or occur at the same time and place should be grouped together. Do not combine unrelated items into a single transformation process. If data are not processed together, or are sometimes processed differently, separate them.
9. ***Identify all files or data stores.*** Identify each temporary or permanent data repository, and identify each data flow into and out of it.
10. ***Identify all data sources and destinations.*** Include them on the DFD.
11. ***Name all DFD elements.*** Except for data flows into or out of data stores (the data store name is usually sufficient to identify the data flow), data elements should be given unique and descriptive names representing what is known about them. Naming data flows first forces you to concentrate on the all-important data flows, rather than on the processes or stores. Processes and data stores typically take their names from the data inflows or outflows. Choose active and descriptive names, such as "update inventory" and "validate transaction," rather than "input data" or "update process." Process names should include action verbs such as *update*, *edit*, *prepare*, *reconcile*, and *record*.
12. ***Subdivide the DFD.*** A cluttered DFD is hard to read and understand. If you have more than five to seven processes on a page, decompose the context diagram into high-level processes. Explode these high-level processes into successively lower-level processes.
13. ***Give each process a sequential number.*** Giving each process a sequential number (lower to higher) helps readers navigate among the DFD levels.
14. ***Refine the DFD.*** Work through data flows several times. Each subsequent pass helps refine the diagram and identify the fine points. Organize the DFD to flow from top to bottom and from left to right.
15. ***Prepare a final copy.*** Do not allow data flow lines to cross each other; if necessary, repeat a data store or destination. Place the name of the DFD, the date prepared, and the preparer's name on each page.

Flowcharts

flowchart - An analytical technique that uses a standard set of symbols to describe pictorially some aspect of an IS in a clear, concise, and logical manner.

A **flowchart** is a pictorial, analytical technique used to describe some aspect of an information system in a clear, concise, and logical manner. Flowcharts record how business processes are performed and how documents flow through the organization. They are also used to analyze how to improve business processes and document flows. Most flowcharts are drawn using a software program such as Visio, Word, Excel, or PowerPoint. Flowcharts use a standard set of symbols to describe pictorially the transaction processing procedures a company uses and the flow of data through a system. Flowcharting symbols are divided into four categories, as shown in Figure 3-8:

1. ***Input/output symbols*** show input to or output from a system.
2. ***Processing symbols*** show data processing, either electronically or by hand.
3. ***Storage symbols*** show where data is stored.
4. ***Flow and miscellaneous symbols*** indicate the flow of data, where flowcharts begin or end, where decisions are made, and how to add explanatory notes to flowcharts.

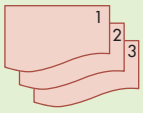
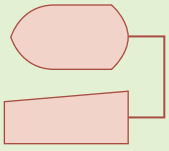
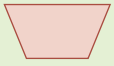
General guidelines for preparing good flowcharts are presented in Focus 3-2.

TYPES OF FLOWCHARTS

document flowchart - Illustrates the flow of documents and data among areas of responsibility within an organization.

Document flowcharts were developed to illustrate the flow of documents and data among areas of responsibility within an organization. They trace a document from its cradle to its grave, showing where each document originates, its distribution, its purpose,

FIGURE 3-8
Common Flowcharting Symbols

Symbol	Name	Explanation
Input/Output Symbols		
	Document	An electronic or paper document or report
	Multiple copies of one paper document	Illustrated by overlapping the document symbol and printing the document number on the face of the document in the upper right corner
	Electronic output	Information displayed by an electronic output device such as a terminal, monitor, or screen
	Electronic data entry	Electronic data entry device such as a computer, terminal, tablet, or phone
	Electronic input and output device	The electronic data entry and output symbols are used together to show a device used for both
Processing Symbols		
	Computer processing	A computer-performed processing function; usually results in a change in data or information
	Manual operation	A processing operation performed manually

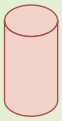
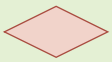
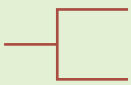
Symbol	Name	Explanation
Storage Symbols		
	Database	Data stored electronically in a database
	Magnetic tape	Data stored on a magnetic tape; tapes are popular back-up storage mediums
	Paper document file	File of paper documents; letters indicate file-ordering sequence: N = numerically, A = alphabetically, D = by date
	Journal/ledger	Paper-based accounting journals and ledgers
Flow and Miscellaneous Symbols		
	Document or processing flow	Direction of processing or document flow; normal flow is down and to the right
	Communication link	Transmission of data from one geographic location to another via communication lines
	On-page connector	Connects the processing flow on the same page; its usage avoids lines crisscrossing a page
	Off-page connector	An entry from, or an exit to, another page
	Terminal	A beginning, end, or point of interruption in a process; also used to indicate an external party
	Decision	A decision-making step
	Annotation	Addition of descriptive comments or explanatory notes as clarification

FIGURE 3-8
Continued

its disposition, and everything that happens as it flows through the system. A special type of flowchart, called an **internal control flowchart**, is used to describe, analyze, and evaluate internal controls. They are used to identify system weaknesses or inefficiencies, such as inadequate communication flows, insufficient segregation of duties, unnecessary complexity in document flows, or procedures responsible for causing wasteful delays.

internal control flowchart - Used to describe, analyze, and evaluate internal controls, including identifying system strengths, weaknesses, and inefficiencies.

Until he automates the other parts of S&S, Ashton decides to process payroll manually. The document flowchart Ashton developed for the manual payroll process at S&S, as described in Tables 3-1 and 3-2, is shown in Figure 3-9.

You can practice creating a document flowchart by drawing one for the comprehensive problem, called Accuflow Cash Disbursements Process, at the end of the chapter content (page 67). You can then compare your diagram to the solution at the very end of the chapter (pages 78–83). You can also read the detailed explanation of how the solution was prepared.

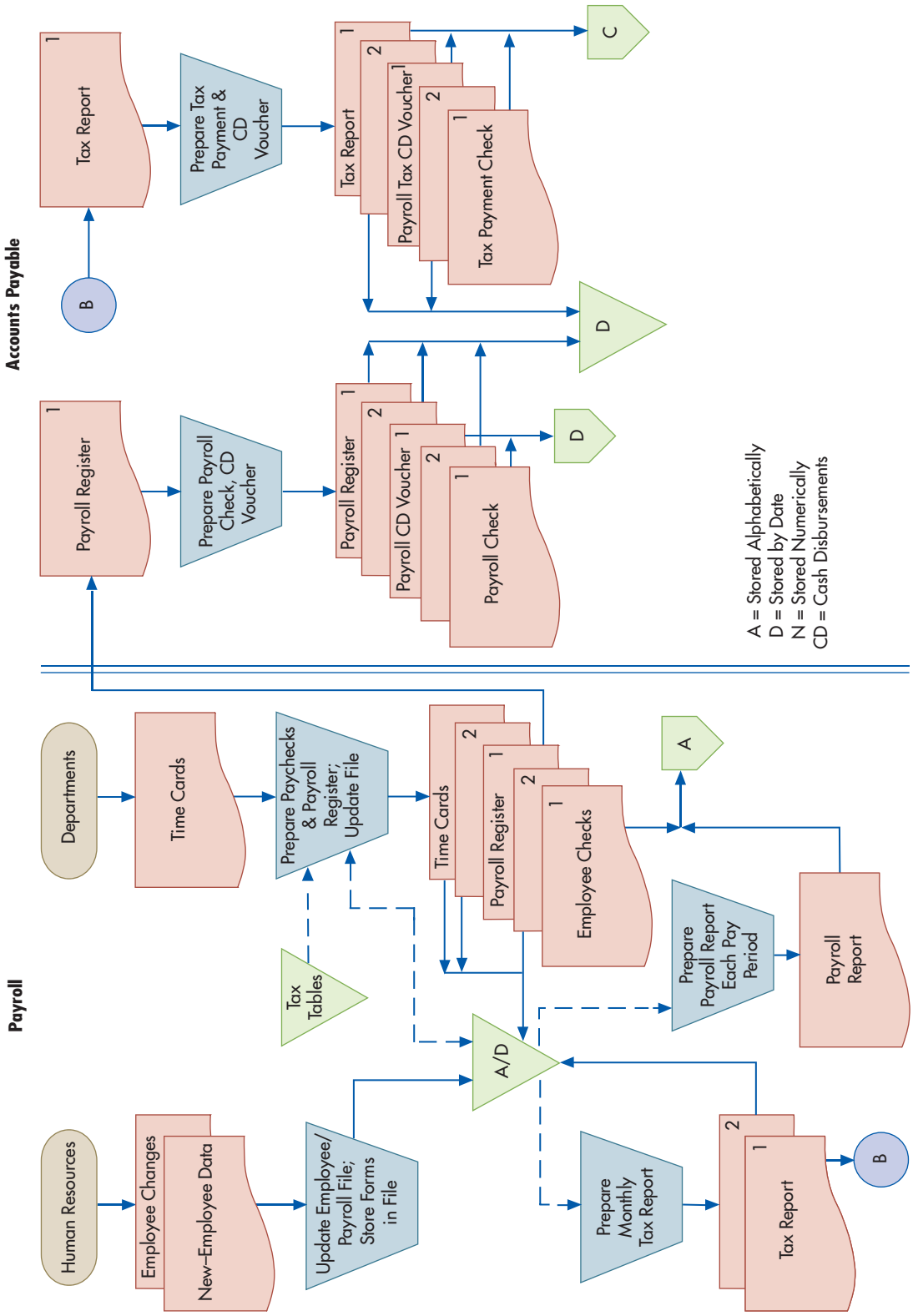


FIGURE 3-9
Document Flowchart of Payroll Processing at S&S

system flowchart - Depicts the relationships among system input, processing, storage, and output.

A **system flowchart** depicts the relationships among system input, processing, storage, and output. The sales processing flowchart in Figure 3-10 represents Ashton's proposal to capture sales data using state-of-the-art sales terminals. The terminals will capture and edit the sales data and print a customer receipt. The terminals periodically send all sales data to corporate headquarters so that the accounts receivable, inventory, and sales/marketing databases

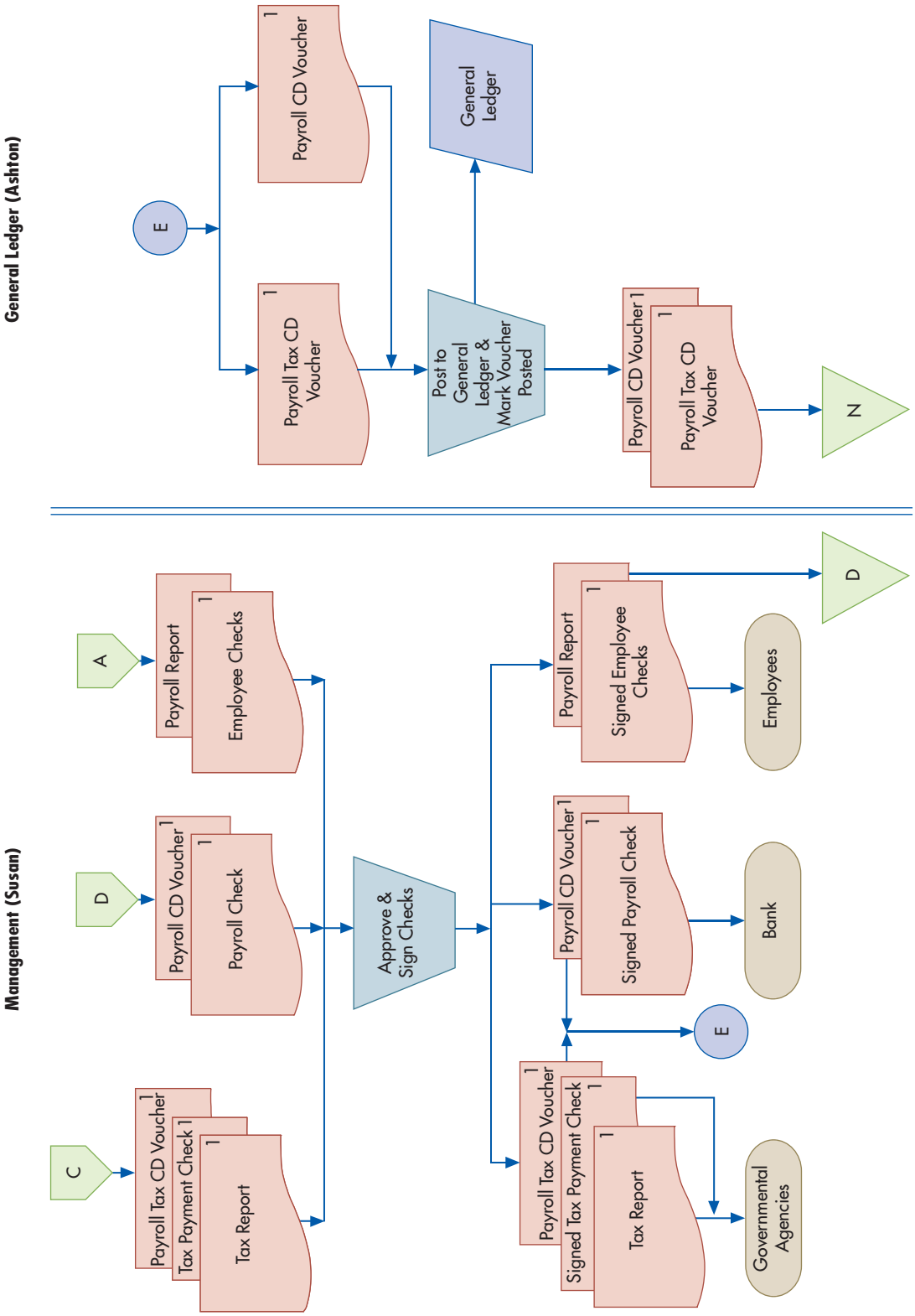


FIGURE 3-9
Continued

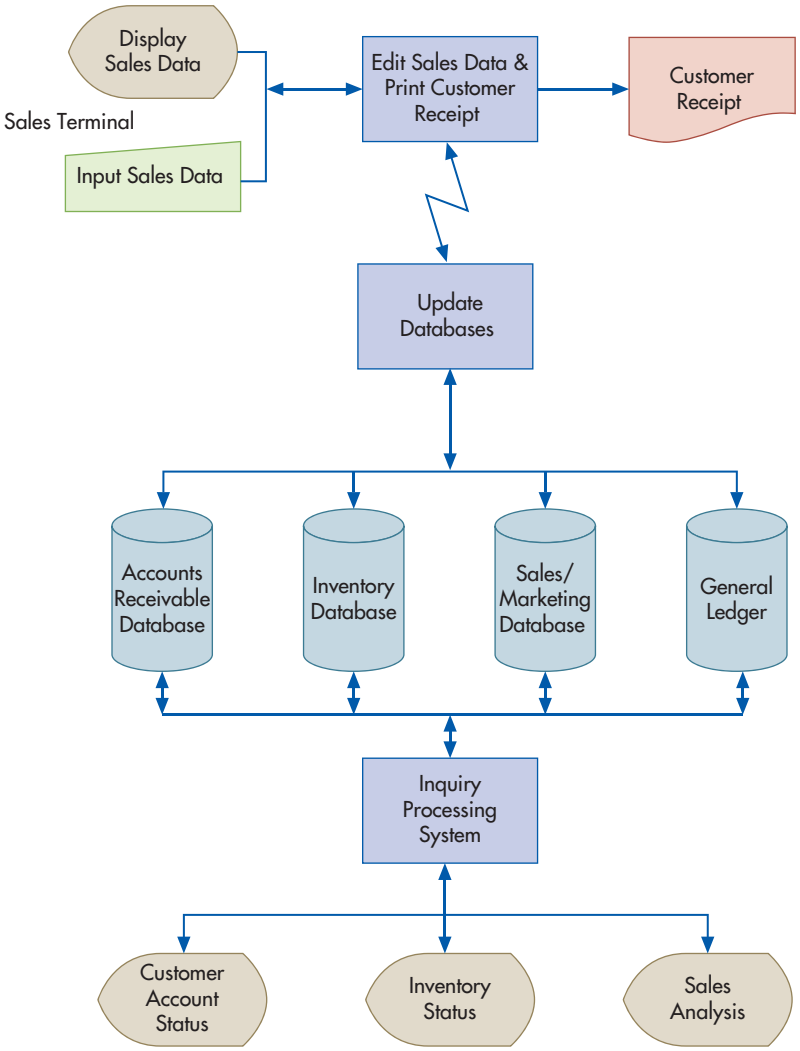
and the general ledger can be updated. Management and other users can access the files at any time by using an inquiry processing system.

System flowcharts are used to describe data flows and procedures within an AIS. Each of the business process chapters (Chapters 12–16) uses a systems flowchart to provide an overview of how each business process works.

FOCUS 3-2 Guidelines for Preparing Flowcharts

1. ***Understand the system.*** Develop this understanding by interviewing users, developers, and management or having them complete a questionnaire; by reading a narrative description of the system; or by walking through system transactions.
2. ***Identify the entities to be flowcharted.*** Identify departments, job functions, and external parties. Identify business processes, documents, data flows, and data processing procedures.
3. ***Organize flowchart.*** Design the flowchart so that data flows from top to bottom and from left to right. Where appropriate, ensure that all procedures and processes are in proper order. Show where documents or processes originate, where data is processed, and where data is stored and sent. Show the final disposition of all documents to prevent loose ends that leave the reader dangling. Show data entered into or retrieved from a database as passing through a processing operation (a computer program) first. In document flowcharts, divide the flowchart into columns with labels.
4. ***Clearly label all symbols.*** Write a description of the source, input, process, output, or destination inside the symbol. Use arrowheads on all flow lines.
5. ***Page connectors.*** If a flowchart cannot fit on a single page, clearly number the pages and use off-page connectors to move from one page to another. Where desired, on-page connectors can be used to avoid excess flow lines and to produce a neat-looking page. Clearly label all connectors to avoid confusion.
6. ***Draw a rough sketch of the flowchart.*** Be more concerned with capturing content than with making a perfect drawing. Few systems can be flowcharted in a single draft. Review it with the people familiar with the system. Make sure all uses of flowcharting conventions are consistent.
7. ***Draw a final copy of the flowchart.*** Place the flowchart name, date, and preparer's name on each page.

FIGURE 3-10
System Flowchart of Sales Processing at S&S



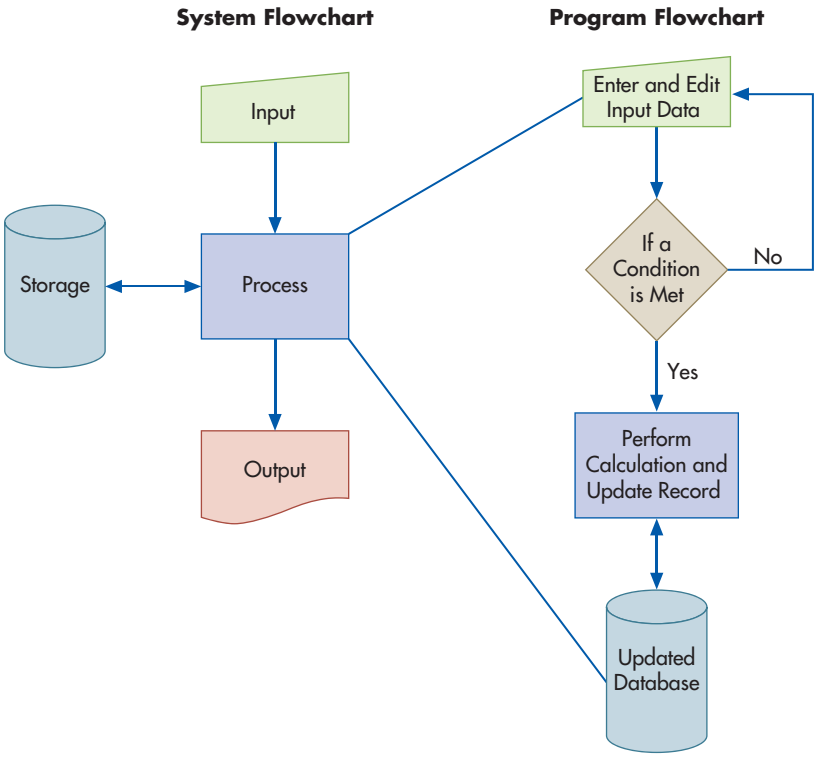


FIGURE 3-11
Relationship Between System and Program Flowcharts

PROGRAM FLOWCHARTS

A **program flowchart** illustrates the sequence of logical operations performed by a computer in executing a program. The relationship between system and program flowcharts is shown in Figure 3-11. A program flowchart describes the specific logic used to perform a process shown on a system flowchart.

program flowchart - Illustrates the sequence of logical operations performed by a computer in executing a program.

Business Process Diagrams

A **Business Process Diagram** (BPD) is a visual way to describe the different steps or activities in a business process. For example, there are many activities in the revenue cycle. Among them are receiving an order, checking customer credit, verifying inventory availability, and confirming customer order acceptance. Likewise, there are multiple activities involved in the expenditure cycle. Among them are shipping the goods ordered, billing the customer, and collecting customer payments. All of these activities can be shown on a BPD to give the reader an easily understood pictorial view of what takes place in a business process.

business process diagram - A visual way to describe the different steps or activities in a business process.

While BPDs can describe interactions within an entity as well as interactions between entities, the BPDs in the textbook do not document the activities performed by external parties. Thus, a BPD for the revenue cycle will only describe the functions performed by the selling company and a BPD for the expenditure cycle only depicts the activities performed by the purchasing company.

The Business Process Modeling Initiative Notation Working Group established standards for drawing BPDs. There are many different symbols that can be used in drawing a BPD. The text uses only a limited set of those symbols, as shown in Figure 3-12, to produce easy to create and understand BPDs.

General guidelines for preparing good business process guidelines are presented in Focus 3-3. In the text, the emphasis on BPDs is less on obeying the rules governing their preparation and more on their clearly communicating the activities involved in the business process being depicted.

Ashton prepared the BPD in Figure 3-13 to document payroll processing at S&S based on the narrative contained in Table 3-1. You can practice creating a BPD by drawing one for the comprehensive problem, called Accuflow Cash Disbursements Process, at the end of the chapter content (page 67).You can then compare your diagram to the solution at the very end of the chapter (pages 78–83). You can also read the detailed explanation of how the solution was prepared.

FIGURE 3-12
Business Process Diagram Symbols

Symbol	Name	Explanation
	Start/Begin	The start or beginning of a process is represented by a small circle.
	End	The end of a process is represented by a small **bolded** circle.
	Activity in a process	An activity in a process is represented by a rounded-edge rectangle. An explanation of the activity is placed inside the rectangle.
	Decision	A decision made during the process is represented by a diamond. An explanation of the decision is placed inside the symbol.
	Flow	The flow of data or information is indicated by an arrow.
	Annotation information	Information that helps explain a business process is entered in the BPD and, if needed, a bolded dashed arrow is drawn from the explanation to the symbol.

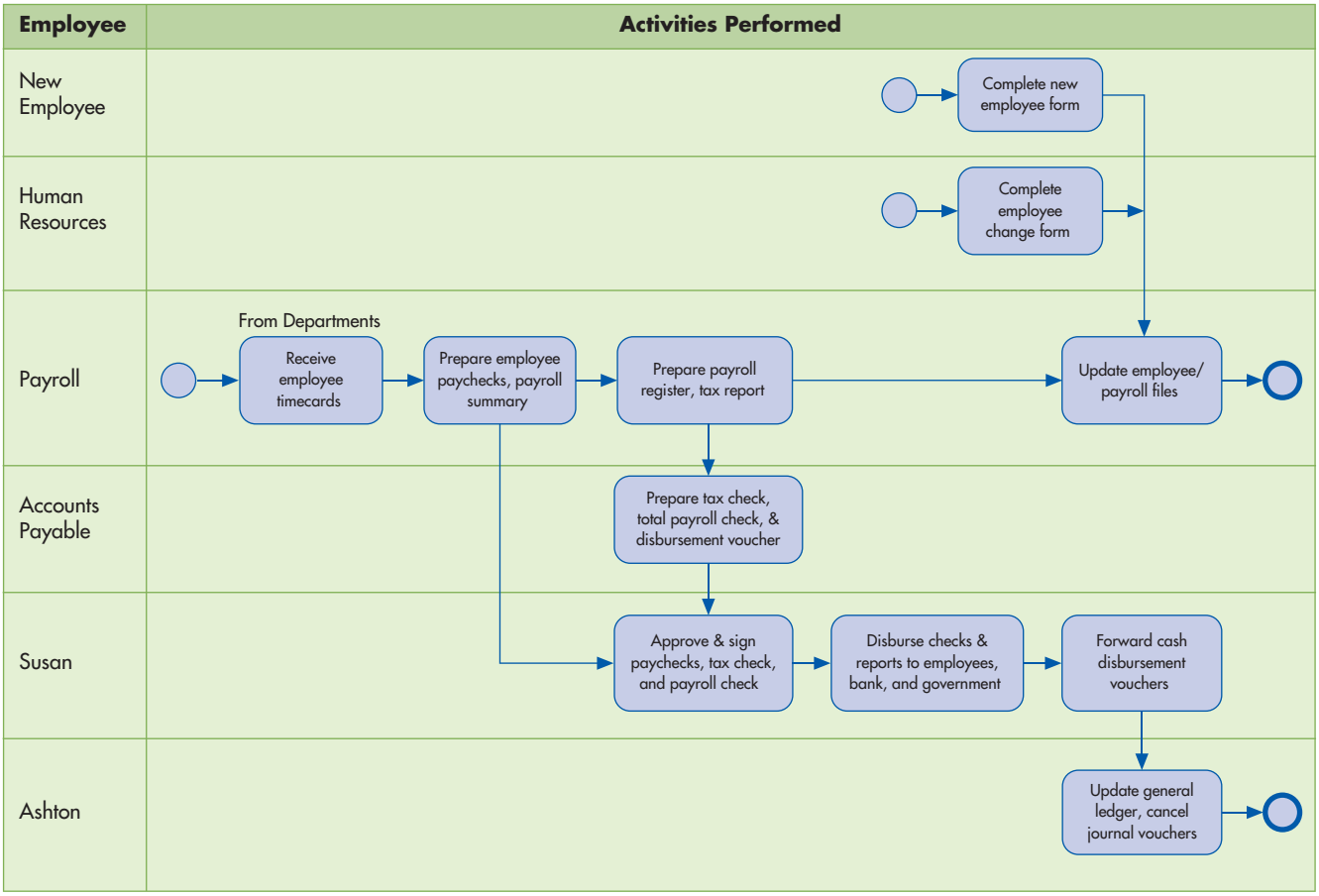


FIGURE 3-13
Business Process Diagram of Payroll Processing at S&S

FOCUS 3-3 Guidelines for Preparing Business Process Diagrams

1. *Identify and understand the business processes.* Develop this understanding by observing organization business processes and data flows, observing and interviewing those involved in the business process, reading a narrative description of the system, or walking through system transactions. Identify departments, job functions, and external parties. Identify business processes, documents, data flows, and data processing procedures.
2. *Ignore certain items.* Like DFDs, BPDs depict what happens, but do not specify how (i.e., by means of what technology) a process activity occurs. Therefore, BPDs do not need to be revised every time the technology used to accomplish the activity is changed. Unlike flowcharts, you do not need to show the documents as they flow through the system or show where they are stored.
3. *Decide how much detail to include.* Like a DFD, varying levels of detail can be shown. A BPD can show only higher-level activities or those higher-level activities can be broken up into subactivities that show more details. If the BPD is drawn in sufficient detail, it is easy to evaluate whether duties are properly segregated by examining the duties performed in every row.
4. *Organize diagram.* BPDs usually consist of two columns and as many rows as needed to explain the process. The first column shows the different employees or departments involved in the business process. The second column shows the activities performed by the employee shown in the first column. Each row, referred to as a "swim lane," contains the activities performed by the indicated employee or department. BPDs depict the major steps in a process sequentially, reading from left to right and top to bottom.
5. *Enter each business process on the diagram.* Show where each business process begins and ends. Show each activity in the business process in the order it takes place and in the appropriate row, using the appropriate symbols. Write an appropriate description inside each symbol; most activity descriptions will start with an action verb (take order, ship goods, etc.). Add annotation information as appropriate to make the diagram more understandable. Use arrowheads on all data flow lines to show the direction of the flow.
6. *Draw a rough sketch of the BPD.* Be more concerned with capturing content than with making a perfect drawing. Few systems can be diagramed in a single draft. Review it with the people familiar with the system. Refine the BPD as needed until the business process is depicted accurately and the diagram is easily understood.
7. *Draw a final copy of the BPD.* Place the BPD name, date, and preparer's name on each page.

Summary and Case Conclusion

Ashton prepared DFDs (Figures 3-6 and 3-7), a flowchart (Figure 3-9), and a BPD (Figure 3-13) of S&S's payroll processing system to document and explain the operation of the existing system. He was pleased to see that Scott and Susan were able to grasp the essence of the system from this documentation. The DFDs indicated the logical flow of data, the flowcharts illustrated the physical dimensions of the system, and the BPD showed the activities in each business process.

Susan and Scott agreed that Ashton should document the remainder of the system. The documentation would help all of them understand the current system. It would also help Ashton and the consultants design the new system. In fact, the payroll documentation had already helped them identify a few minor changes they wanted to make in their system. Using Figure 3-9, Susan now understands why the payroll clerk sometimes had to borrow the only copy of the payroll report that was prepared. She recommended that a second copy be made and kept in the payroll department. Susan also questioned the practice of keeping all the payroll records in one employee/payroll file. To keep the file from becoming unwieldy, she recommended that it be divided into three files: personal employee data, pay period documentation, and payroll tax data. A discussion with the payroll clerk verified that this approach would make payroll processing easier and more efficient.

Over the next few weeks, Ashton documented the remaining business processes. This process helped him identify inefficiencies and unneeded reports. He also found that some system documents were inadequately controlled. In addition, he got several ideas about how an automated system could help him reengineer the business processes at S&S. By substituting

technology for human effort, outdated processes and procedures could be eliminated to make the system more effective.

When Ashton completed his analysis and documentation of the current system, Susan and Scott asked him to continue his work in designing a new system. To do that, Ashton must thoroughly understand the information needs of the various employees in the company. Then he can design a new system using the tools that were explained in this chapter. Systems development is discussed in Chapters 20 through 22.

KEY TERMS

documentation 51
narrative description 51
data flow diagram (DFD) 52
data source 52
data destination 52
data flow 53
process 53
data store 54
context diagram 54
flowchart 58
document flowchart 58
internal control flowchart 59
system flowchart 60
program flowchart 61
business process diagram (BPD) 63

AIS in Action

CHAPTER QUIZ

1. A DFD is a representation of which of the following?
   a. the logical operations performed by a computer program
   b. flow of data in an organization
   c. decision rules in a computer program
   d. computer hardware configuration

2. Documentation methods such as DFDs, BPDs, and flowcharts save both time and money, adding value to an organization.
   a. True
   b. False

3. Which of the following statements is FALSE?
   a. Flowcharts make use of many symbols.
   b. A document flowchart emphasizes the flow of documents or records containing data.
   c. DFDs help convey the timing of events.
   d. Both a and b are false.

4. A DFD consists of the following four basic elements: data sources and destinations, data flows, transformation processes, and data stores. Each is represented on a DFD by a different symbol.
   a. True
   b. False

5. All of the following are guidelines that should be followed in naming DFD data elements EXCEPT:
   a. Process names should include action verbs such as *update*, *edit*, *prepare*, and *record*.
   b. Make sure the names describe all the data or the entire process.
   c. Name only the most important DFD elements.
   d. Choose active and descriptive names.

6. The documentation skills that accountants require vary with their job function. However, they should at least be able to do which of the following?
   a. Read documentation to determine how the system works.
   b. Critique and correct documentation that others prepare.
   c. Prepare documentation for a newly developed information system.
   d. Teach others how to prepare documentation.

7. Which of the following statements is FALSE?
a. A flowchart is an analytical technique used to describe some aspect of an information system in a clear, concise, and logical manner.
b. Flowcharts use a standard set of symbols to describe pictorially the flow of documents and data through a system.
c. Flowcharts are easy to prepare and revise when the designer utilizes a flowcharting software package.
d. A system flowchart is a narrative representation of an information system.

8. Which of the following flowcharts illustrates the flow of data among areas of responsibility in an organization?
a. program flowchart
b. computer configuration chart
c. system flowchart
d. document flowchart

9. All of the following are recommended guidelines for making flowcharts more readable, clear, concise, consistent, and understandable EXCEPT:
a. Divide a document flowchart into columns with labels.
b. Flowchart all data flows, especially exception procedures and error routines.
c. Design the flowchart so that flow proceeds from top to bottom and from left to right.
d. Show the final disposition of all documents to prevent loose ends that leave the reader dangling.

10. How are data sources and destinations represented in a data flow diagram?
a. as a square
b. as a curved arrow
c. as a circle
d. as two parallel lines
e. none of the above

COMPREHENSIVE PROBLEM

ACCUFLOW CASH DISBURSEMENTS PROCESS

SoftData, a vendor, sends an invoice to Accuflow for data warehousing support services. The invoice is sent directly to Megan Waters, the accounts payable clerk, who manually records the invoice in the accounts payable subsidiary ledger. Once the invoice is recorded, it is forwarded to Stan Phillips, the cash disbursements clerk, for processing. Stan prepares a check to pay the invoice and sends the check and invoice to John Sterling, the company treasurer. John approves and signs the check and cancels the invoice. John then mails the check to SoftData and returns the canceled invoice to Stan for recording in the cash disbursements journal and filing. Once a week, Megan manually posts disbursements from the cash disbursements journal to the accounts payable subsidiary ledger.

REQUIRED

Prepare a document flowchart, a BPD, a context diagram, a Level 0 data flow diagram, and a Level 1 DFD for the Accuflow cash disbursement process. To maximize learning from this problem, do your best to solve it before looking at the solution at the end of the chapter.

DISCUSSION QUESTIONS

3.1 Identify the DFD elements in the following narrative: A customer purchases a few items from a local grocery store. Jill, a salesclerk, enters the transaction in the cash register and takes the customer's money. At closing, Jill gives both the cash and the register tape to her manager.

3.2 Do you agree with the following statement: "Any one of the systems documentation procedures can be used to adequately document a given system"? Explain.

3.3 Compare the guidelines for preparing flowcharts, BPDs, and DFDs. What general design principles and limitations are common to all three documentation techniques?

3.4 Your classmate asks you to explain flowcharting conventions using real-world examples. Draw each of the major flowchart symbols from memory, placing them into one of four categories: input/output, processing, storage, and flow and miscellaneous. For each symbol, suggest several uses.

PROBLEMS

3.1 Prepare flowcharting segments for each of the following operations:

a. Processing transactions stored on a sequential medium such as a magnetic tape to update a master file stored on magnetic tape
b. Processing transactions stored on magnetic tape to update a database
c. Querying a database and printing the query result
d. Using a terminal to enter paper-based source document data and send it to a remote location where a corporate computer updates the company database
e. Using a terminal to query your customer sales database
f. A scheduled automatic backup of a database to an external hard drive
g. Use a terminal to enter employee hours recorded on time cards to update both the payroll transaction file and the wage data in the payroll master file
h. Use a terminal to access a price list in the sales database to complete a purchase order. An electronic copy of the purchase order is sent to the vendor and a backup copy is printed and filed by vendor name
i. Make an airline reservation using your home computer

3.2 Employees at the Dewey Construction Company enter the work they perform on job-time tickets. Most construction sites have data input terminals that employees use to enter the time they start and stop work and the job code that represents the project they are working on. Every night the job-time ticket data for that day is sent electronically to company headquarters, where it is stored until payroll is processed.

A few construction sites are so remote that employees still fill out paper job-time tickets. These tickets are express mailed weekly to company headquarters, where they are scanned and processed.

Payroll is processed weekly. The job-time tickets are used to update the payroll database as well as the work-in-process database. Since all employees are paid electronically, no checks are printed; instead, the payroll system deposits an employee's net pay in the employee's bank account. Payments are made to government tax bodies and the company handling the employee's and the company's 401K plan contributions. All disbursements are accompanied by a report summarizing the disbursement. The system also produces pay stub data that is stored in a payroll transaction file that is accessible to employees over the internet. An electronic summary payroll report is created and sent to the payroll supervisor.

REQUIRED

a. Prepare a system flowchart for Dewey Construction Company's payroll processing.
b. Prepare a BPD for Dewey Construction Company's payroll processing.

3.3 ANGIC Insurance Company begins processing casualty claims when the claims department receives a notice of loss from a claimant. The claims department prepares and sends the claimant four copies of a proof-of-loss form on which the claimant must detail the cause, amount, and other aspects of the loss. The claims department also initiates a record of the claim, which is sent with the notice of loss to the data processing department, where it is filed by claim number.

The claimant must fill out the proof-of-loss forms with an adjuster's assistance. The adjuster must concur with the claimant on the estimated amount of loss. The claimant and adjuster each keep one copy of the proof-of-loss form. The adjustor files his copy numerically. The adjustor sends the first two copies to the claims department. Separately, the adjuster submits a report to the claims department, confirming the estimates on the claimant's proof-of-loss form.

The claims department authorizes a payment to the claimant, forwards a copy of the proof-of-loss form to data processing, and files the original proof-of-loss form and the adjuster's report alphabetically. The data processing department prepares payment checks and mails them to the customers, files the proof-of-loss form with the claim record, and prepares a list of cash disbursements, which it transmits to the accounting department, where it is reviewed.

REQUIRED

a. Prepare a document flowchart to reflect how ANGIC Insurance Company processes its casualty claims.
b. Prepare a BPD to reflect how ANGIC Insurance Company processes its casualty claims.

3.4 Beccan Company is a discount tire dealer operating 25 retail stores in a large metropolitan area. The company purchases all tires and related supplies using the company's central purchasing department to optimize quantity discounts. The tires and supplies are received at the central warehouse and distributed to the retail stores as needed. The perpetual inventory system at the central facility maintains current inventory records, designated reorder points, and optimum order quantities for each type and size of tire and other related supplies. Beccan has a state-of-the-art computer system and uses the following five documents in its inventory control system.

- **Retail stores requisition.** The retail stores electronically submit a retail store requisition to the central warehouse when they need tires or supplies. The warehouse shipping clerk fills the orders from inventory and authorizes store deliveries.
- **Purchase requisition.** The system notifies the inventory control clerk when the quantity on hand for an item stored in the central warehouse falls below the designated reorder point and prepares a purchase requisition. The inventory control clerk adjusts the purchase requisition as needed, approves it, and forwards it to the purchasing department.
- **Purchase order.** The system uses the data in the purchase requisition to prepare a purchase order and tentatively select a vendor based on selection criteria built into the system such as price and availability. The purchasing agent adjusts the order or vendor selection as needed, approves it, and e-mails it to the vendor. A copy of the purchase order is sent to accounts payable.
- **Receiving report.** For every purchase order, the system prepares a receiving report showing the goods ordered, but not the quantities ordered. When the goods arrive, the receiving clerk enters the date they arrived and the quantity of each item received. The completed receiving report is sent to accounts payable.
- **Invoice.** Vendors send Beccan an electronic invoice that shows the goods shipped, their prices, and the total amounts owed.

The following departments are involved in Beccan's inventory control system:

- **Retail stores.** Each store counts its inventory at the end of every quarter and reconciles it to the corporate database. On a weekly basis, each store reviews its inventory to determine what to requisition from the central warehouse. When a store runs out of inventory, or is dangerously low, it can send a rush order to the warehouse.
- **Inventory control department.** Responsible for the maintenance of all perpetual inventory records, including quantity on hand, reorder point, optimum order quantity, and quantity on order for each item carried.
- **Warehouse department.** Maintains the physical inventory of all items carried in stock. All orders from vendors are received (receiving clerk) and all distributions to retail stores are filled (shipping clerks) in this department.

- **Purchasing department.** Places all orders for items needed by the company.
- **Accounts payable department.** Maintains all open accounts with vendors and other creditors. Accounts payable reviews and reconciles the vendor invoice, purchase order, and receiving report. Any discrepancies are cleared up, and the vendor invoice is paid within 10 days of the receipt of goods by electronically transferring the amount due to the vendor's bank account.

REQUIRED

a. Prepare a BPD that documents Beccan's business processes. (*CMA Examination, adapted*)

3.5 As the internal auditor for No-Wear Products, you have been asked to document the company's payroll processing system. Based on your documentation, No-Wear hopes to develop a plan for revising the current system to eliminate unnecessary delays in paycheck processing. The head payroll clerk explained the system:

The payroll processing system at No-Wear Products is fairly simple. Time data are recorded in each department using time cards and clocks. It is annoying, however, when people forget to punch out at night, and we have to record their time by hand. At the end of the period, our payroll clerks enter the time card data into a payroll file for processing. Our clerks are pretty good—though I've had to make my share of corrections when they mess up the data entry.

Before the payroll file is processed for the current period, human resources sends us personnel changes, such as increases in pay rates and new employees. Our clerks enter this data into the payroll file. Usually, when mistakes get back to us, it's because human resources is recording the wrong pay rate or an employee has left and the department forgets to remove the record.

The data are processed and individual employee paychecks are generated. Several reports are generated for management—though I don't know what they do with them. In addition, the government requires regular federal and state withholding reports for tax purposes. Currently, the system generates these reports automatically, which is nice.

REQUIRED

a. Prepare a context diagram and Level 0 DFD to document the payroll processing system at No-Wear Products.
b. Prepare a document flowchart to document the payroll processing system at No-Wear Products.

3.6 Ashton Fleming has decided to document and analyze the accounts payable process at S&S so the transition to a computerized system will be easier. He also hopes to improve any weaknesses he discovers in the system. In the following narrative, Ashton explains what happens at S&S:

Before S&S pays a vendor invoice, the invoice must be matched against the purchase order used to request the goods and the receiving report that the receiving department prepares. Because all three of these documents enter the accounts payable department at different times, a separate alphabetical file is kept for each type of document. The purchase orders that are forwarded from purchasing are stored in a purchase order file. The receiving reports are stored in a receiving report file. When vendor invoices are received, the accounts payable clerk records the amount due in the accounts payable file and files the invoices in the vendor invoice file.

S&S pays all accounts within 10 days to take advantage of early-payment discounts. When it is time to pay a bill, the accounts payable clerk retrieves the vendor invoice, attaches the purchase order and the receiving report, and forwards the matched documents to Ashton Fleming.

Ashton reviews the documents to ensure they are complete, prepares a two-part check, forwards all the documents to Susan, and records the check in the cash disbursements journal.

Susan reviews the documents to ensure that they are valid payables and signs the checks. She forwards the check to the vendor and returns the documents and the check copy to the accounts payable clerk. The clerk files the documents alphabetically in a paid invoice file. At the end of every month, the accounts payable clerk uses the accounts payable ledger to prepare an accounts payable report that is forwarded to Susan. After she is finished with the report, Susan files it chronologically.

REQUIRED

a. Prepare a context diagram and a Level 0 DFD to document accounts payable processing at S&S.
b. Prepare a document flowchart to document accounts payable processing at S&S.

3.7 Ashton Fleming has asked you to document the cash receipts system at S&S. Ashton's narrative of the system follows:

Customer payments include cash received at the time of purchase and payments received in the mail. At day's end, the treasurer endorses all checks and prepares a deposit slip for the checks and the cash. A clerk deposits the checks, cash, and deposit slip at the local bank each day.

When checks are received as payment for accounts due, a remittance slip is included with the payment. The Treasurer sends this to accounts receivable. Data from the remittance slips are entered into the computer, and the accounts receivable database is updated. The remittance slips are stored in a file drawer by date.

Every week, accounts receivable generates a cash receipts report and an aged trial balance using the accounts receivable ledger. The cash receipts report is sent to Scott and Susan and one of them reviews it. A copy of the aged trial balance is sent to the credit and collections department, where it is reviewed.

REQUIRED

a. Develop a context diagram and a Level 0 DFD for the cash receipts system at S&S.
b. Prepare a document flowchart for the cash receipts system at S&S.
c. Prepare a business process diagram for the cash receipts system at S&S.

3.8 A mail-order skin and body care company advertises in magazines. Magazine subscribers initiate most orders by completing and sending coupons directly to the company. The firm also takes orders by phone, answers inquiries about products, and handles payments and cancellations of orders. Products that have been ordered are sent either directly to the customer or to the company's regional offices that handle the required distribution. The mail-order company has three basic data files, which contain customer mailing information, product inventory information, and billing information based on invoice number. During the next few years, the company expects to become a multimillion-dollar operation. Recognizing the need to computerize much of the mail-order business, the company has begun the process by calling you.

REQUIRED

Draw a context diagram and at least two levels of DFDs for the preceding operations.

3.9 The local college requires that each student complete an online registration request form. The system checks the accounts receivable subsystem to ensure that no fees are owed. Next, for each course, the system checks the student transcript to ensure that he or she has completed the course prerequisites. Then the system checks class availability and, if there is room, adds the student's Social Security number to the class list.

The report back to the student shows the result of registration processing: If the student owes fees, a bill is sent and the registration is rejected. If prerequisites for a course are not fulfilled, the student is notified and that course is not registered. If the class is full, the student request is annotated with "course closed." If a student is accepted into

a class, then the day, time, and room are shown next to the course number. Student fees and total tuition are computed and shown on the report. Student fee data is interfaced to the accounts receivable subsystem. When registration is complete, course enrollment reports are prepared for the instructors.

REQUIRED

a. Prepare a context diagram and at least two levels of DFDs for this process.
b. Prepare a flowchart to document this process.

3.10 Prepare a context diagram and a Level 0 DFD for each of the following situations.
a. Prepare and file a tax return with the tax owed to the Internal Revenue Service.
b. A customer pays an invoice with a check. Accounts receivable is updated to reflect the payment. The check is recorded and deposited into the bank.
c. A customer places an online order to purchase merchandise. The order is approved, filled, and sent to the customer with an invoice.
d. An inventory request is received by the purchasing department. The purchasing department prepares and sends a purchase order to the appropriate vendor.
e. A vendor invoice is received, reviewed, and compared against the appropriate purchase order, then paid and filed.
f. A bill of lading for ordered inventory is received from a vendor, recorded, checked against the appropriate purchase order, and filed.

3.11 Melanie is doing a study on various weight-loss plans and needs to determine an individual's weight status by calculating his or her body mass index. To calculate a person's body mass index, height must be measured in meters and weight measured in kilograms. The index is calculated by dividing a person's weight by the square of his height. The result is then compared to the following scale to determine the person's weight status: Below 18.5 = underweight; 18.5–24.5 = normal weight; over 25.0 = overweight. Five hundred people have agreed to participate in Melanie's study. With so many calculations to perform, she would like a computer program that will do this calculation for her. She decides to prepare a flowchart to help her properly design the computer program.

REQUIRED

Prepare a program flowchart to help Melanie program this process.

3.12 Match the flowchart or DFD segments in the right column to an appropriate description in the left column.

DFDS

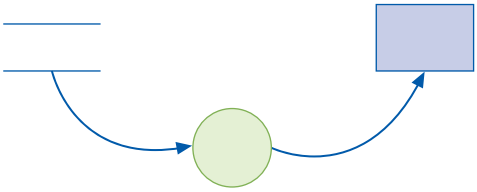
1. Statements are prepared and sent to customers from data contained in the accounts receivable data store.

2. A vendor sends a sales invoice to the accounts payable process.

3. The cash receipt process updates the cash receipts data store.

A.

B.

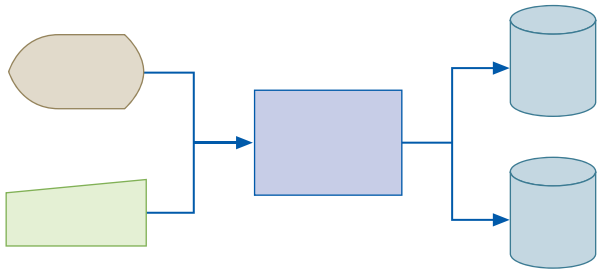


C.

FLOWCHARTS

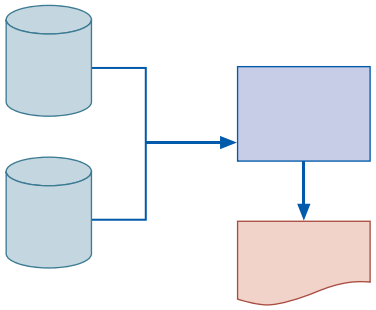
4. A two-part check is manually prepared from data on a vendor invoice.

D.



5. The system prepares a check that is mailed to the customer.

E.

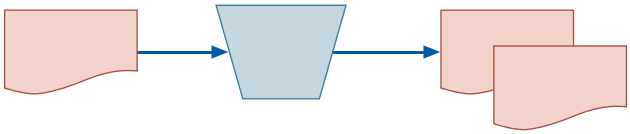


6. A report is prepared from data stored on magnetic tape.

F.

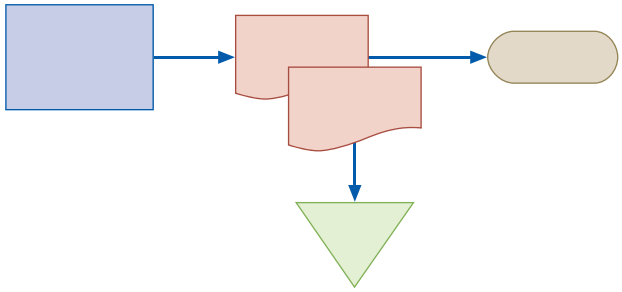
7. Billing data are entered into a system from a terminal and used to update both the sales order database and the customer database.

G.



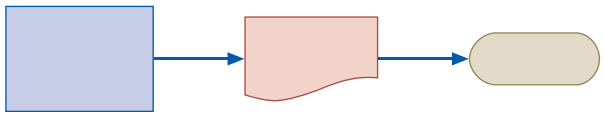
8. Data from a paper invoice are used to update the cash disbursements file.

H.



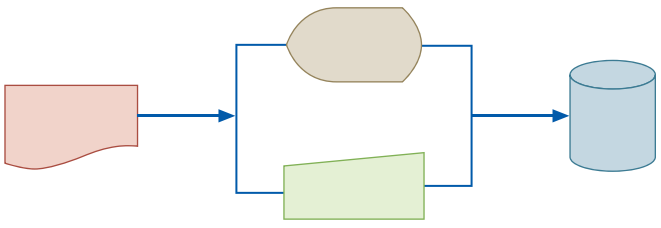
9. The system prepares two copies of a sales order; one copy is sent to the customer and the other is filed.

I.

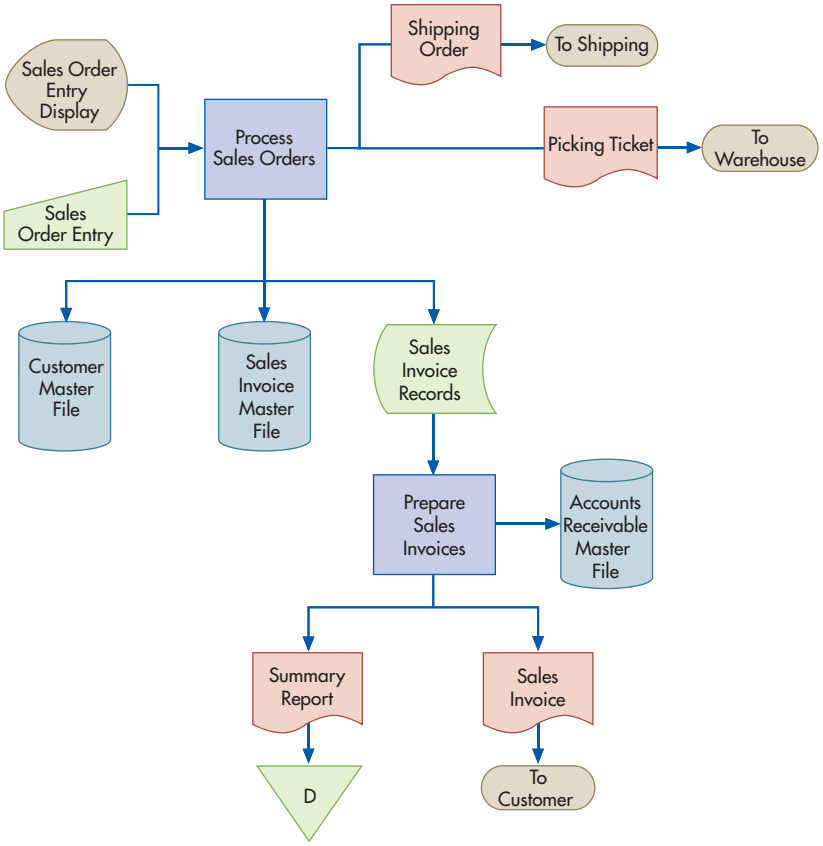


10. An accounts receivable aging report is prepared from the accounts receivable master file and the cash receipts master file.

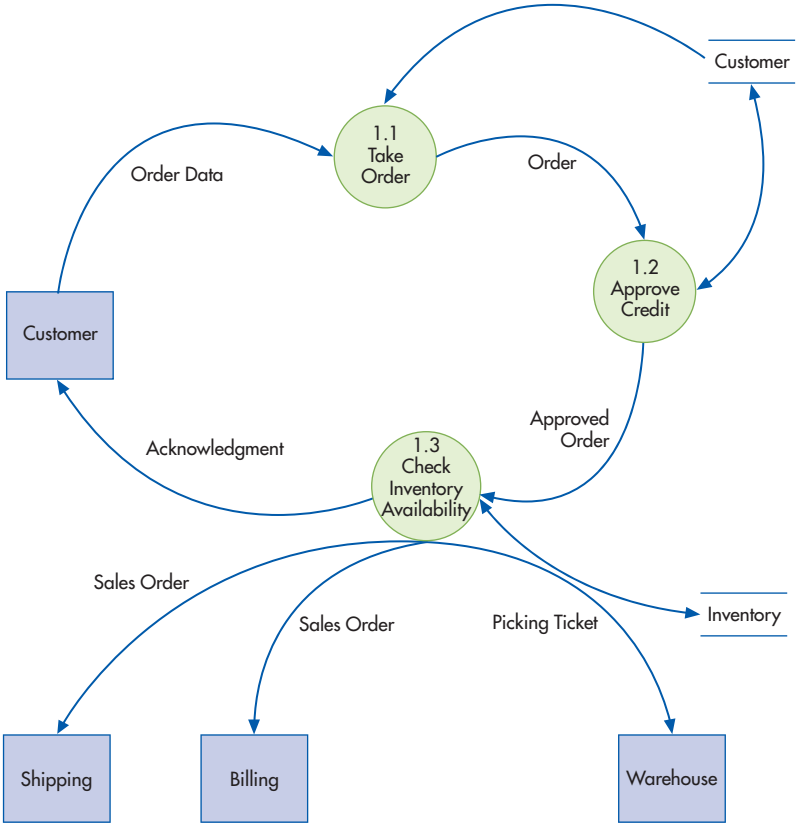
J.



3.13 Replicate the following flowchart in Visio, Microsoft Word, Microsoft Excel, or some other documentation software package.



3.14 Replicate the following DFD in Visio, Microsoft Word, Microsoft Excel, or some other documentation software package.



CASE 3-1 Dub 5

You are the systems analyst for the Wee Willie Williams Widget Works (also known as Dub 5). Dub 5 has been producing computer keyboard components for more than 20 years and has recently signed an exclusive 10-year contract to provide the keyboards for all Dell and HP personal computers. As the systems analyst, you have been assigned the task of documenting Dub 5's order-processing system.

Customer orders, which are all credit sales, arrive via e-mail and by phone. When an order is processed, a number of other documents are prepared. You have diagrammed the overall process and the documents produced, as shown in the context diagram shown below.

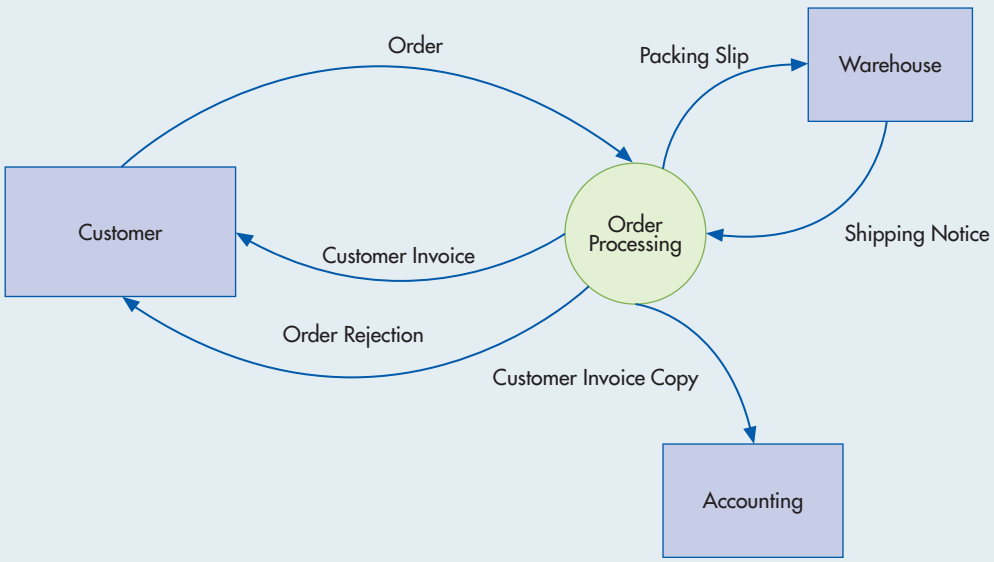
The following documents are created:

- Order processing creates a packing slip, which the warehouse uses to fill the order.
- A customer invoice is prepared and sent once the goods have been shipped.
- When orders are not accepted, an order rejection is sent to the customer, explaining why the order cannot be filled.
- A receivables notice, which is a copy of the customer invoice, is sent to the accounting department so accounts receivable records can be updated.

After reviewing your notes, you write the following narrative summary:

> When an order comes in, the order-processing clerk checks the customer's credit file to confirm credit approval and ensure that the amount falls within the credit limit. If either of these conditions is not met, the order is sent to the credit department. If an order meets both conditions, the order-processing clerk enters it into the system on a standard order form. The data on the form is used to update the company's customer file (in which the name, address, and other data are stored), and the form is placed in the company's open order file.
>
> When the credit department receives a rejected order, the credit clerk determines why the order has been rejected. If the credit limit has been exceeded, the customer is notified that the merchandise will be shipped as soon as Dub 5 receives payment. If the customer has not been approved for credit, a credit application is sent to the customer along with a notification that the order will be shipped as soon as credit approval is granted.
>
> Before preparing a packing slip, the system checks the inventory records to determine whether the company has the products ordered on hand. If the items are in stock, a packing slip is prepared and sent to the warehouse.
>
> Once notification of shipped goods has been received from the warehouse, a customer invoice is prepared. A copy is filed by the order-processing department, another is sent to the customer, and another is sent to the accounting department so that accounts receivables can be updated. A note is placed in the customer file indicating that the invoice has been sent.

From the information presented, complete a Level 0 DFD for order processing, a Level 1 DFD for the credit review process for Dub 5, and a BPD for order processing.



AIS in Action Solutions

QUIZ KEY

1. A DFD is a representation of which of the following?
a. the logical operations performed by a computer program [Incorrect. This is a description of a program flowchart.]
► **b.** flow of data in an organization [Correct.]
c. decision rules in a computer program [Incorrect. A DFD is a graphical representation of how data move through an organization. Decision rules are objective statements specific to computer programs.]
d. computer hardware configuration [Incorrect. A computer hardware configuration shows how various parts of a computer fit together.]

2. Documentation methods such as DFDs, BPDs, and flowcharts save both time and money, adding value to an organization.
► **a.** True [Correct. A picture is worth a thousand words: Many people learn more and learn it more quickly by studying the DFD, BPD, or flowchart of a system than by reading a narrative description of the same system.]
b. False [Incorrect]

3. Which of the following statements is FALSE?
a. Flowcharts make use of many symbols. [Incorrect. The statement is true. See Figure 3-8 for an illustration of the many symbols used in flowcharts.]
b. A document flowchart emphasizes the flow of documents or records containing data. [Incorrect. The statement is true. The reason it is called a document flowchart is that it shows the flow of documents or records containing data.]
► **c.** DFDs help convey the timing of events. [Correct. DFDs show data movement, but not necessarily the timing of the movement.]
d. Both a and b are false. [Incorrect. As explained above, a and b are true statements.]

4. A DFD consists of the following four basic elements: data sources and destinations, data flows, transformation processes, and data stores. Each is represented on a DFD by a different symbol.
► **a.** True [Correct. The four elements of DFDs are illustrated in Figure 3-1.]
b. False [Incorrect]

5. All of the following are guidelines that should be followed in naming DFD data elements EXCEPT:
a. Process names should include action verbs such as *update*, *edit*, *prepare*, and *record*. [Incorrect. Action verbs should be used to name process data elements. See item 11 in Focus 3-1.]
b. Make sure the names describe all the data or the entire process. [Incorrect. Data element names should reflect what is known about the element. See item 11 in Focus 3-1.]
► **c.** Name only the most important DFD elements. [Correct. All data elements should be named, with the exception of data flows into data stores, when the inflows and outflows make naming the data store redundant. See item 11 in Focus 3-1.]
d. Choose active and descriptive names. [Incorrect. Active and descriptive names should be used in naming data elements. See item 11 in Focus 3-1.]

6. The documentation skills that accountants require vary with their job function. However, all accountants should at least be able to do which of the following?
► **a.** Read documentation to determine how the system works. [Correct. All accountants should at least be able to read and understand system documentation.]
b. Critique and correct documentation that others prepare. [Incorrect. Although senior accountants may critique and correct documentation prepared by junior

accountants, at a minimum all accountants need to be able to read and understand documentation.]

c. Prepare documentation for a newly developed information system. [Incorrect. Some accountants may need to develop internal control documentation, but system developers and analysts normally prepare systems documentation.]

d. Teach others how to prepare documentation. [Incorrect. Most accountants will not be asked to teach documentation skills.]

7. Which of the following statements is FALSE?

a. A flowchart is an analytical technique used to describe some aspect of an information system in a clear, concise, and logical manner. [Incorrect. This is the definition of a flowchart given previously in the text.]

b. Flowcharts use a standard set of symbols to describe pictorially the flow of documents and data through a system. [Incorrect. The symbols used for flowcharting are shown in Figure 3-8.]

c. Flowcharts are easy to prepare and revise when the designer utilizes a flowcharting software package. [Incorrect. There are a number of good flowcharting software packages that make it easy to draw and modify flowcharts.]

► **d.** A system flowchart is a narrative representation of an information system. [Correct. A flowchart is a graphical rather than a narrative representation of an information system.]

8. Which of the following flowcharts illustrates the flow of data among areas of responsibility in an organization?

a. program flowchart [Incorrect. A program flowchart documents a computer program.]

b. computer configuration chart [Incorrect. A computer configuration chart illustrates how computer hardware is arranged and implemented.]

c. system flowchart [Incorrect. A system flowchart illustrates the relationship among inputs, processes, and outputs of a system, but not areas of responsibility.]

► **d.** document flowchart [Correct. A document flowchart traces the life of a document from its cradle to its grave as it works its way through the areas of responsibility within an organization.]

9. All of the following are recommended guidelines for making flowcharts more readable, clear, concise, consistent, and understandable EXCEPT:

a. Divide a document flowchart into columns with labels. [Incorrect. Dividing the flowchart into columns helps make it more readable, clear, concise, consistent, and understandable.]

► **b.** Flowchart all data flows, especially exception procedures and error routines. [Correct. Including all exception procedures and error routines clutters the flowchart and makes it difficult to read and understand.]

c. Design the flowchart so that flow proceeds from top to bottom and from left to right. [Incorrect. Flowcharts should be prepared so that they are read like a book.]

d. Show the final disposition of all documents to prevent loose ends that leave the reader dangling. [Incorrect. All documents should be placed either in a file or sent to another entity.]

10. How are data sources and destinations represented in a data flow diagram?

► **a.** as a square [Correct. See Figure 3-1.]

b. as a curved arrow [Incorrect. A curved arrow represents a data flow. See Figure 3-1.]

c. as a circle [Incorrect. A circle represents a process. See Figure 3-1.]

d. as two parallel lines [Incorrect. Two parallel lines represent a data store. See Figure 3-1.]

e. as none of the above [Incorrect. Option a is correct.]

COMPREHENSIVE PROBLEM SOLUTION

FLOWCHART

The first step in preparing a document flowchart is to become familiar with the problem. The next step is to identify the primary actors or major players. In this problem there are three major players: Megan Waters (accounts payable clerk), Stan Phillips (cash disbursement clerk), and John Sterling (treasurer). Since we are documenting Accuflow's cash disbursement process, we are not interested in the internal workings of the vendor, SoftData. As a result, we do not include its activities on our flowchart. Now that we have identified the major players, we can list their functions in Table 3-3. Note that forwarding to and receiving from the next major player are not considered functions in preparing document flowcharts.

TABLE 3-3 Accuflow's Table of Functions

ACCOUNTS PAYABLE CLERK (MEGAN WATERS)	CASH DISBURSEMENTS CLERK (STAN PHILLIPS)	TREASURER (JOHN STERLING)
Receives invoice	Prepares check	Approves and signs check
Records invoice	Records cash disbursement	Cancels invoice
Posts cash disbursement	Files cancelled invoice	Mails check

We will now explain, step by step, how to create the document flowchart solution for Accuflow shown in Figure 3-14. To document the functions of the three major players, divide the document flowchart into three columns, one for each player. It is usually best to arrange the columns in the order in which they occur and to use the primary function of the major player as the column name. Because the accounts payable clerk receives the invoice from the vendor, we place her in the first column. After the accounts payable clerk records the invoice, she sends it to the cash disbursements clerk, who prepares a check and sends it to the treasurer. Therefore, the cash disbursements clerk should be in the second column, and the treasurer should be in the last column, as illustrated in Figure 3-14.

Because the process begins with an invoice from an external party (a vendor), a terminal symbol with the term "From Vendor" is placed in the upper left portion of the Accounts Payable Clerk column. Next, a document symbol with the words "Vendor Invoice" printed inside it is placed below the terminal symbol. An arrow representing the document's flow and the order of operations connects the two symbols.

According to the narrative, Megan manually records the invoice in the accounts payable subsidiary ledger. Thus, a manual process symbol with the words "Record Invoice" is placed below the invoice document symbol, and the two symbols are connected with an arrow. Then, a journal/ ledger symbol is placed to the side of the manual process and an arrow is used to connect the two symbols. A new vendor invoice symbol is drawn below the record invoice symbol.

Because the vendor invoice moves from the accounts payable clerk to the cash disbursements clerk, the vendor invoice symbol is placed at the top of the cash disbursements column with an arrow connecting the two representations of the same document. We redraw the vendor invoice symbol in the cash disbursements clerk column to make the flowchart easier to read.

To show that the cash disbursement clerk prepares a check to pay the vendor invoice, a manual process symbol with "Prepare Check" inside it is placed next to the vendor invoice. We could have placed it below the invoice symbol but put it beside the symbol to save space. Two document symbols are placed below the manual process for the vendor invoice and the newly prepared check.

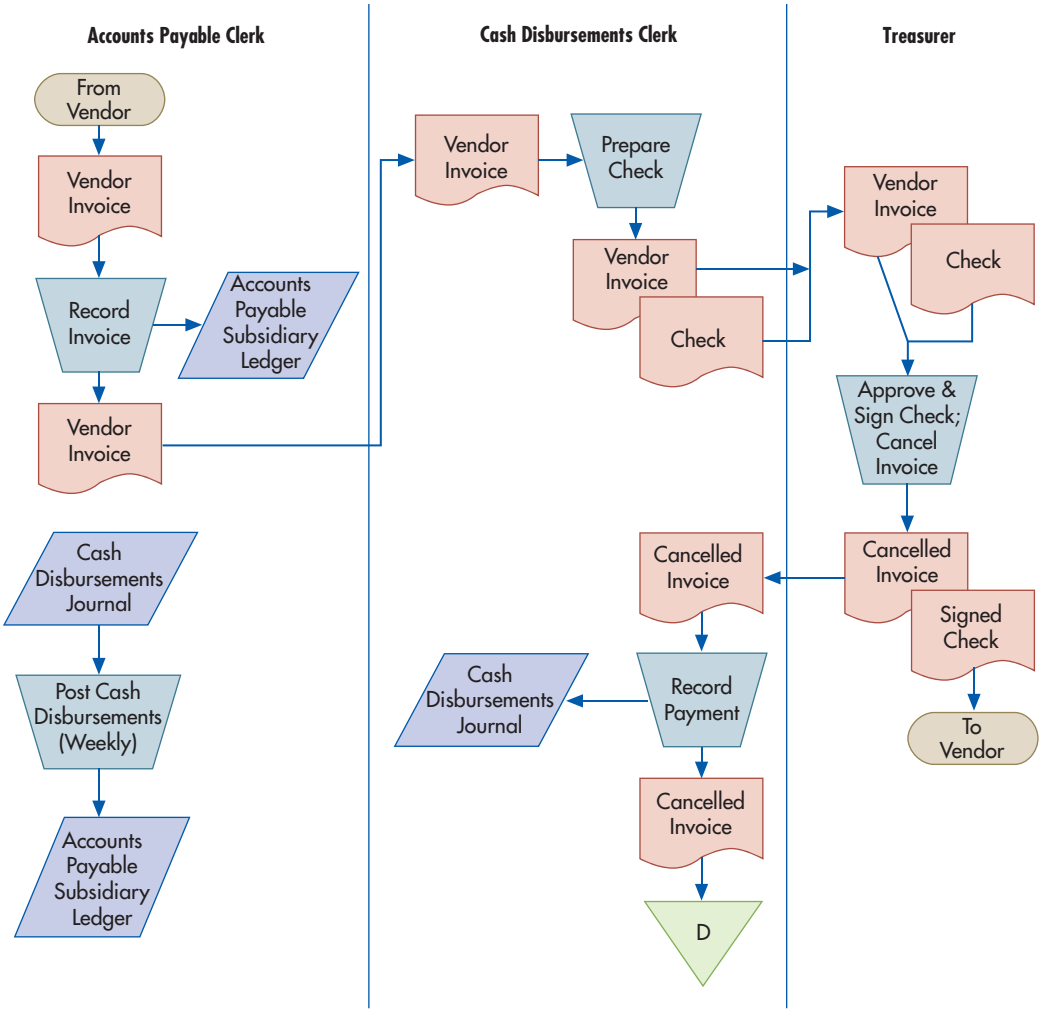


FIGURE 3-14
Accuflow's Document Flowchart

The cash disbursements clerk then sends the invoice and check to the treasurer. As a result, the vendor invoice and check appear in the Treasurer column. A manual symbol with "Approve & Sign Check; Cancel Invoice" inside is used to show that the check is signed and the invoice is cancelled. The documents are again shown in the flowchart, this time with new titles (Cancelled Invoice and Signed Check) to show the changed nature of the documents. The treasurer sends the signed check to the vendor, which is illustrated using a terminal symbol with words "To Vendor" written in it.

The cancelled invoice is used to record the cash disbursement in the cash disbursements journal, so it is sent back to the middle column (Cash Disbursements). A manual process symbol with "Record Payment" inside it and an arrow is used to show that the disbursement is recorded in the cash disbursements journal, represented by a journal/ledger symbol. To illustrate that the cancelled invoice is filed by date, it is shown, using appropriate arrows, as exiting the record payment manual process and entering a file. A "D" is placed in the file symbol to indicate that the documents are filed by date.

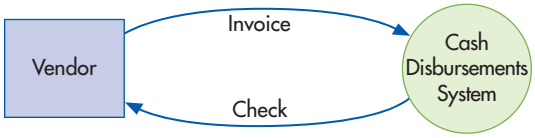
Each week, the accounts payable clerk manually posts entries from the cash disbursements journal to the accounts payable subsidiary ledger. To show this, the cash disbursements journal symbol is reproduced in the accounts payable clerk column, and a manual process symbol with the words "Post Cash Disbursements (Weekly)" is placed under it. An arrow shows data from this journal being entered into the accounts payable subsidiary ledger.

This completes the document flowchart for the Accuflow Company's cash disbursements process.

CONTEXT DIAGRAM

A context diagram is an overview of the data processing being documented. As such, a context diagram includes a single transformation process (circle or bubble) and the data sources and data destinations that send data to or receive data from the transformation process. Thus, the first step in preparing a context diagram is to draw a single circle or bubble and then label it with a name that best describes the process being documented. In this case, "Cash Disbursements System" effectively describes the process (see Figure 3-15).

FIGURE 3-15
Accuflow's Context Diagram



The next step is to draw and label squares for the entities that either send data to the cash disbursements process or receive data from the cash disbursements process. In this example, there is a single entity—the vendor that acts as both a source and a destination of data to/from the cash disbursements process. In other processes, an outside entity could be just a source or a destination of data, and there could be more than one source or destination of data.

The last step is to connect the process (circle) with the source/destination (square) with arrows representing data flows. We have two arrows representing an invoice sent to Accuflow's cash disbursement process and a check sent to the vendor from Accuflow.

LEVEL 0 DATA FLOW DIAGRAM

In the context diagram, we saw the entire cash disbursements process in one bubble. In a Level 0 DFD, we break down the cash disbursements process into its major functions. In reading the narrative, we find the following five primary steps in the cash disbursements process:

1. Receive vendor invoice and record payable
2. Prepare the check
3. Sign and send the check and cancel the invoice
4. Record the cash disbursement
5. Post the cash disbursements to the accounts payable ledger

Each of these processes is represented by a circle or bubble in Figure 3-16. Since this is the Level 0 DFD, we assign each of these processes a real number, with the first digit after the decimal point being a zero. We also place the circles in the order that the data should flow in the process. As a result, "Receive and Record Invoice" is assigned process 1.0, "Prepare Check" is assigned process 2.0, "Approve and Sign Check" is 3.0, "Record Cash Disbursement" is 4.0, and "Post Cash Disbursement to Accounts Payable Ledger" is 5.0. This numbering system allows us to decompose these processes into more detailed subprocesses and still keep a consistent numbering system. Thus, if we needed to decompose process 3.0 to a more detailed level, we could assign subprocess bubbles as 3.1, 3.2, 3.3, etc. We can even provide greater detail by decomposing process 3.1 into subprocesses 3.1.1, 3.1.2, 3.1.3, etc.

Next, we place the data sources and data destinations on the Level 0 DFD. Because we had only one data source and destination (i.e., the vendor), we draw a square and label it "Vendor." It is very important that we reconcile back to the context diagram when we prepare the different levels of DFDs. That is, the same data sources and destinations that appeared on the context diagram must also appear on the Level 0 DFD. No new data sources and destinations may appear on the Level 0 DFD. If, when preparing the Level 0 DFD, you discover that a data source/destination is necessary to document the system properly, then you must revise the context diagram with the new data source/destination, because the context diagram should represent the entire process.

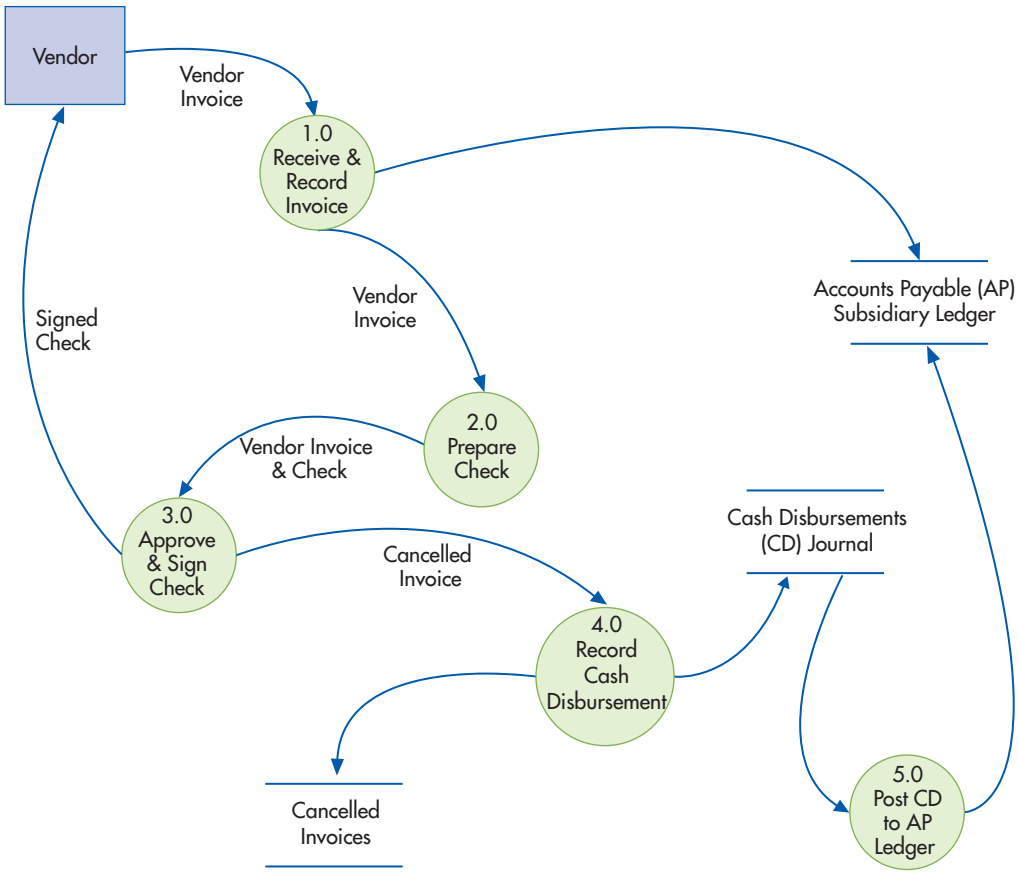


FIGURE 3-16
Accuflow's Level 0 Data Flow Diagram

Once the data source/destinations and processes are drawn, we then connect them by drawing the arrows between the appropriate symbols. These arrows represent the data moving or flowing from one process to another and from one source or destination to or from a particular process. Accordingly, we have a vendor invoice moving from the vendor to the "Receive and Record Invoice" process and from that process to the "Prepare Check" process. The vendor invoice and a check move from the "Prepare Check" process to the "Approve and Sign Check" process. We also have arrows leaving process 3.0 to represent the signed check being sent to the vendor and the cancelled invoice going to process 4.0, "Record Cash Disbursements."

Some processes require that data be stored. As a result, we also draw any necessary files or data stores. The Level 0 DFD is the first time data stores appear in a DFD set. (Note: Data stores should not be represented on a context diagram.) Data store labels should identify the data being sent to or from it. As a result, labeling the data flows to or from data stores is normally unnecessary. Data stores are prepared by drawing two parallel lines and inserting the name of the data store between the parallel lines.

In Figure 3-16 we have three data stores: the cash disbursements journal, accounts payable subsidiary ledger, and cancelled invoices data store. Because the cash disbursements journal is updated in process 4.0, a data flow is sent from the process 4.0 circle to the cash disbursements journal data store. To show that the accounts payable ledger is updated when invoices are received (process 1.0), an arrow is drawn from that process to the accounts payable ledger. To show that accounts payable is updated with data from the cash disbursements journal (process 5.0), a data flow arrow is drawn from the cash disbursements data store to process 5.0, and another data flow arrow is drawn from process 5.0 to the accounts payable subsidiary ledger data store. The update takes place weekly, but unlike document flowcharts, a DFD does not indicate the timing of data flows.

LEVEL 1 DATA FLOW DIAGRAM

When additional detail is needed to document data flows, a process bubble may be decomposed further. As indicated in Focus 3-1, to be clear, understandable, and easy to read, a DFD should contain no more than seven process bubbles. In the Accuflow example, we broke the company's data flows into five main processes. Each of these five processes can be further decomposed. To illustrate this, we will decompose process 3.0. The narrative indicates that the treasurer approves and signs the prepared check, sends it to the vendor, and cancels the invoice to prevent duplicate payments. Therefore, we will break down process 3.0 into process 3.1 (approve and sign check), 3.2 (send check to vendor), and 3.3 (cancel invoice). To display the three processes, we draw three circles and label them as shown on Figure 3-17. We also draw the data flows and label them. Notice that the vendor data source/destination is not needed on the Level 1 DFD since it is already shown on Level 0. Since it would clutter the DFD, and because we are showing greater detail on the Level 1 than on the Level 0 for one particular process, we do not replicate all of the processes and data stores in the Level 0 DFD.

BUSINESS PROCESS DIAGRAM

The first step in preparing a business process diagram is to identify and understand the business processes to be diagrammed. This includes identifying the primary players in Accuflow's cash disbursement process: Megan Waters (accounts payable clerk), Stan Phillips (cash disbursement clerk), and John Sterling (treasurer). Since we are documenting Accuflow's cash disbursement process, we do not include the vendor, SoftData, as one of our major players. Table 3-3 (page 78) lists the functions performed by the three people involved in cash disbursements.

We will now explain each step in creating the BPD solution for Accuflow shown in Figure 3-18. The first step is to create two columns to show the employees involved and the activities they perform. Next, we create three rows, sometimes called "swim lanes" to show the three employees and the activities each of them performs in the cash disbursements process.

Because the process begins when Megan Waters receives an invoice from a vendor, a circle is placed in the upper left portion of the Accounts Payable Clerk column to show where the cash disbursement process begins (see Figure 3-12 for the BPD symbols). The first activity (shown by a rectangle in the BPD) is entering the vendor invoice in the accounts payable subsidiary ledger. An arrow representing the document's flow and the order of operations connects the beginning of the process (circle) and the first activity (rounded rectangle). Since we got the invoice from someone not represented in a swim lane, we write "From Vendor" above the rectangle.

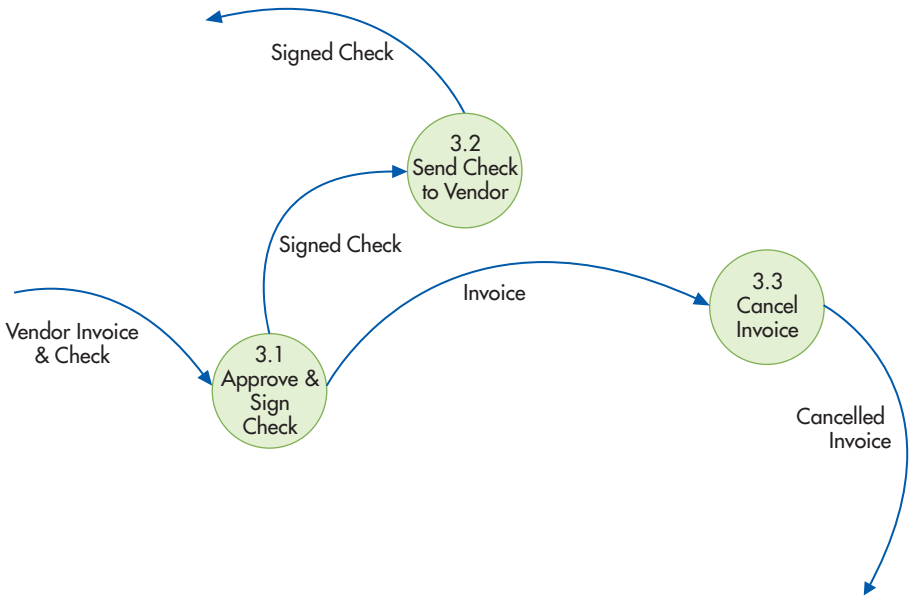


FIGURE 3-17
Accuflow's Level 1 Data Flow Diagram

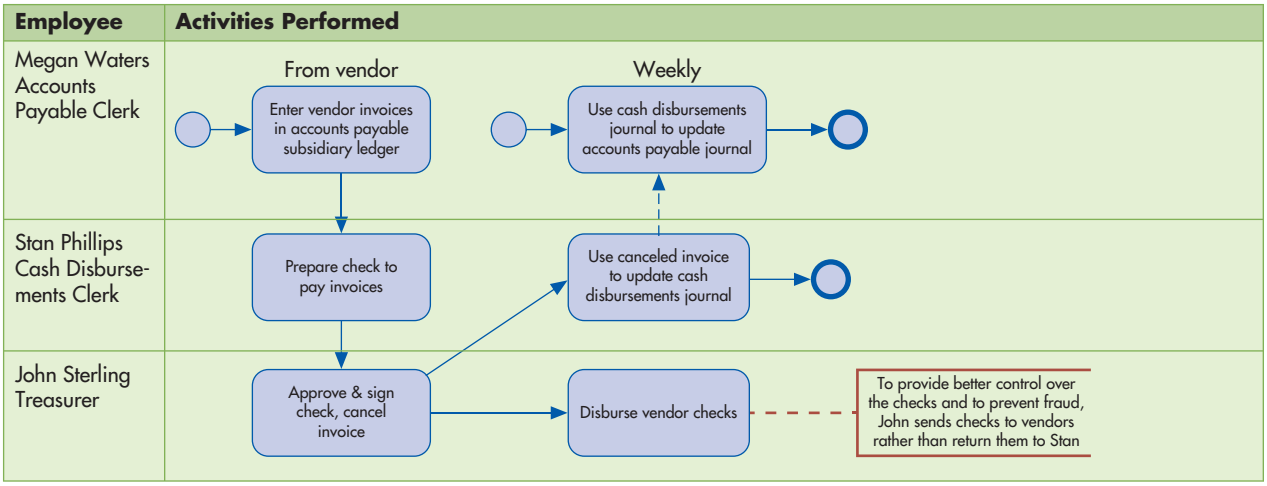


FIGURE 3-18
Accuflow's Business Process Diagram

The next activity is preparing checks to pay the invoices. Since that is done by Stan Phillips, the cash disbursements clerk, we draw the appropriate rectangle in his swim lane and connect the two rectangles with an arrow to indicate process flow. Note that, unlike a flowchart, in a BPD we do not show the documents created, their flow, or where they are stored. The emphasis is on the activities performed and the process flow.

The third activity in the cash disbursements process is John Sterling, the Treasurer, approving and signing the checks and canceling the invoice (marking it paid). That rectangle is drawn, the appropriate explanation placed inside it, and an arrow is drawn to show the process flow.

The fourth activity is the Treasurer sending the signed check to the vendor. There is no row or swim lane for the vendor; instead, the rectangle with "disburse vendor checks" communicates that the checks are sent to the external party. Internal controls can be highlighted on a BPD by explaining them and drawing a dotted arrow to the appropriate activity. In the Accuflow BPD, the annotation symbol (see Figure 3-8) is used, with the internal control description written inside the three-sided rectangle.

John sends the canceled invoice to Stan, who updates the cash disbursements journal, represented by another rectangle in Stan's swim lane and a connecting arrow between the two swim lanes. Accuflow receives and pays for invoices every day, and updating cash disbursements is the final daily activity in that business process; hence, the bolded circle to the right of the rectangle to indicate the end of that process.

There is one more activity in the process—Megan uses the cash disbursement journal to update the accounts payable journal. Since the timing of the activity is different (weekly rather than daily), it is shown as a separate activity with its own beginning and end. A dotted line connects the rectangles in Stan's and Megan's swim lanes to show that the flow is different than the other flows. The word "Weekly" is placed above the activity rectangle to indicate the different timing.

This completes the business process diagram for Accuflow's cash disbursements process.

CHAPTER

4

Relational Databases

LEARNING OBJECTIVES

After studying this chapter, you should be able to:

1. Explain the importance and advantages of databases, as well as the difference between database systems and file-based legacy systems.
2. Explain database systems, including logical and physical views, schemas, the data dictionary, and DBMS languages.
3. Describe what a relational database is, how it organizes data, and how to create a set of well-structured relational database tables.

INTEGRATIVE CASE **S&S**

S&S is very successful and operates five stores and a popular website. Ashton Fleming believes that it is time to upgrade S&S's accounting information system (AIS) so that Susan and Scott can easily access the information they need to run their business. Most new AISs are based on a relational database. Since Ashton knows that Scott and Susan are likely to have questions, he prepared a brief report that explains why S&S's new AIS should be a relational database system. His report addresses the following questions:

1. What is a database system, and how does it differ from file-oriented systems?
2. What is a *relational* database system?
3. How do you design a well-structured set of tables in a relational database?
4. How do you query a relational database system?

Introduction

Relational databases underlie most modern integrated AISs. This chapter and Chapters 17 through 19 explain how to participate in the design and implementation of a database. This chapter defines a database, with the emphasis on understanding the relational database structure. Chapter 17 introduces two tools used to design databases—entity-relationship diagramming and REA data modeling—and demonstrates how to use them to build a data model.

Chapter 18 explains how to implement an REA data model and how to produce the information needed to manage an organization. Chapter 19 discusses advanced data modeling and database design issues.

Databases and Files

To appreciate the power of databases, it is important to understand how data are stored in computer systems. Figure 4-1 shows a data hierarchy. Information about the attributes of a customer, such as name and address, are stored in fields. All the fields containing data about one entity (e.g., one customer) form a record. A set of related records, such as all customer records, forms a file (e.g., the customer file). A set of interrelated, centrally coordinated data files that are stored with as little data redundancy as possible forms a **database**. A database consolidates records previously stored in separate files into a common pool and serves a variety of users and data processing applications.

database - A set of interrelated, centrally coordinated data files that are stored with as little data redundancy as possible.

Databases were developed to address the proliferation of master files. For many years, companies created new files and programs each time a need for information arose. Bank of America once had 36 million customer accounts in 23 separate systems. This proliferation created problems such as storing the same data in two or more master files, as shown in Figure 4-2. This made it difficult to integrate and update data and to obtain an organization-wide view of data. It also created problems because the data in the different files were inconsistent. For example, a customer's address may have been correctly updated in the shipping master file but not the billing master file.

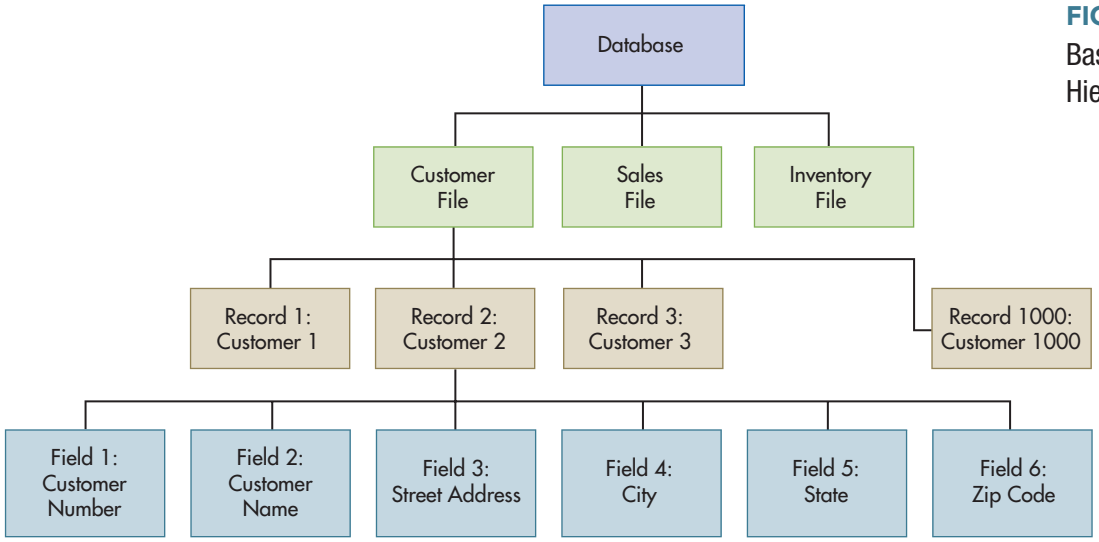


FIGURE 4-1
Basic Elements of Data Hierarchy

Figure 4-2 illustrates the differences between file-oriented systems and database systems. In the database approach, data is an organizational resource that is used by and managed for the entire organization, not just the originating department. A **database management system (DBMS)** is the program that manages and controls the data and the interfaces between the data and the application programs that use the data stored in the database. The database, the DBMS, and the application programs that access the database through the DBMS are referred to as the **database system**. The **database administrator (DBA)** is responsible for coordinating, controlling, and managing the database.

database management system (DBMS) - The program that manages and controls the data and the interfaces between the data and the application programs that use the data stored in the database.

database system - The database, the DBMS, and the application programs that access the database through the DBMS.

database administrator (DBA) - The person responsible for coordinating, controlling, and managing the database.

USING DATA WAREHOUSES FOR BUSINESS INTELLIGENCE

In today's fast-paced global economy, management must constantly reevaluate financial and operating performance in light of strategic goals and quickly alter plans as needed. Since strategic decision making requires access to large amounts of historical data, organizations are building separate databases called data warehouses. A **data warehouse** is one or more very large databases containing both detailed and summarized data for a number of years that is used for analysis rather than transaction processing. It is not unusual for data warehouses to contain hundreds or thousands of terabytes of data. Some data warehouses are measured in petabytes (1,000 terabytes or 1 million gigabytes).

Data warehouses do not replace transaction processing databases; they complement them by providing support for strategic decision making. Since data warehouses are not used for transaction processing, they are usually updated periodically rather than in real time. Whereas transaction processing databases minimize redundancy and maximize the efficiency of updating them to reflect the results of current transactions, data warehouses are purposely redundant to maximize query efficiency.

Analyzing large amounts of data for strategic decision making is often referred to as **business intelligence**. There are two main techniques used in business intelligence: online analytical processing (OLAP) and data mining. **Online analytical processing (OLAP)** is using queries to investigate hypothesized relationships among data. For example, a manager may analyze supplier purchases for the last 3 years, followed by additional queries that "drill down" to lower levels by grouping purchases by item number and by fiscal period. **Data mining** is using sophisticated statistical analysis, including artificial intelligence techniques such as neural networks, to "discover" unhypothesized relationships in the data. For example,

data warehouse - Very large databases containing detailed and summarized data for a number of years that are used for analysis rather than transaction processing.

business intelligence - Analyzing large amounts of data for strategic decision making.

online analytical processing (OLAP) - Using queries to investigate hypothesized relationships among data.

data mining - Using sophisticated statistical analysis to "discover" unhypothesized relationships in the data.

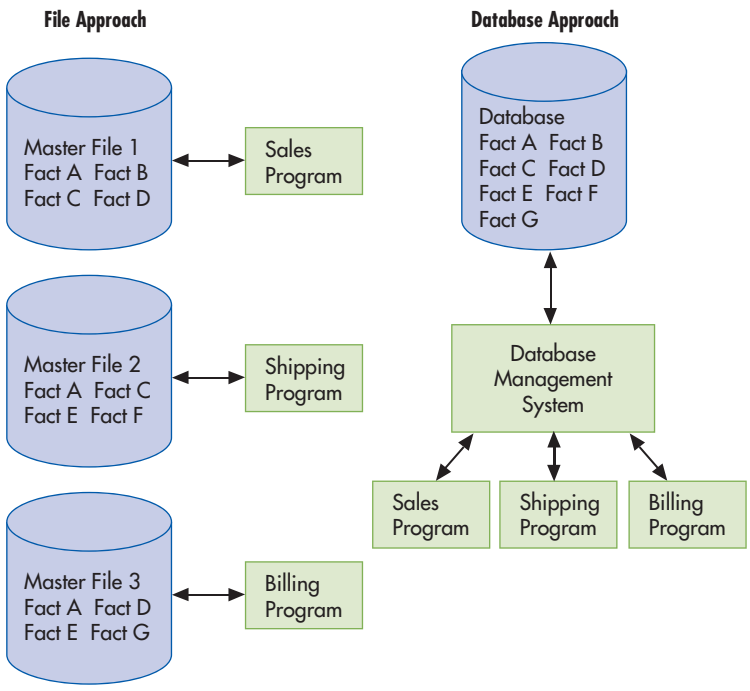


FIGURE 4-2
File-Oriented Systems versus Database Systems

credit card companies use data mining to identify usage patterns indicative of fraud. Similarly, data mining techniques can identify previously unknown relationships in sales data that can be used in future promotions.

Proper controls are needed to reap significant benefits from data warehousing. Data validation controls are needed to ensure that data warehouse input is accurate. Verifying the accuracy, called scrubbing the data, is often one of the most time-consuming and expensive steps in creating a data warehouse. It is also important to control access to the data warehouse as well as to encrypt the stored data. Finally, it is important to regularly backup the data warehouse and store the backups securely.

Bank of America created a customer information database to provide customer service, marketing analysis, and managerial information. It was the largest in the banking industry, with over 600 billion characters of data. It contained all bank data on checking and savings accounts; real estate, consumer, and commercial loans; ATMs; and bankcards. Although the bank spends $14 million a year to maintain the data warehouse, it is worth the cost. Queries that formerly averaged two hours took only five minutes. Minutes after Los Angeles suffered an earthquake, the bank sorted its $28 billion mortgage loan portfolio by zip code, identified loans in the earthquake area, and calculated its potential loan loss.

THE ADVANTAGES OF DATABASE SYSTEMS

Virtually all mainframes and servers use database technology, and database use in personal computers is growing rapidly. Most accountants are involved with databases through data entry, data processing, querying, or auditing. They also develop, manage, or evaluate the controls needed to ensure database integrity. Databases provide organizations with the following benefits:

- ***Data integration***. Master files are combined into large "pools" of data that many application programs access. An example is an employee database that consolidates payroll, personnel, and job skills master files.
- ***Data sharing***. Integrated data are more easily shared with authorized users. Databases are easily browsed to research a problem or obtain detailed information underlying a report. The FBI, which does a good job of collecting data but a poor job of sharing it, is spending eight years and $400 million to integrate data from their different systems.
- ***Minimal data redundancy and data inconsistencies***. Because data items are usually stored only once, data redundancy and data inconsistencies are minimized.
- ***Data independence***. Because data and the programs that use them are independent of each other, each can be changed without changing the other. This facilitates programming and simplifies data management.
- ***Cross-functional analysis***. In a database system, relationships, such as the association between selling costs and promotional campaigns, can be explicitly defined and used in the preparation of management reports.

THE IMPORTANCE OF GOOD DATA

Incorrect database data can lead to bad decisions, embarrassment, and angry users. For example:

- A company sent half its mail-order catalogs to incorrect addresses. A manager finally investigated the large volume of returns and customer complaints. Correcting customer addresses in the database saved the company $12 million a year.
- Valparaiso, Indiana, used the county database to develop its tax rates. After the tax notices were mailed, a huge error was discovered: A $121,900 home was valued at $400 million and caused a $3.1 million property tax revenue shortfall. As a result, the city, the school district, and governmental agencies had to make severe budget cuts.

The Data Warehousing Institute estimates that bad data cost businesses over $600 billion a year in unnecessary postage, marketing costs, and lost customer credibility. It is estimated that over 25% of business data is inaccurate or incomplete. In a recent survey, 53% of 750 information technology (IT) professionals said their companies experienced problems due to poor-quality data.

Managing data gets harder every year: The quantity of data generated and stored doubles every 18 months. To avoid outdated, incomplete, or erroneous data, management needs policies and procedures that ensure clean, or scrubbed, data.The Sarbanes-Oxley Act (SOX) states that top executives face prosecution and jail time if a company's financial data are not in order. Preventing and detecting bad data are discussed in more detail in Chapters 5 through 11.

Database Systems

LOGICAL AND PHYSICAL VIEWS OF DATA

In file-oriented systems, programmers must know the physical location and layout of records. Suppose a programmer wants a report showing customer number, credit limit, and current balance. To write the program, she must understand the location and length of the fields needed (i.e., record positions 1 through 10 for customer number) and the format of each field (alphanumeric or numeric). The process becomes more complex if data from several files are used.

record layout - Document that shows the items stored in a file, including the order and length of the data fields and the type of data stored.

A **record layout** is a document that shows the items stored in a file, including the order and length of the data fields and the type of data stored in an accounts receivable file. Figure 4-3 shows a record layout of an accounts receivable file.

Database systems overcome this problem by separating the storage of the data from the use of data elements. The database approach provides two separate views of the data: the physical view and the logical view. The **logical view** is how people conceptually organize and understand the relationships among data items. For example, a sales manager views all customer information as being stored in a table. The **physical view** refers to the way data are physically arranged and stored in the computer system.

logical view - How people conceptually organize, view, and understand the relationships among data items.

physical view - The way data are physically arranged and stored in the computer system.

As shown in Figure 4-4, database management (DBMS) software links the way data are physically stored with each user's logical view of the data. The DBMS allows users to access, query, or update the database without reference to how or where data are physically stored. Separating the logical and physical views of data also means that users can change their logical view of data without changing the way data are physically stored. Likewise, the DBA can change physical storage to improve system performance without affecting users or application programs.

SCHEMAS

A **schema** is a description of the data elements in a database, the relationships among them, and the logical model used to organize and describe the data. There are three levels of schemas: the conceptual, the external, and the internal. Figure 4-5 shows the relationships among these three levels. The **conceptual-level schema**, the organization-wide view of the *entire* database, lists all data elements and the relationships among them. The **external-level schema** is an individual user's view of portions of a database, each of which is referred to as a **subschema**. The **internal-level schema**, a low-level view of the database, describes how the data are stored and accessed, including record layouts, definitions, addresses, and indexes. Figure 4-5 connects each of the levels with bidirectional arrows to represent schema mappings. The DBMS uses the mappings to translate a user's or a program's request for data (expressed in terms of logical names and relationships) into the indexes and addresses needed to physically access the data.

schema - A description of the data elements in a database, the relationships among them, and the logical model used to organize and describe the data.

conceptual-level schema - The organization-wide view of the entire database that lists all data elements and the relationships between them.

external-level schema - An individual user's view of portions of a database; also called a subschema.

subschema - A subset of the schema; the way the user defines the data and the data relationships.

internal-level schema - A low-level view of the entire database describing how the data are actually stored and accessed.

Customer Number N	Customer Name A	Address A	Credit Limit N	Balance N
1 10	11 30	31 60	61 68	69 76

A = alphanumeric field
N = numeric field

FIGURE 4-3
Accounts Receivable File Record Layout

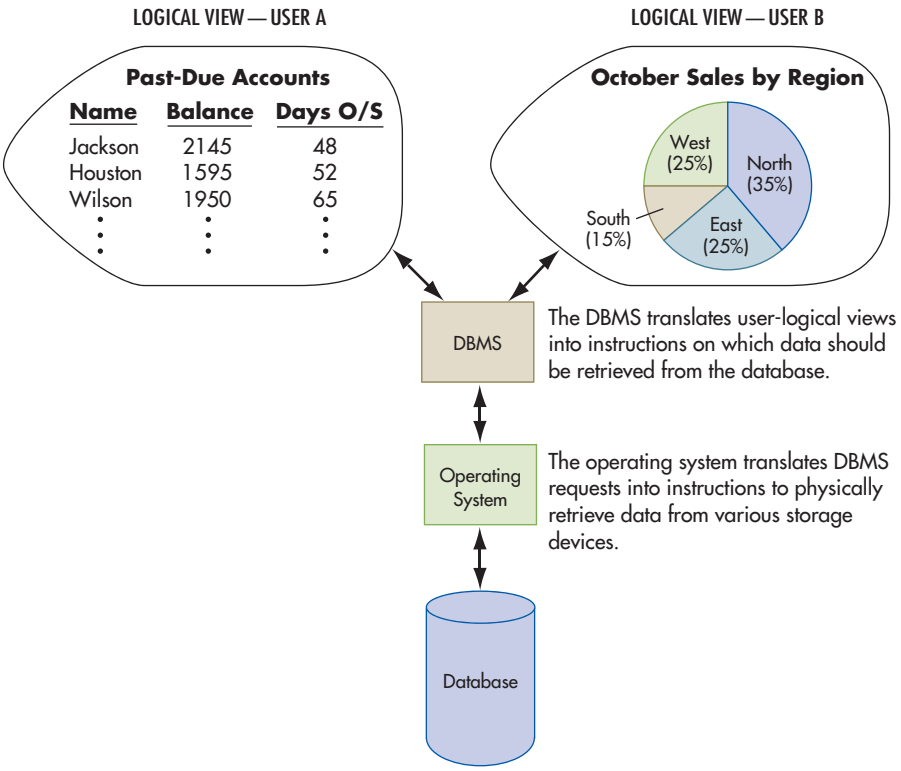


FIGURE 4-4
Function of the DBMS: To Support Multiple Logical Views of Data

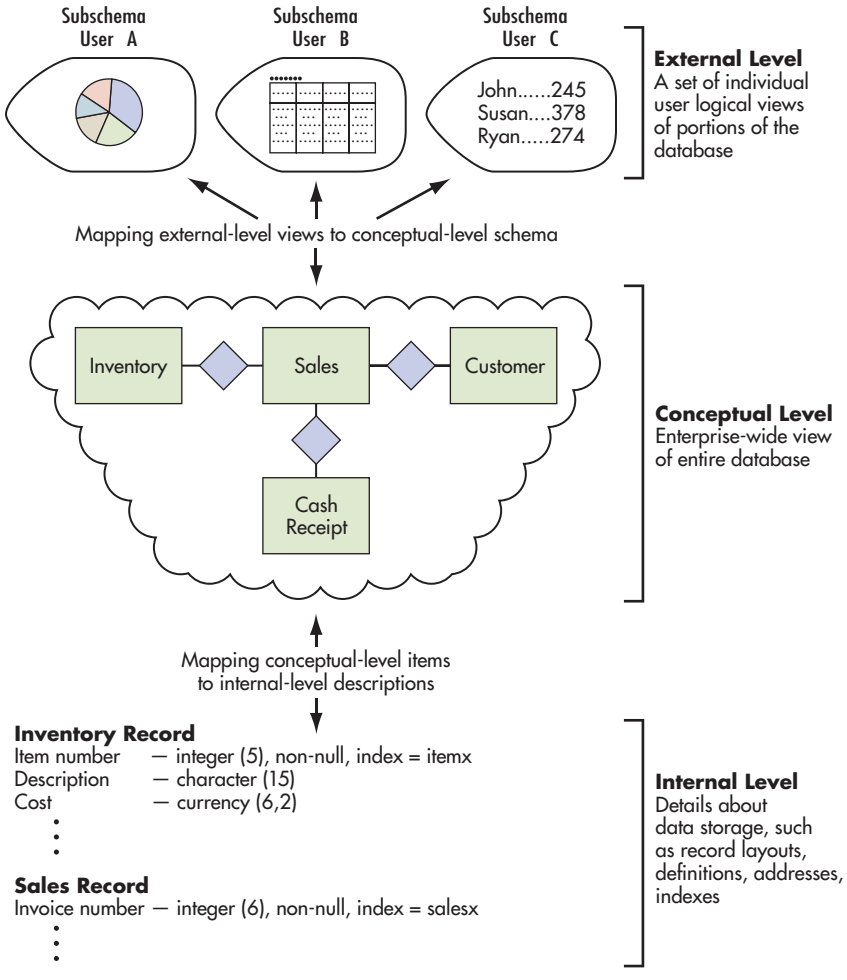


FIGURE 4-5
Three Levels of Schemas

At S&S, the conceptual schema for the revenue cycle database contains data about customers, sales, cash receipts, sales personnel, cash, and inventory. External subschemas are derived from this schema, each tailored to the needs of different users or programs. Each subschema can prevent access to those portions of the database that do not apply to it. For example, the sales order entry subschema includes data about customer credit limits, current balances, and inventory quantities and prices. It would not include the cost of inventory or bank account balances.

THE DATA DICTIONARY

data dictionary - Information about the structure of the database, including a description of each data element.

A **data dictionary** contains information about the structure of the database. As shown in Table 4-1, for each data element stored in the database, there is a record in the dictionary describing it. The DBMS maintains the data dictionary, whose inputs include new or deleted data elements and changes in data element names, descriptions, or uses. Outputs include reports for programmers, designers, and users, such as (1) programs or reports using a data item, (2) synonyms for the data elements in a file, and (3) data elements used by a user. These reports are used for system documentation, for database design and implementation, and as part of the audit trail.

DBMS LANGUAGES

data definition language (DDL) - DBMS language that builds the data dictionary, creates the database, describes logical views, and specifies record or field security constraints.

data manipulation language (DML) - DBMS language that changes database content, including data element creations, updates, insertions, and deletions.

data query language (DQL) - High-level, English-like, DBMS language that contains powerful, easy-to-use commands that enable users to retrieve, sort, order, and display data.

report writer - DBMS language that simplifies report creation.

A DBMS has several languages. The **data definition language (DDL)** builds the data dictionary, creates the database, describes logical views for each user, and specifies record or field security constraints. The **data manipulation language (DML)** changes database content, including data element creations, updates, insertions, and deletions. The **data query language (DQL)** is a high-level, English-like language that contains powerful, easy-to-use commands that enable users to retrieve, sort, order, and display data. A **report writer** simplifies report creation. Users specify the data elements they want printed, and the report writer searches the database, extracts the data elements, and prints them in the user-specified format. The DQL and report writer are available to users. The DDL and DML should be restricted to authorized administrators and programmers.

Relational Databases

data model - An abstract representation of database contents.

relational data model - A two-dimensional table representation of data; each row represents a unique entity (record) and each column is a field where record attributes are stored.

tuple - A row in a table that contains data about a specific item in a database table.

A DBMS is characterized by the logical **data model**, or abstract representation of database contents. As most new DBMSs are relational databases, this chapter focuses primarily on them. The **relational data model** represents conceptual- and external-level schemas as if data are stored in two-dimensional tables like the one shown in Table 4-2. The data are actually stored not in tables, but in the manner described in the internal-level schema.

Each row in a table, called a **tuple** (rhymes with *couple*), contains data about a specific item in a database table. Each column contains data about an attribute of that entity. For example, each row in Table 4-2 contains data about a particular inventory item that S&S carries, and each column contains data about specific inventory attributes, such as description, color, and price. Similarly, each row in a Customer table contains data about a specific customer, and each column contains data about customer attributes, such as name and address.

TYPES OF ATTRIBUTES

primary key - Database attribute, or combination of attributes, that uniquely identifies each row in a table.

foreign key - An attribute in a table that is also a primary key in another table; used to link the two tables.

A **primary key** is the database attribute, or combination of attributes, that uniquely identifies a specific row in a table. The primary key in Table 4-2 is Item Number, as it uniquely identifies each merchandise item that S&S sells. Usually, the primary key is a single attribute. In some tables, two or more attributes are needed to identify uniquely a specific row in a table. The primary key of the Sales-Inventory table in Table 4-5 is the combination of Sales Invoice # and Item #.

A **foreign key** is an attribute in a table that is also a primary key in another table and is used to link the two tables. Customer # in Table 4-5 is the primary key in the Customer table and a foreign key in the Sales table. In the Sales table, Customer # links a sale to data about the customer who made the purchase, as contained in the Customer table (see arrows connecting tables).

TABLE 4-1 Example of a Data Dictionary

DATA ELEMENT NAME	DESCRIPTION	RECORDS IN WHICH CONTAINED	SOURCE	FIELD LENGTH	FIELD TYPE	PROGRAMS IN WHICH USED	OUTPUTS IN WHICH CONTAINED	AUTHORIZED USERS	OTHER DATA NAMES
Customer number	Unique identifier of each customer	A/R record, customer record, sales analysis record	Customer number listing	10	Numeric	A/R update, customer file update, sales analysis update, credit analysis	A/R aging report, customer status report, sales analysis report, credit report	No restrictions	None
Customer name	Complete name of customer	Customer record	Initial customer order	20	Alphanumeric	Customer file update, statement processing	Customer status report, monthly statement	No restrictions	None
Address	Street, city, state, and zip code	Customer record	Credit application	30	Alphanumeric	Customer file update, statement processing	Customer status report, monthly statement	No restrictions	None
Credit limit	Maximum credit that can be extended to customer	Customer record, A/R record	Credit application	8	Numeric	Customer file update, A/R update, credit analysis	Customer status report, A/R aging report, credit report	D. Dean G. Allen H. Heaton	CR_limit
Balance	Balance due from customer on credit purchases	A/R record, sales analysis record	Various sales and payment transactions	8	Numeric	A/R update, sales analysis update, statement processing, credit analysis	A/R aging report, sales analysis report, monthly statement, credit report	G. Burton B. Heninger S. Summers	Cust_bal

TABLE 4-2 Sample Inventory Table for S&S

Inventory

Item Number	Description	Color	Vendor Number	Quantity on Hand	Price
1036	Refrigerator	White	10023	12	1199
1038	Refrigerator	Almond	10023	7	1299
1039	Refrigerator	Hunter Green	10023	5	1499
2061	Range	White	10011	6	799
2063	Range	Black	10011	5	999
3541	Washer	White	10008	15	499
3544	Washer	Black	10008	10	699
3785	Dryer	White	10019	12	399
3787	Dryer	Almond	10019	8	499
0			0	0	0

Record: 10 of 10 No Filter Search

Other nonkey attributes in a table store important information about that entity. The inventory table in Table 4-2 contains information about the description, color, vendor number, quantity on hand, and price of each item S&S carries.

DESIGNING A RELATIONAL DATABASE FOR S&S, INC.

In a manual accounting system, S&S would capture sales information on a preprinted sales invoice that provides both a logical and physical view of the data collected. Physical storage of sales invoice data is simple; a copy of the invoice is stored in a file cabinet.

Storing the same data in a computer is more complex. Suppose S&S wanted to store five sales invoices (numbered 101 to 105) electronically. On several invoices, a customer buys more than one item. Let us look at the effects of several ways of storing this information.

1: Store All Data in One Uniform Table. S&S could store sales data in one table, as illustrated in Table 4-3. This approach has two disadvantages. First, it stores lots of redundant data. Examine invoice 102 in Table 4-3. Because three inventory items are sold, invoice and customer data (columns 1 to 9) are recorded three times. Likewise, inventory descriptions and unit prices are repeated each time an item is sold. Because sales volumes are high in a retail store (remember, Table 4-3 represents only five invoices), such redundancy makes file maintenance unnecessarily time-consuming and error-prone.

update anomaly - Improper database organization where a non-primary key item is stored multiple times; updating the item in one location and not the others causes data inconsistencies.

Second, problems occur when invoice data are stored in these types of tables. The first is called an **update anomaly**, because data values are not correctly updated. Changing a customer's address involves searching the entire table and changing every occurrence of that customer's address. Overlooking even one row creates an inconsistency, because multiple addresses would exist for the same customer. This could result in unnecessary duplicate mailings and other errors.

insert anomaly - Improper database organization that results in the inability to add records to a database.

An **insert anomaly** occurs in our example because there is no way to store information about prospective customers until they make a purchase. If prospective customer data is entered before a purchase is made, the Sales Invoice # column would be blank. However, the Sales Invoice # is the primary key for Table 4-3 and cannot be blank, as it uniquely identifies the record.

delete anomaly - Improper organization of a database that results in the loss of all information about an entity when a row is deleted.

A **delete anomaly** occurs when deleting a row has unintended consequences. For example, if customer addresses are stored in the sales table, then deleting the row where the only sale to a customer is stored results in the loss of all information for that customer.

TABLE 4-3 Example of Storing All Sales Data for S&S in One Table

Sales

Sales Invoice #	Date	Salesperson	Customer #	Invoice Total	Customer Name	Street	City	State	Item #	Quantity	Description	Unit Price	Extended Amount
101	10/15/2018	J. Buck	151	1447	D. Ainge	123 Lotus Lane	Phoenix	AZ	10	2	Television	499	998
101	10/15/2018	J. Buck	151	1447	D. Ainge	123 Lotus Lane	Phoenix	AZ	50	1	Microwave	449	449
102	10/15/2018	S. Knight	152	4394	G. Kite	40 Quatro Road	Mesa	AZ	10	1	Television	499	499
102	10/15/2018	S. Knight	152	4394	G. Kite	40 Quatro Road	Mesa	AZ	20	3	Freezer	699	2097
102	10/15/2018	S. Knight	152	4394	G. Kite	40 Quatro Road	Mesa	AZ	30	2	Refrigerator	899	1798
103	10/15/2018	S. Knight	151	898	D. Ainge	123 Lotus Lane	Phoenix	AZ	50	2	Microwave	449	898
104	10/15/2018	J. Buck	152	789	G. Kite	40 Quatro Road	Mesa	AZ	40	1	Range	789	789
105	11/14/2018	J. Buck	153	3994	F. Roberts	401 Excel Way	Chandler	AZ	10	3	Television	499	1497
105	11/14/2018	J. Buck	153	3994	F. Roberts	401 Excel Way	Chandler	AZ	20	1	Freezer	699	699
105	11/14/2018	J. Buck	153	3994	F. Roberts	401 Excel Way	Chandler	AZ	30	2	Refrigerator	899	1796
0				0					0	0		0	0

Record: 11 of 11 No Filter Search

TABLE 4-4 Example of Storing S&S Sales Data by Adding Columns for Each Additional Item Sold

Sales

Sales Invoice #	Columns 2-9	Item #	Quantity	Description	Unit Price	Extended Amount	Item #2	Quantity2
101	Same 8	10	2	Television	499	998	50	1
102	columns	10	1	Television	499	499	20	3
103	as in	50	2	Microwave	449	898		
104	Table 4-3	40	1	Range	789	789		
105	above	10	3	Television	499	1497	20	1
0		0	0		0	0	0	0

Record: 6 of 6 No Filter Search

2: Vary the Number of Columns. An alternative to Table 4-3 is to record sales invoice and customer data once and add additional columns to record each item sold. Table 4-4 illustrates this approach. Although this reduces data redundancy and eliminates some anomalies associated with Table 4-3, it has drawbacks. S&S would have to decide in advance how many item numbers to leave room for in each row (i.e., how many columns to put in the table; note in Table 4-4 that to store each additional item requires five additional columns—Item, Quantity, Description, Unit Price, and Extended Amount). If room is left for four items (20 columns), how would data about a sale involving eight items (40 columns) be stored? If room is left for eight items, however, there will be a great deal of wasted space, as is the case for sales invoices 103 and 104.

3: The Solution: A Set of Tables. The storage problems in Tables 4-3 and 4-4 are solved using a **relational database**. The set of tables in Table 4-5 represent a well-structured relational database.

relational database - A database built using the relational data model.

BASIC REQUIREMENTS OF A RELATIONAL DATABASE

We now turn to the guidelines used to develop a properly structured relational database.

1. ***Every column in a row must be single valued.*** In a relational database, there can only be one value per cell. At S&S, each sale can involve more than one item. On invoice 102, the customer bought a television, a freezer, and a refrigerator. If Item # were an attribute in the Sales table, it would have to take on three values (item numbers 10, 20, and 30). To solve this problem, a Sales-Inventory table was created that lists each item sold on an invoice. The third line in the Sales-Inventory table in Table 4-5 shows invoice 102 and item number 10 (television). The fourth line shows invoice 102 and item 20 (freezer). The fifth line shows invoice 102 and item 30 (refrigerator). This table repeats the invoice number as often as needed to show all the items purchased on a sales invoice.
2. ***Primary keys cannot be null.*** A primary key cannot uniquely identify a row in a table if it is null (blank). A nonnull primary key ensures that every row in a table represents something and that it can be identified. This is referred to as the **entity integrity rule**. In the Sales-Inventory table in Table 4-5, no single field uniquely identifies each row. However, the first two columns, taken together, do uniquely identify each row and constitute the primary key.
3. ***Foreign keys, if not null, must have values that correspond to the value of a primary key in another table.*** Foreign keys link rows in one table to rows in another table. In Table 4-5, Customer # can link each sales transaction with the customer who participated in that event only if the Sales table Customer # value corresponds to an actual customer number in the Customer table. This constraint, called the **referential integrity rule**, ensures database consistency. Foreign keys can contain null values. For example, when customers pay cash, Customer # in the sales table can be blank.
4. ***All nonkey attributes in a table must describe a characteristic of the object identified by the primary key.*** Most tables contain other attributes in addition to the primary and foreign keys. In the Customer table in Table 4-5, Customer # is the primary key, and customer name, street, city, and state are important facts that describe the customer.

entity integrity rule - A nonnull primary key ensures that every row in a table represents something and that it can be identified.

referential integrity rule - Foreign keys which link rows in one table to rows in another table must have values that correspond to the value of a primary key in another table.

TABLE 4-4 Continued

Description2	Unit Price2	Extended Amount2	Item #3	Quantity3	Description3	Unit Price3	Extended Amount3
Microwave	449	449					
Freezer	699	2097	30	2	Refrigerator	889	1798
Freezer	699	699	30	2	Refrigerator	899	1798
	0	0	0	0		0	0

No Filter | Search

These four constraints produce a well-structured (normalized) database in which data are consistent and data redundancy is minimized and controlled. In Table 4-5, having a table for each entity of interest avoids the anomaly problems discussed previously and minimizes redundancy. Redundancy is not eliminated, as certain items, such as Sales Invoice #, appear in more than one table when they are foreign keys. The referential integrity rule ensures that there are no update anomaly problems with the foreign keys.

When data about objects of interest are stored in separate database tables, it is easy to add new data by adding another row to the table. For example, adding a new customer is as simple as adding a new row to the Customer table. Thus, the tables depicted in Table 4-5 are free from insert anomalies.

Relational databases also simplify data deletion. Deleting sales invoice 105, the only sale to customer 153, does not erase all data about that customer, because it is stored in the Customer table. This avoids delete anomalies.

Another benefit of the schema shown in Table 4-5 is that space is used efficiently. The Sales-Inventory table contains a row for each item sold on each invoice. There are no blank rows, yet all sales data are recorded. In contrast, the schema in Table 4-4 results in much wasted space.

TWO APPROACHES TO DATABASE DESIGN

One way to design a relational database, called **normalization**, begins by assuming that everything is initially stored in one large table. Rules are then followed to decompose that initial table into a set of tables in what is called *third normal form (3NF)*, because they are free of update, insert, and delete anomalies. The details of the normalization process are found in the Appendix to this chapter.

normalization - Following relational database creation rules to design a relational database that is free from delete, insert, and update anomalies.

In an alternative design approach, called **semantic data modeling**, the designer uses knowledge of business processes and information needs to create a diagram that shows what to include in the database. This diagram is used to create a set of relational tables that are already in 3NF.

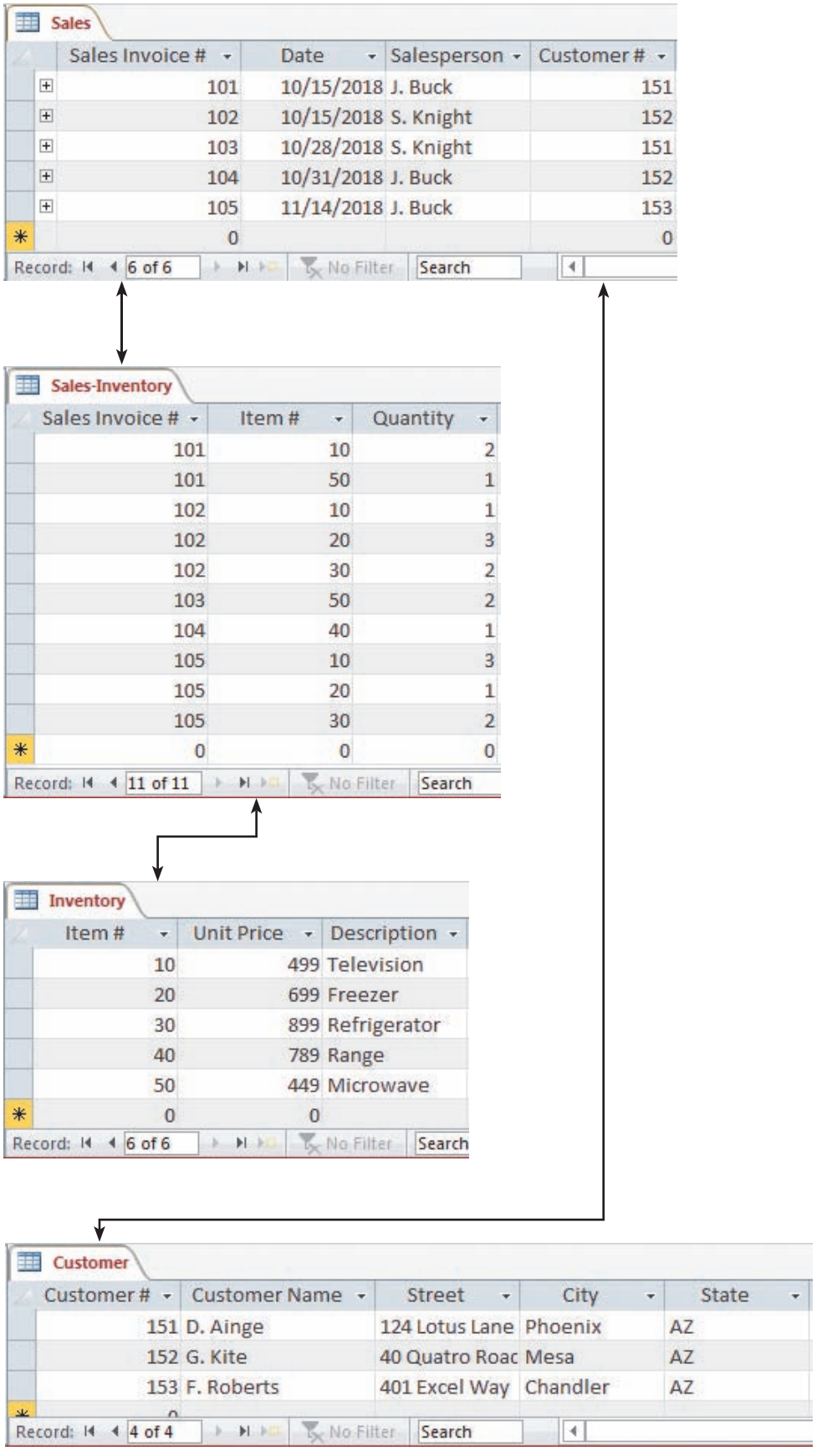
semantic data modeling - Using knowledge of business processes and information needs to create a diagram that shows what to include in a fully normalized database (in 3NF).

Semantic data modeling has significant advantages. First, using a system designer's knowledge of business processes facilitates the efficient design of transaction processing databases. Second, the graphical model explicitly represents the organization's business processes and policies and, by facilitating communication with system users, helps ensure that the new system meets users' actual needs. Semantic data modeling is discussed in Chapters 17 through 19. Chapter 17 introduces two semantic data modeling tools, entity-relationship diagramming and REA modeling, used to design transaction processing databases. Chapter 18 discusses how to implement an REA data model in a relational database. Chapter 19 discusses special topics in REA modeling.

CREATING RELATIONAL DATABASE QUERIES

To retrieve stored data, users query databases.This section of the chapter shows you how to query databases using Microsoft Access. If you want to follow along by creating the queries illustrated in this section, download the S&S In-Chapter Database from the text's website. When you open the database and select the Create ribbon, the ribbon in the top half of Table 4-6 appears. There are two ways to query the database: create a query in Design view

TABLE 4-5 Set of Relational Tables for Storing S&S Sales Data



Sales

Sales Invoice #	Date	Salesperson	Customer #
101	10/15/2018	J. Buck	151
102	10/15/2018	S. Knight	152
103	10/28/2018	S. Knight	151
104	10/31/2018	J. Buck	152
105	11/14/2018	J. Buck	153
0			0

Record: 6 of 6 No Filter Search

Sales-Inventory

Sales Invoice #	Item #	Quantity
101	10	2
101	50	1
102	10	1
102	20	3
102	30	2
103	50	2
104	40	1
105	10	3
105	20	1
105	30	2
0	0	0

Record: 11 of 11 No Filter Search

Inventory

Item #	Unit Price	Description
10	499	Television
20	699	Freezer
30	899	Refrigerator
40	789	Range
50	449	Microwave
0	0	

Record: 6 of 6 No Filter Search

Customer

Customer #	Customer Name	Street	City	State
151	D. Ainge	124 Lotus Lane	Phoenix	AZ
152	G. Kite	40 Quatro Roac	Mesa	AZ
153	F. Roberts	401 Excel Way	Chandler	AZ

Record: 4 of 4 No Filter Search

(the "Query Design" button) or use the wizard (the "Query Wizard" button). These options are outlined in blue in the top half of Table 4-6. The Design view is used in all of the query examples shown. Clicking on the "Query Design" button produces the Show Table window shown in Table 4-6. The user selects the tables needed to produce the desired information; if more tables than necessary are selected, the query may not run properly.

We will use the tables in Table 4-5 to walk through the steps needed to create and run five queries. This will not make you an expert in querying an Access database, but it will show you how to produce useful information.

QUERY 1

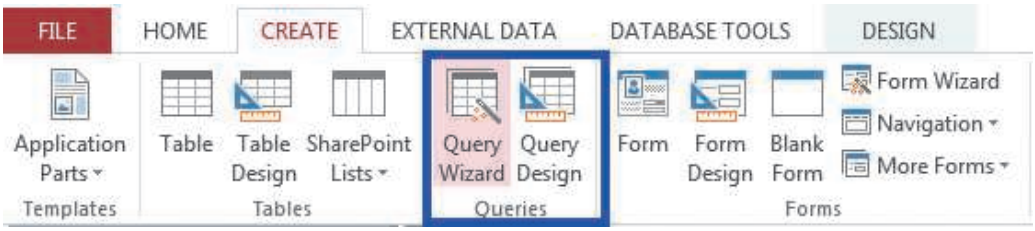
Query 1 answers two questions: What are the invoice numbers of all sales made to D. Ainge, and who was the salesperson for each sale?

The Sales and Customer tables contain the three items needed to answer this query: Sales Invoice #, Salesperson, and Customer Name. Click the "Query Design" button (see Table 4-6), and select the Sales and Customer tables by double-clicking on their names or by single-clicking on the name and clicking the "Add" button. The selected tables appear as shown in Table 4-7. A line between the two tables connects the Customer # fields (the Customer table primary key and the Sales table foreign key). Click on Close to make the Show Table window disappear.

To populate the bottom half of the screen shown in Table 4-7, double-click on Sales Invoice #, Salesperson, and Customer Name or drag and drop them into the Field row. Access automatically checks the box in the Show line, so the item will be shown when the query is run.

Since we only want sales to D. Ainge, enter that in the criteria line of the Customer Name column. Access will automatically put question marks around the criteria. Run the query by clicking on the red ! (exclamation) mark on the Query Tools Design ribbon. Table 4-8 shows the tables used, the relationship of the primary and foreign keys between tables, and the query

TABLE 4-6 Creating Queries in the Microsoft Access Database



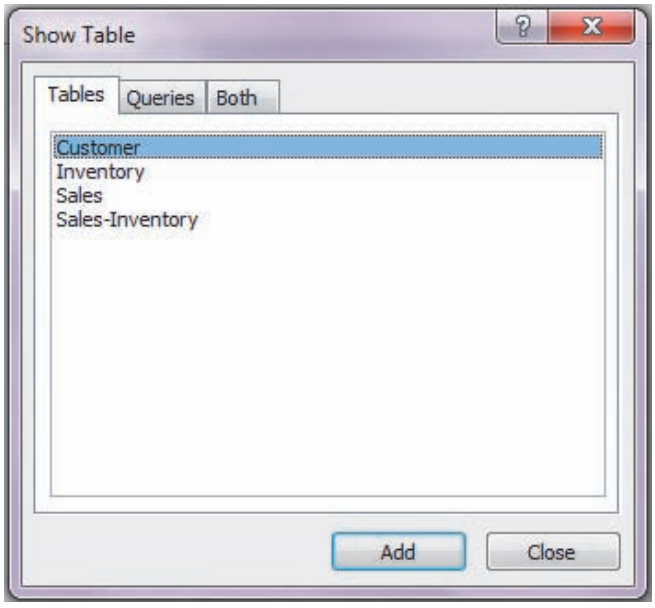


TABLE 4-7 Completed Query 1

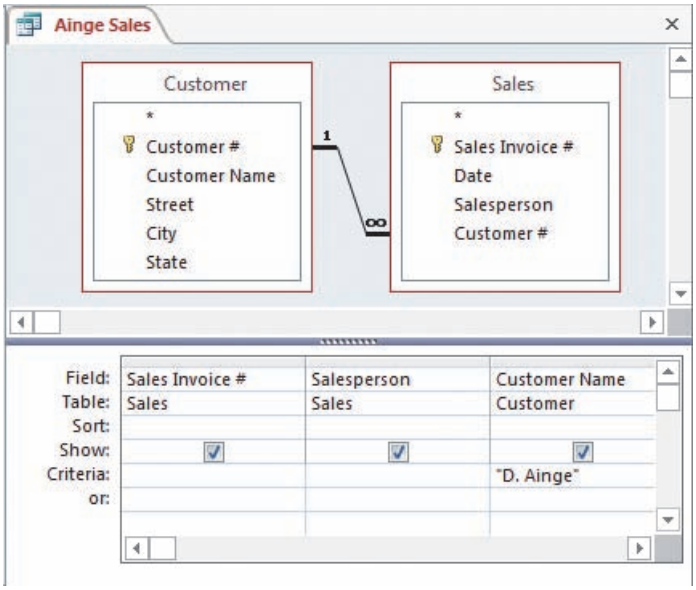
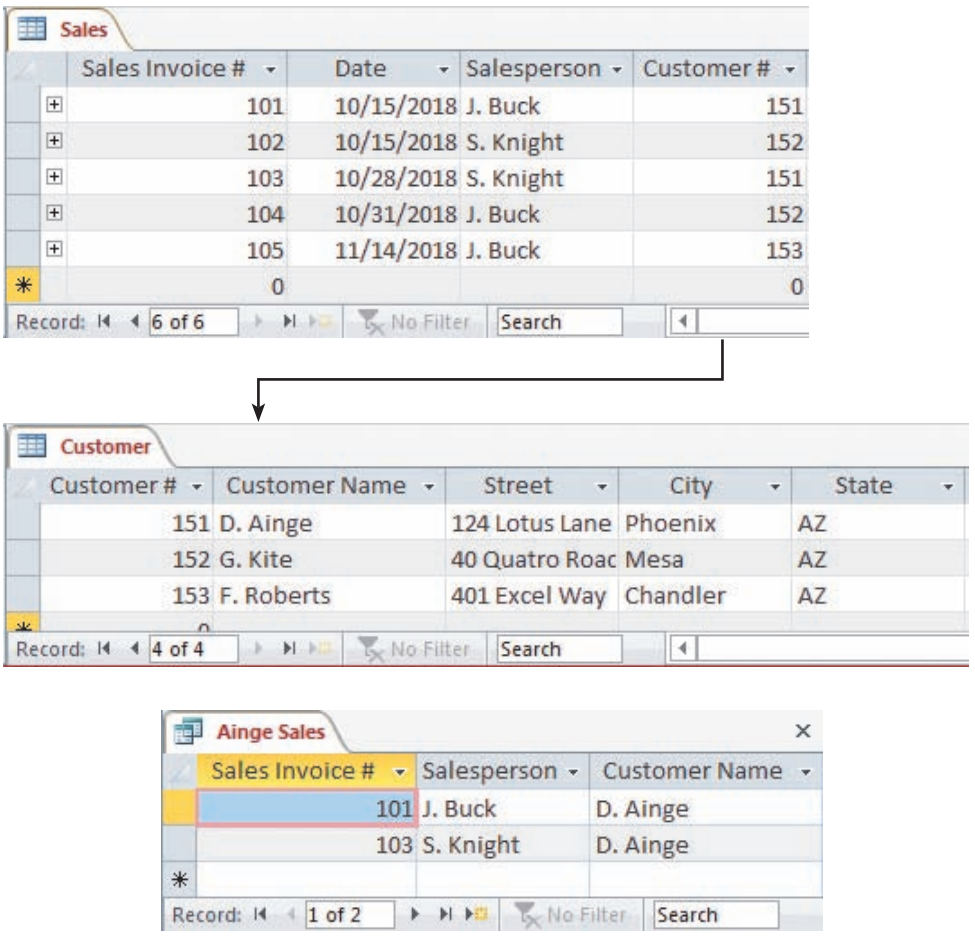


TABLE 4-8 Query 1 Relationships and Query Answer



answer. The query answer does not automatically have the title "Ainge Sales." To assign the query a name, save it by selecting File from the Access menu, then Save Object As, and then enter "Ainge Sales" in the first line of the Save As window, making sure the Object select box is set to "Query," and then clicking OK. When the query is rerun, the title shown in Table 4-8 will appear.

QUERY 2

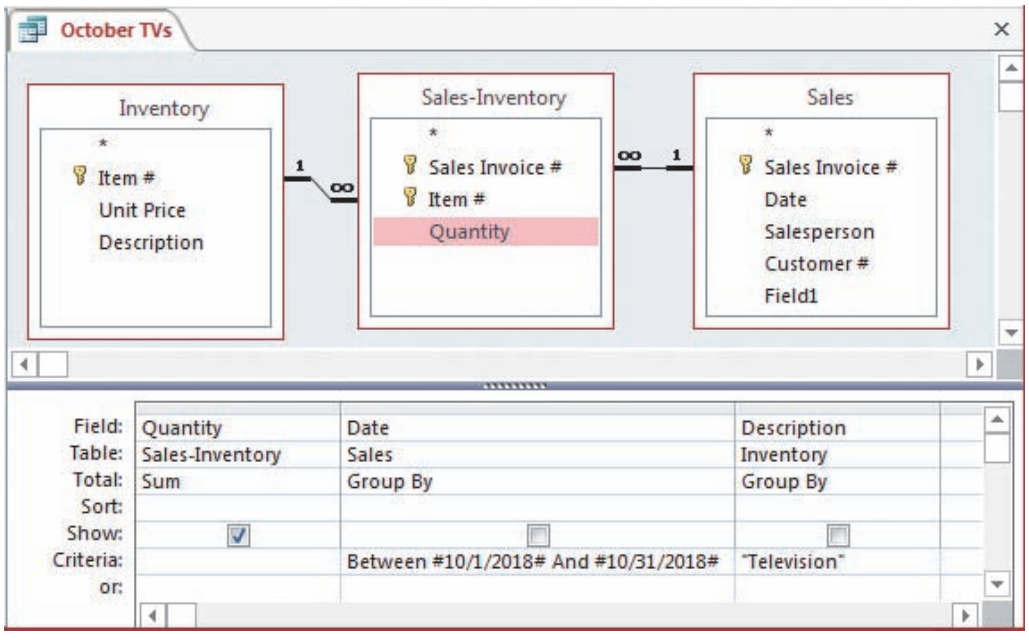
Query 2 answers this question: How many televisions were sold in October?

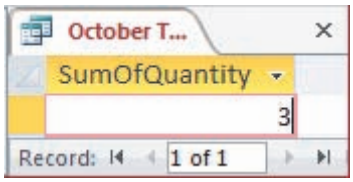
The Sales, Inventory, and Sales-Inventory tables contain the three items needed to answer this query: Date, Inventory Description, and Quantity. Click on the "Query Design" button in the Create ribbon and select the three tables and the three fields, as shown in Table 4-9. Since we want the quantity of televisions sold in October, we add the criteria "Between #10/1/2018# And #10/31/2018#" to the Date field and "Television" to the Description field.

To specify criteria, Access uses operators such as "And," "Or," and "Between." An "And" operator returns the data that meets *all* the criteria linked by "And" operators. The "Between" operator selects all the data in October of 2018; that is, between and including the first and last days of the month. The "Or" operator returns data that meets at least one of the criteria linked by the "Or" operators. The "#" symbol tells Access to look for a date rather than some other type of text.

Since we are only looking for total television sales in October, we don't need to show the Date or Description. Uncheck the "Show" box in the Date and Description columns. To generate total sales, click the "Totals" button in the Show/Hide portion of the Query Tools Design ribbon. A new row, labeled Total, appears (compare Tables 4-7 and 4-9). Click on the Totals line in the Quantity column, click on the down-arrow symbol, and select Sum from the drop-down menu that appears. The remaining two fields in the Total line will stay as Group By. Running the query in Table 4-9 produces the answer shown.

TABLE 4-9 Completed Query 2 and Answer





QUERY 3

Query 3 answers this question: What are the names and addresses of customers buying televisions in October?

This query needs these fields: Date (to select October sales), Description (to select televisions), and Customer Name, Street, City, and State (the information requested). All four tables are used because the Sales-Inventory table is used to move between the Sales and Inventory tables. The query uses the same criteria as Query 2. The Date and Description data do not need to be displayed, so the boxes in the Show line are unchecked. Running the query produces the answer shown in Table 4-10.

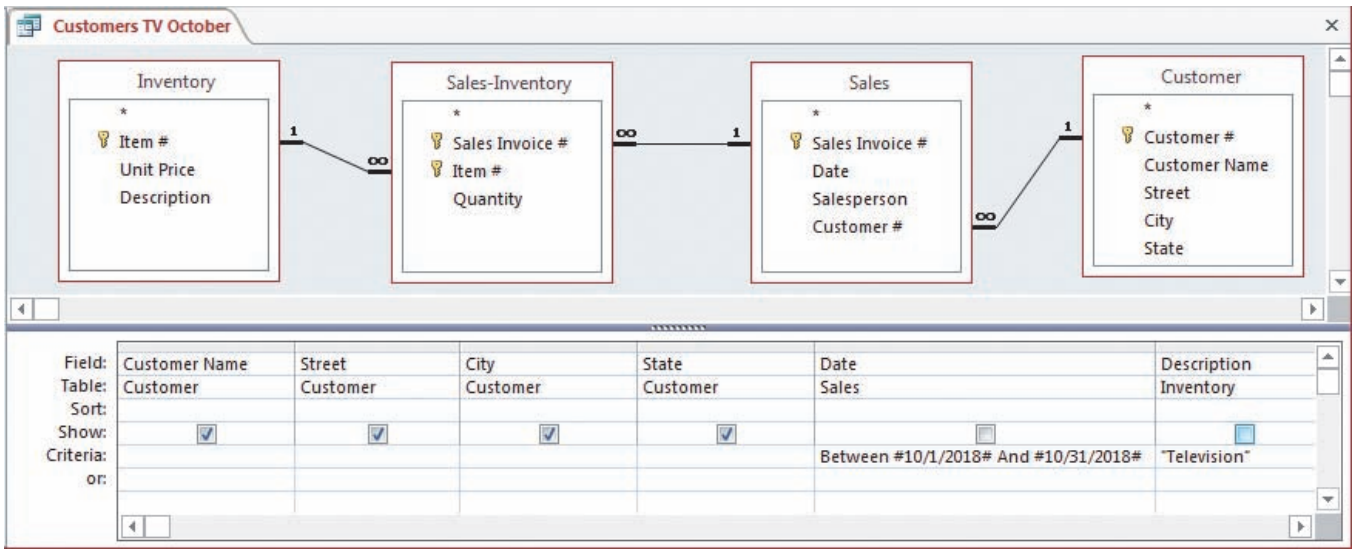
QUERY 4

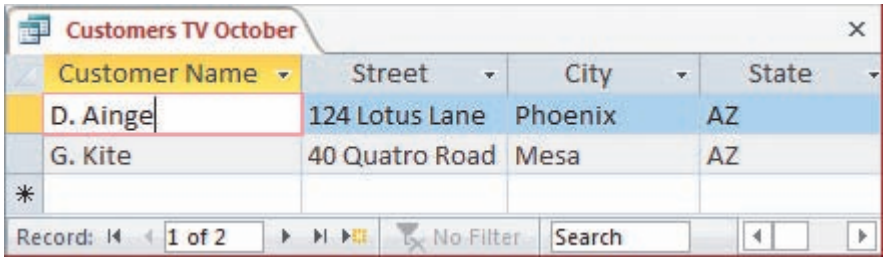
Query 4 answers this question: What are the sales invoice numbers, dates, and invoice totals for October sales, arranged in descending order by sale amount?

Since the database does not contain an Invoice Total column, it is calculated by multiplying the unit price by the quantity for each sale. For example, we would calculate the total sales price of each item sold by multiplying the Quantity field in the Sales-Inventory table by the Unit Price field in the Inventory table. The Sales-Inventory table in Table 4-5 shows that three items were sold on Sales Invoice 102. For item 20, we multiply the quantity (3) by the Unit Price (699), producing 2,097. The same calculation is made for items 10 and 30. Finally, we sum the three item totals to get an invoice total.

Query 4 requires the Sales table (Date, Sales Invoice #), Sales-Inventory table (Quantity), and the Inventory table (Unit Price). However, some fields will not appear in columns on the Select Query window. As shown in Table 4-11, three columns are displayed: Sales Invoice #, Date, and Invoice Total, which we will calculate. The other fields, Quantity and Unit Price, are used in the Invoice Total calculations.

TABLE 4-10 Completed Query 3 and Answer

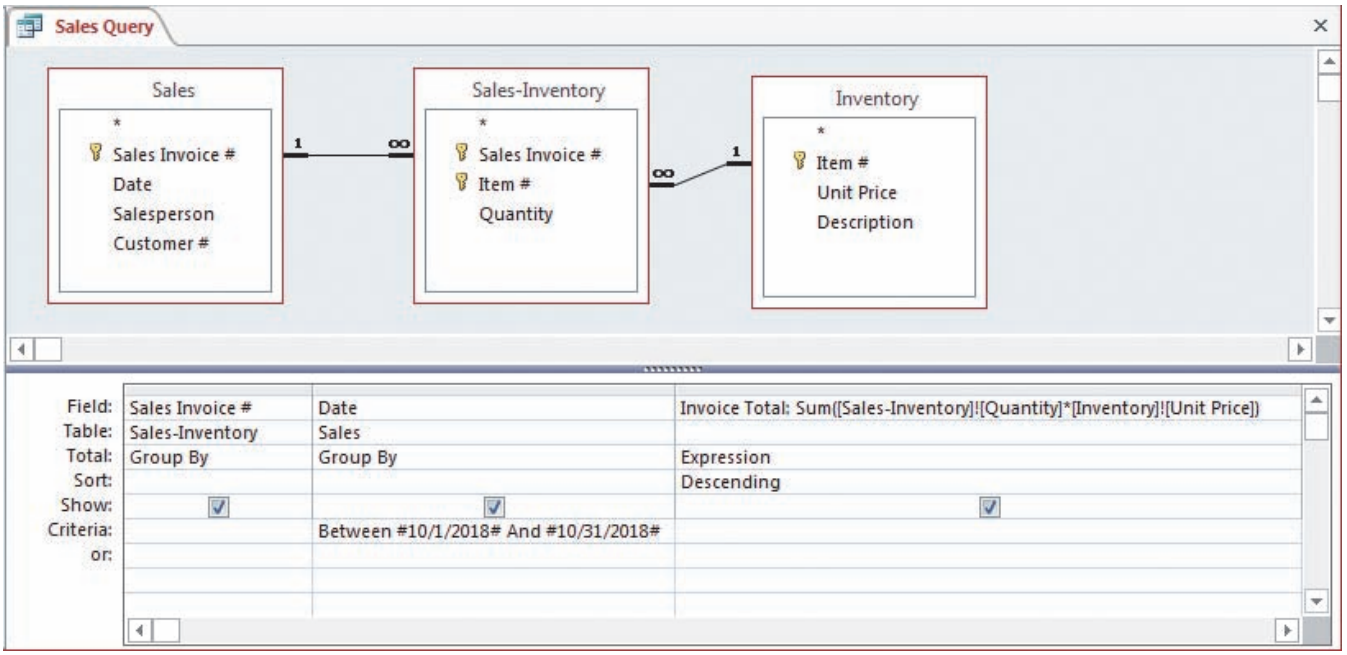




To calculate Invoice Total, type "Invoice Total:" in the first blank Field cell, right-click in the cell, and select Build from the pop-up menu that appears. An Expression Builder window (see Table 4-12) appears, where the formula to calculate the Invoice Total is entered by typing "Sum( )". Between the parentheses, click on the + sign in front of the S&S In-Chapter Database folder in the Expressions Elements box. Then clicking on the + sign in the Tables folder causes the four database tables to appear. Click on the Sales-Inventory table, and the fields in the Sales-Inventory table appear. Double-click on Quantity to put this field in the expression. Note in Table 4-12 that the expression shows the table name and the field name, separated by an exclamation point. To multiply Quantity by Unit Price, type * (the multiplication symbol) and select the Inventory table and the Unit Price field. The formula is now complete, and the screen will appear as shown. To enter the expression into the Select Query window, click on OK.

To complete Query 4, click the "Totals" button in the Query Tools Design ribbon. Click on the down arrow in the Total row of the Invoice Totals column, and select Expression from the pop-up menu. This tells Access to calculate the indicated expression for all items with the same sales invoice number and date. In the same column, click on the down arrow in the Sort row, and select Descending so that the answer is shown in descending Invoice Total order. In the criteria section of the Date column, use the "Between" operator to specify the month of October. Running Query 4 produces the answer shown in Table 4-11.

TABLE 4-11 Completed Query 4 and Answer



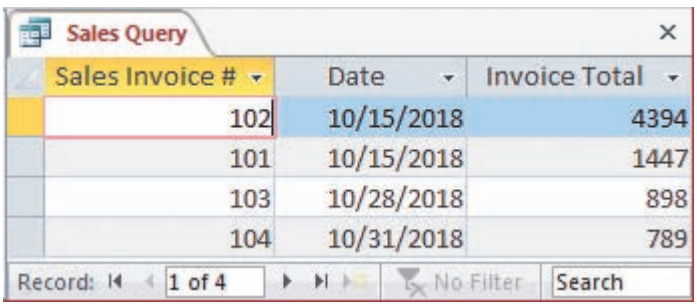
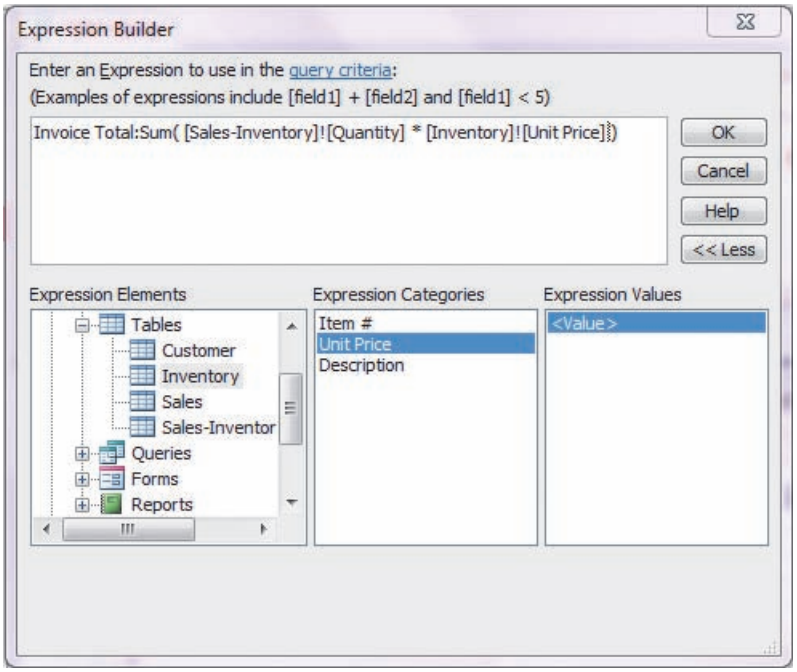


TABLE 4-12 Expression Builder for Query 4



QUERY 5

Query 5 will answer this question: What are total sales by salesperson?

This query is similar to Query 4, except that we total invoices by salesperson rather than by invoice number. We are also not confining our query to the month of October. Try coming up with the query by yourself. The completed query and the answer are shown in Table 4-13.

DATABASE SYSTEMS AND THE FUTURE OF ACCOUNTING

Database systems have the potential to alter external reporting significantly. Considerable time and effort are currently invested in defining how companies should summarize and report accounting information to external users. In the future, companies may make a copy of the company's financial database available to external users in lieu of the traditional financial statements. Users would be free to analyze the raw data however they see fit.

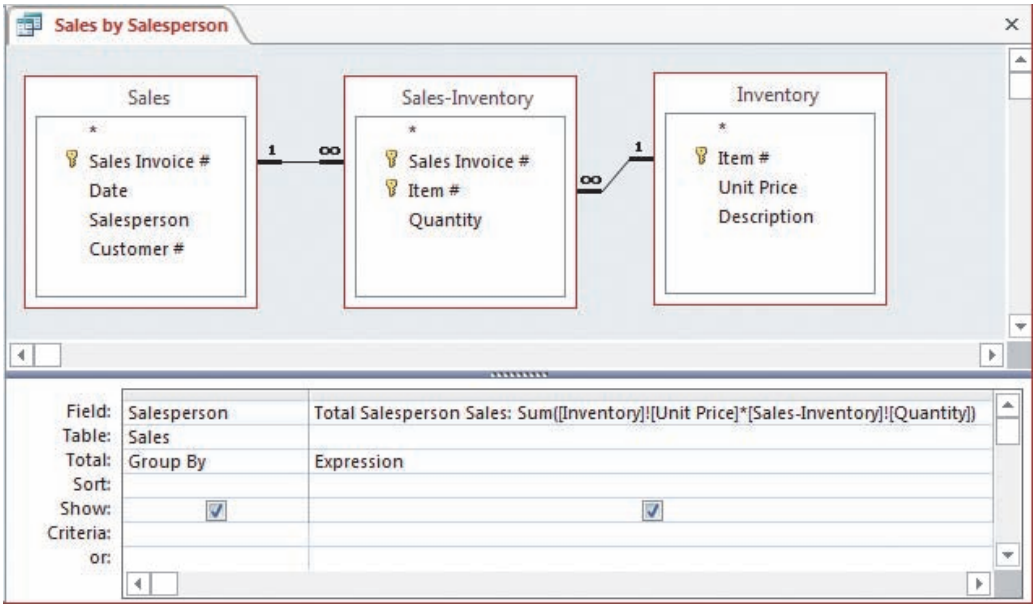
A significant advantage of database systems is the ability to create ad hoc queries to provide the information needed for decision making. No longer is financial information available only in predefined formats and at specified times. Instead, powerful and easy-to-use relational database query languages can find and prepare the information management needs whenever they want it.

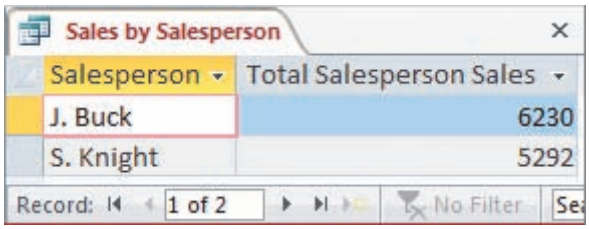
Relational DBMSs can also accommodate multiple views of the same underlying phenomenon. For example, tables storing information about assets can include historical costs as well as current replacement costs and market values. Thus, managers will no longer be forced to look at data in ways predefined by accountants.

Finally, relational DBMSs are capable of integrating financial and operational data. For example, customer satisfaction data can be stored in the database, giving managers a richer set of data for decision making.

Relational DBMSs have the potential to increase the use and value of accounting information. Accountants must understand database systems so they can help design and use the

TABLE 4-13 Completed Query 5 and Answer





AISs of the future. Such participation is important for ensuring that adequate controls are included in those systems to safeguard the data and ensure the reliability of the information produced.

Summary and Case Conclusion

Ashton prepared a report for Scott and Susan summarizing what he knew about databases. He explained that a database management system (DBMS), the software that makes a database system work, is based on a logical data model that shows how users perceive the way the data is stored. Many DBMSs are based on the relational data model that represents data as being stored in tables. Every row in a relational table has only one data value in each column. Neither row nor column position is significant. These properties support the use of simple, yet powerful, query languages for interacting with the database. Users only need to specify the data they want and do not need to be concerned with how the data are retrieved. The DBMS functions as an intermediary between the user and the database, thereby hiding the complex addressing schemes actually used to retrieve and update the information stored in the database.

After reading Ashton's report, Scott and Susan agreed that it was time to upgrade S&S's AIS and to hire a consulting firm to help select and install the new system. They asked Ashton to oversee the design process to ensure that the new system meets their needs.

KEY TERMS

database 85
database management system (DBMS) 86
database system 86
database administrator (DBA) 86
data warehouse 86
business intelligence 86
online analytical processing (OLAP) 86
data mining 86
record layout 88
logical view 88
physical view 88
schema 88
conceptual-level schema 88
external-level schema 88
subschema 88
internal-level schema 88
data dictionary 90
data definition language (DDL) 90
data manipulation language (DML) 90
data query language (DQL) 90
report writer 90
data model 90
relational data model 90
tuple 90
primary key 90
foreign key 90
update anomaly 92
insert anomaly 92
delete anomaly 92
relational database 94
entity integrity rule 94
referential integrity rule 94
normalization 95
semantic data modeling 95

AIS in Action

CHAPTER QUIZ

1. The relational data model portrays data as being stored in _____.
a. hierarchies
b. tables
c. objects
d. files

2. How a user conceptually organizes and understands data is referred to as the _____.
a. physical view
b. logical view
c. data model view
d. data organization view

3. What is each row in a relational database table called?
a. relation
b. attribute
c. anomaly
d. tuple

4. Which of the following is an individual user's view of the database?
a. conceptual-level schema
b. external-level schema
c. internal-level schema
d. logical-level schema

5. Which of the following would managers most likely use to retrieve information about sales during the month of October?
a. DML
b. DSL
c. DDL
d. DQL

6. Which of the following attributes would most likely be a primary key?
a. supplier name
b. supplier number
c. supplier zip code
d. supplier account balance

7. Which of the following is a software program that runs a database system?
a. DQL
b. DBMS
c. DML
d. DDL

8. The constraint that all primary keys must have nonnull data values is referred to as which of the following?
a. referential integrity rule
b. entity integrity rule
c. normalization rule
d. relational data model rule

9. The constraint that all foreign keys must have either null values or the value of a primary key in another table is referred to as which of the following?
a. referential integrity rule
b. entity integrity rule
c. foreign key value rule
d. null value rule

10. Which of the following attributes in the Cash Receipts table (representing payments received from customers) would most likely be a foreign key?
a. cash receipt number
b. customer check number
c. customer number
d. cash receipt date

COMPREHENSIVE PROBLEM

The Butler Financing Company runs a mortgage brokerage business that matches lenders and borrowers. Table 4-14 lists some of the data that Butler maintains on its borrowers and lenders. The data are stored in a spreadsheet that must be manually updated for each new borrower, lender, or mortgage. This updating is error-prone, which has harmed the business. In addition, the spreadsheet has to be sorted in many different ways to retrieve the necessary data.

TABLE 4-14 Butler Financing Company Spreadsheet

BORROWER NUMBER	LAST NAME	FIRST NAME	CURRENT ADDRESS	REQUESTED MORTGAGE AMOUNT	LENDER NUMBER	LENDER NAME	LENDER OFFICE ADDRESS	PROPERTY APPRAISER NUMBER	PROPERTY APPRAISER NAME
450	Adams	Jennifer	450 Peachtree Rd.	$245,000	13	Excel Mortgage	6890 Sheridan Dr.	8	Advent Appraisers
451	Adamson	David	500 Loop Highway	$124,688	13	Excel Mortgage	6890 Sheridan Dr.	9	Independent Appraisal Service
452	Bronson	Paul	312 Mountain View Dr.	$345,000	14	CCY	28 Buckhead Way	10	Jones Property Appraisers
453	Brown	Marietta	310 Loop Highway	$57,090	15	Advantage Lenders	3345 Lake Shore Dr.	10	Jones Property Appraisers
454	Charles	Kenneth	3 Commons Blvd.	$34,000	16	Capital Savings	8890 Coral Blvd.	8	Advent Appraisers
455	Coulter	Tracey	1367 Peachtree Rd.	$216,505	13	Excel Mortgage	6890 Sheridan Dr.	8	Advent Appraisers
456	Foster	Harold	678 Loop Highway	$117,090	12	National Mortgage	750 16 St.	9	Independent Appraisal Service
457	Frank	Vernon	210 Bicayne Blvd.	$89,000	12	National Mortgage	750 16 St.	10	Jones Property Appraisers
458	Holmes	Heather	1121 Bicayne Blvd.	$459,010	16	Capital Savings	8890 Coral Blvd.	10	Jones Property Appraisers
459	Johanson	Sandy	817 Mountain View Dr.	$67,900	15	Advantage Lenders	3345 Lake Shore Dr.	9	Independent Appraisal Service
460	Johnson	James	985 Loop Highway	$12,000	12	National Mortgage	750 16 St.	10	Jones Property Appraisers
461	Jones	Holly	1650 Washington Blvd.	$67,890	15	Advantage Lenders	3345 Lake Shore Dr.	9	Independent Appraisal Service

Create a database from Butler's spreadsheet that does not have any of the data anomalies explained in this chapter. To test the database, prepare a query to show which borrowers (both borrower number and name) took out loans from Excel Mortgage and who the appraiser was for each loan.

DISCUSSION QUESTIONS

4.1 Contrast the logical and the physical views of data, and discuss why separate views are necessary in database applications. Describe which perspective is most useful for each of the following employees: a programmer, a manager, and an internal auditor. How will understanding logical data structures assist you when designing and using database systems?

4.2 The relational data model represents data as being stored in tables. Spreadsheets are another tool that accountants use to employ a tabular representation of data. What are some similarities and differences in the way these tools use tables? How might an accountant's familiarity with the tabular representation of spreadsheets facilitate or hinder learning how to use a relational DBMS?

4.3 Some people believe database technology may eliminate the need for double-entry accounting. This creates three possibilities: (1) the double-entry model will be abandoned; (2) the double-entry model will not be used directly, but an external-level schema based on the double-entry model will be defined for accountants' use; or (3) the double-entry model will be retained in database systems. Which alternative do you think is most likely to occur? Why?

4.4 Relational DBMS query languages provide easy access to information about the organization's activities. Does this mean that online, real-time processing should be used for all transactions? Does an organization need real-time financial reports? Why, or why not?

4.5 Why is it so important to have good data?

4.6 What is a data dictionary, what does it contain, and how is it used?

4.7 Compare and contrast the file-oriented approach and the database approach. Explain the main advantages of database systems.

PROBLEMS

4.1 The following data elements comprise the conceptual-level schema for a database:

billing address
cost
credit limit
customer name
customer number
description
invoice number
item number
price
quantity on hand
quantity sold
shipping address
terms

REQUIRED

a. Identify three potential users and design a subschema for each. Justify your design by explaining why each user needs access to the subschema data elements.
b. Use Microsoft Access or some other relational database product to create the schema tables. Specify the primary key(s), foreign key(s), and other data for each table. Test your model by entering sample data in each table.

4.2 Most DBMS packages contain data definition, data manipulation, and data query languages. For each of the following, indicate which language would be used and why.

a. A database administrator defines the logical structure of the database.
b. The controller requests a cost accounting report containing a list of all employees being paid for more than 10 hours of overtime in a given week.
c. A programmer develops a program to update the fixed-assets records stored in the database.
d. The human resources manager requests a report noting all employees who are retiring within five years.
e. The inventory serial number field is extended in the inventory records to allow for recognition of additional inventory items with serial numbers containing more than 10 digits.
f. A user develops a program to print out all purchases made during the past two weeks.
g. An additional field is added to the fixed-asset records to record the estimated salvage value of each asset.

4.3 Ashton wants to store the following data about S&S's purchases of inventory:

item number
date of purchase
vendor number
vendor address
vendor name
purchase price
quantity purchased
employee number
employee name
purchase order number
description
quantity on hand
extended amount
total amount of purchase

REQUIRED

a. Design a set of relational tables to store this data. Do all of the data items need to be stored in a table? If not, which ones do not need to be stored, and why do they not need to be stored?
b. Identify the primary key for each table.
c. Identify the foreign keys needed in the tables to implement referential integrity.
d. Implement your tables using any relational database product to which you have access.
e. Test your specification by entering sample data in each table.
f. Create a few queries to retrieve or analyze the data you stored.

4.4 Retrieve the S&S In-Chapter Database (in Microsoft Access format) from the text's website (or create the tables in Table 4-5 in a relational DBMS product). Write queries to answer the following questions. *Note*: For some questions, you may have to create two queries—one to calculate an Invoice Total and the second to answer the question asked.

a. How many different kinds of inventory items does S&S sell?
b. How many sales were made during October?

TABLE 4-15 Problem 4.5 Tables

Customer

Customer #	Customer Name	City	State	Credit Limit
1000	Smith	Phoenix	AZ	2500
1001	Jones	St. Louis	MO	1500
1002	Jeffries	Atlanta	GA	4000
1003	Gilkey	Phoenix	AZ	5000
1004	Lankford	Phoenix	AZ	2000
1005	Zeile	Chicago	IL	2000
1006	Pagnozzi	Salt Lake City	UT	3000
1007	Arocha	Chicago	IL	1000
0				0

Record: 9 of 9 No Filter Search

Inventory

Item #	Description	Unit Cost	Unit Price	Quantity on Hand
1010	Blender	$14.00	$29.95	200
1015	Toaster	$12.00	$19.95	300
1020	Mixer	$23.00	$33.95	250
1025	Television	$499.00	$699.95	74
1030	Freezer	$799.00	$999.95	32
1035	Refrigerator	$699.00	$849.95	25
1040	Radio	$45.00	$79.95	100
1045	Clock	$79.00	$99.95	300
0		$0.00	$0.00	0

Record: 9 of 9 No Filter Search

Sales

Invoice Number	Date	Salesperson	Customer Number	Amount
101	10/3/2018	Wilson	1000	$1,549.90
102	10/5/2018	Mahomet	1003	$299.95
103	10/5/2018	Jackson	1002	$1,449.80
104	10/15/2018	Drezen	1000	$799.90
105	10/15/2018	Martinez	1005	$849.95
106	10/16/2018	Martinez	1007	$99.95
107	10/29/2018	Mahomet	1002	$2,209.70
108	11/3/2018	Martinez	1000	$779.90
0			0	$0.00

Record: 9 of 9 No Filter Search

Sales-Inventory

Invoice Number	Item Number	Quantity	Extension
101	1025	1	$699.95
101	1035	1	$849.95
102	1045	3	$299.85
103	1010	1	$29.95
103	1015	1	$19.95
103	1025	2	$1,399.90
104	1025	1	$699.95
104	1045	1	$99.95
105	1035	1	$849.95
106	1045	1	$99.95
107	1030	1	$999.95
107	1035	1	$849.95
107	1040	2	$159.90
107	1045	2	$199.90
108	1025	1	$699.95
108	1045	1	$99.95
0	0	0	$0.00

Record: 17 of 17 No Filter Search

c. What were total sales in October?
d. What was the average amount of a sales transaction?
e. Which salesperson made the largest sale?
f. How many units of each product were sold?
g. Which product was sold most frequently?

4.5 Enter the tables in Table 4-15 into a relational DBMS package. Write queries to answer the following questions. *Note*: For some questions, you may have to create two queries—one to calculate a total and the second to answer the question asked.

a. Which customers (show their names) made purchases from Martinez?
b. Who has the largest credit limit?
c. How many sales were made in October?
d. What were the item numbers, price, and quantity of each item sold on invoice number 103?
e. How much did each salesperson sell?
f. How many customers live in Arizona?
g. How much credit does each customer still have available?

h. How much of each item was sold? (Include the description of each item in your answer.)
i. Which customers still have more than $1,000 in available credit?
j. For which items are there at least 100 units on hand?

4.6 The BusyB Company wants to store data about its employee skills. Each employee may possess one or more specific skills, and several employees may have the same skill. Include the following facts in the database:

date hired
date of birth

TABLE 4-16 Database That Needs To Be Extended

Inventory

Item Number	Description	Quantity on Hand	List Price
10573	19" Monitor	13	$495.00
10574	21" Monitor	8	$949.00
10622	Laser Printer	22	$395.00
10623	Color Laser Prir	5	$699.00
10624	Multi-function	12	$799.00
0		0	$0.00

Record: 6 of 6 No Filter Search

Customer

Customer Number	Name	Street	City	State	Zip Code	Credit Limit	Account Balance
11255	G. Hwang	2993 Main	Mesa	AZ	85281	$4,000.00	$875.00
12971	J. Jackson	466 W. Oak	Tempe	AZ	85286	$5,000.00	$2,588.00
13629	P. Szabo	246 E. Palm	Mesa	AZ	85281	$6,000.00	$3,955.00
15637	S. Martinez	2866 Spring	Tempe	AZ	85287	$5,000.00	$250.00
18229	B. Adams	1744 Apache	Tempe	AZ	85287	$3,000.00	$1,675.00
0					0	$0.00	$0.00

Record: 6 of 6 No Filter Search

Sales

Invoice Number	Date	Salesperson	Customer #	Amount
10001	9/8/2018	25	15637	$399.00
10002	9/10/2018	22	12971	$1,748.00
10003	9/25/2018	24	13629	$1,185.00
10004	10/2/2018	25	11255	$399.00
10005	10/11/2018	22	15637	$1,098.00
10006	10/25/2018	25	18229	$990.00
0		0	0	$0.00

Record: 7 of 7 No Filter Search

Sales-Inventory

Invoice Number	Item Number	Quantity	Actual Unit Price
10001	10573	1	$495.00
10002	10574	1	$949.00
10002	10624	1	$799.00
10003	10622	3	$395.00
10004	10573	1	$495.00
10005	10573	1	$495.00
10005	10623	1	$699.00
10006	10573	2	$495.00
0	0	0	$0.00

Record: 9 of 9 No Filter Search

date skill acquired
employee name
employee number
pay rate
skill name
skill number
supervisor

REQUIRED

a. Design a set of relational tables to store these data.
b. Identify the primary key for each table, and identify any needed foreign keys.
c. Implement your schema using any relational DBMS. Specify primary and foreign keys, and enforce referential integrity. Demonstrate the soundness of your design by entering sample data in each table.

4.7 You want to extend the schema shown in Table 4-16 to include information about customer payments. Some customers make installment payments on each invoice. Others write a check to pay for several different invoices. You want to store the following information:

amount applied to a specific invoice
cash receipt number
customer name
customer number
date of receipt
employee processing payment
invoice payment applies to
total amount received

REQUIRED

a. Modify the set of tables in Table 4-16 to store this additional data.
b. Identify the primary key for each new table you create.
c. Implement your schema using any relational DBMS package. Indicate which attributes are primary and foreign keys, and enter sample data in each table you create.

4.8 Create relational tables that solve the update, insert, and delete anomalies in Table 4-17.

TABLE 4-17 Invoice Table

INVOICE #	DATE	ORDER DATE	CUSTOMER ID	CUSTOMER NAME	ITEM #	DESCRIPTION	QUANTITY
52	6-19-2018	5-25-2018	201	Johnson	103	Trek 9000	5
52	6-19-2018	5-25-2018	201	Johnson	122	Nimbus 4000	8
52	6-19-2018	5-25-2018	201	Johnson	10	Izzod 3000	11
52	6-19-2018	5-25-2018	201	Johnson	71	LD Trainer	12
57	6-20-2018	6-01-2018	305	Henry	535	TR Standard	18
57	6-20-2018	6-01-2018	305	Henry	115	NT 2000	15
57	6-20-2018	6-01-2018	305	Henry	122	Nimbus 4000	5

4.9 Create relational tables that solve the update, insert, and delete anomalies in Table 4-18.

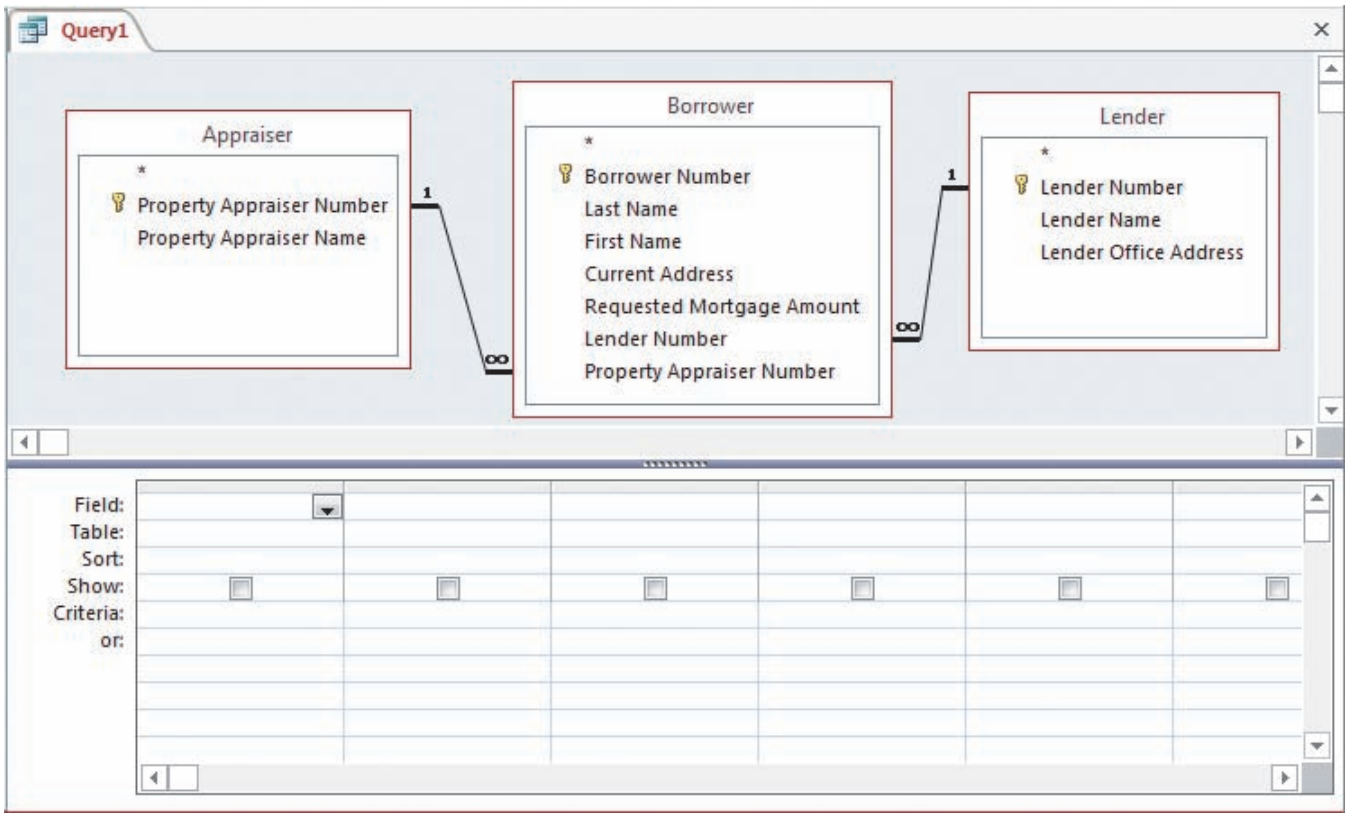
TABLE 4-18 Purchase Order (PO) Table

PURCHASE ORDER #	PURCHASE DATE	ORDER PART #	DESCRIPTION	UNIT PRICE	QUANTITY ORDERED	VENDOR #	VENDOR NAME	VENDOR ADDRESS
2	3/9/2018	334	XYZ	$30	3	504	KL Supply	75 Stevens Dr.
2	3/9/2018	231	PDQ	$50	5	504	KL Supply	75 Stevens Dr.
2	3/9/2018	444	YYM	$80	6	504	KL Supply	75 Stevens Dr.
3	4/5/2018	231	PDQ	$50	2	889	OSCAN INC	55 Cougar Cir.

4.10 From the database created in the comprehensive problem, perform queries based on the tables and query grid shown in Table 4-19.

a. Which borrowers use Advent Appraisers?
b. What is the average amount borrowed from National Mortgage?
c. List all of the property appraisers.
d. List all of the lenders.
e. List the lenders that lent more than $100,000.
f. Which borrower requested the largest mortgage?
g. Which borrower requested the smallest mortgage?

TABLE 4-19 Selected Query Screen for Chapter Comprehensive Problem



4.11 Answer the following multiple choice questions.

1. With respect to data warehouses, databases, and files, which of the following statement(s) is (are) true?
   a. Analyzing large amounts of data for strategic decision making is often referred to as strategic processing.
   b. Databases were developed to address the proliferation of master files, which were created each time a need for information arose.
   c. A DBMS manages and controls the interface between stored data and the application programs that use the data.
   d. Since data warehouses are only used for transaction processing, they are updated in real time rather than periodically.
   e. Few mainframes and servers use database technology, and database use in personal computers is growing slowly.

2. With respect to data warehouses, databases, and files, which of the following statement(s) is (are) true?
   a. A problem with databases is data inconsistencies, as the same data is stored in two or more master files.
   b. A database system consists of the database, the DBMS, and the application programs that access the database through the DBMS.
   c. Data mining is using queries to investigate hypothesized relationships among data.
   d. A data warehouse is one or more very large databases containing both detailed and summarized data for a number of years.
   e. Data sharing refers to data and the programs that use them being independent of each other; each can be changed without changing the other.

3. With respect to data warehouses, databases, and files, which of the following statement(s) is (are) true?
   a. Cross-functional analysis refers to combining master files into larger pools of data so more application programs can access the data.
   b. In the master file approach, data is an organizational resource used by and managed for the entire organization, not just the originating department
   c. Data warehouses complement transaction processing databases by providing support for strategic decision making.
   d. OLAP is using sophisticated statistical analysis to find unhypothesized relationships in data.
   e. To avoid outdated, incomplete, or erroneous data, management needs policies and procedures that ensure scrubbed data.

4. With respect to data warehouses, databases, and files, which of the following statement(s) is (are) true?
   a. The database controller (DBC) is responsible for coordinating, controlling, and managing the database.
   b. Since strategic decision making requires access to large amounts of historical data, organizations are building separate databases called data warehouses.
   c. Data warehouses minimize redundancy, while transaction processing databases are purposely redundant to maximize query efficiency.
   d. Data validation controls that ensure input accuracy are one of the most time-consuming and expensive steps in creating a data warehouse.
   e. While it is important to regularly backup transaction processing databases, that is not the case with data warehouses.

5. With respect to databases and files, which of the following statement(s) is (are) true?
   a. There is a record in the data dictionary that describes each file in the database.
   b. The DQL is used to change the database, such as creating, deleting, and updating records.
   c. A schema describes data elements and the relationships among them in a user's logical view of the data.

d. In file-based systems, programmers do not need to know the physical location and layout of records like they do in databases.
e. A DBA can change physical storage to improve system performance without affecting users or application programs.

6. With respect to database systems, which of the following statement(s) is (are) true?
a. A record layout shows the items stored in a file, including the type of data stored and both the order and length of the data fields.
b. The physical view of data is how people conceptually organize and understand the relationships among data items.
c. A DBMS allows users to query or update a database without knowing where data are actually stored.
d. The DML builds the data dictionary, creates the database, describes logical views for each user, and specifies security constraints.
e. The external-level schema is the organization-wide view of a database and lists all data elements and the relationships among them.

7. With respect to database systems, which of the following statement(s) is (are) true?
a. A subschema can prevent access to those portions of the database that do not apply to it.
b. A report writer is a high-level, English-like language with powerful, easy-to-use commands to help sort, order, and update data.
c. The DDL and DML should be restricted to authorized administrators and programmers; the DQL is available to users.
d. DBMS software links the way data are physically stored with each user's logical view of the data.
e. An individual user's view of portions of a database is referred to as an internal-level schema.

8. With respect to relational databases, which of the following statement(s) is (are) true?
a. The referential integrity rule ensures that there are no update anomaly problems with the foreign keys.
b. A delete anomaly occurs when deleting a row has unintended consequences.
c. Each relational table row is called a couple and contains data about a specific item in the table; each column contains data about an attribute of that item.
d. The normalization process is used to create a set of relational tables in 3NF.
e. In a relational database, there can be no more than two values per cell.

9. With respect to relational databases, which of the following statement(s) is (are) true?
a. A foreign key is only found in one table; it is not allowed to be in another table.
b. When data about objects of interest are stored in separate database tables, it is easier to avoid insert anomalies.
c. According to the entity integrity rule, a primary key can uniquely identify a table row if it is blank.
d. An insert anomaly occurs when there is no way to update records to a database.
e. Semantic data modeling uses a system designer's knowledge of business processes to create tables in 3NF.

CASE 4-1 Research Project

As in all areas of IT, DBMSs are constantly changing and improving. Research how businesses are using DBMSs, and write a report of your findings. Address the following issues:

1. Which popular DBMS products are based on the relational data model?
2. Which DBMS products are based on a logical model other than the relational data model?
3. What are the relative strengths and weaknesses of the different types (relational versus other logical models) of DBMSs?

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QUIZ KEY

1. The relational data model portrays data as being stored in _____.
a. hierarchies [Incorrect. A hierarchical database portrays data as being stored in hierarchies.]
► **b.** tables [Correct. The relational data model portrays data as being stored in a table or relation format.]
c. objects [Incorrect. An object-oriented database portrays data as being stored as objects.]
d. files [Incorrect. The file-based data model portrays data as being stored in files.]

2. How a user conceptually organizes and understands data is referred to as the _____.
a. physical view [Incorrect. The physical view shows how and where data are physically stored.]
► **b.** logical view [Correct. The logical view shows how a user conceptually organizes and understands data.]
c. data model view [Incorrect. This is not a typical database view.]
d. data organization view [Incorrect. This is not a typical database view.]

3. What is each row in a relational database table called?
a. relation [Incorrect. A relation is a table in a relational database.]
b. attribute [Incorrect. Each column in a relational database is an attribute that describes some characteristic of the entity about which data are stored.]
c. anomaly [Incorrect. An anomaly is a problem in a database, such as an insert anomaly or a delete anomaly.]
► **d.** tuple [Correct. A tuple is also called a row in a relational database.]

4. Which of the following is an individual user's view of the database?
a. conceptual-level schema [Incorrect. A conceptual-level schema is the organization-wide view of the entire database.]
► **b.** external-level schema [Correct. The external-level schema represents an individual user's view of the database.]
c. internal-level schema [Incorrect. The internal-level schema represents how the data are actually stored and accessed.]
d. logical-level schema [Incorrect. This is not a schema mentioned in the text.]

5. Which of the following would managers most likely use to retrieve information about sales during the month of October?
a. DML [Incorrect. DML—data manipulation language—is used for data maintenance.]
b. DSL [Incorrect. DSL is not a DBMS language.]
c. DDL [Incorrect. DDL—data definition language—is used to build the data dictionary, create a database, describe logical views, and specify any limitations or constraints on security.]
► **d.** DQL [Correct. DQL—data query language—is used to retrieve information from a database.]

6. Which of the following attributes would most likely be a primary key?
a. supplier name [Incorrect. The primary key must be unique. The same name could be used by multiple entities.]
► **b.** supplier number [Correct. A unique number can be assigned as a primary key for each entity.]
c. supplier zip code [Incorrect. The primary key must be unique. More than one supplier could reside in the same zip code.]
d. supplier account balance [Incorrect. The primary key must be unique. The same account balance, such as a $0.00 balance, could be maintained by multiple entities.]

7. Which of the following is a software program that runs a database system?
a. DQL [Incorrect. DQL—data query language—is used to retrieve information from a database.]
► **b.** DBMS [Correct. A DBMS—database management system—is a software program that acts as an interface between a database and various application programs.]
c. DML [Incorrect. DML—data manipulation language—is used for data maintenance.]
d. DDL [Incorrect. DDL—data definition language—is used to build the data dictionary, create a database, describe logical views, and specify any limitations or constraints on security.]

8. The constraint that all primary keys must have nonnull data values is referred to as which of the following?
a. referential integrity rule [Incorrect. The referential integrity rule stipulates that foreign keys must have values that correspond to the value of a primary key in another table or be empty.]
► **b.** entity integrity rule [Correct. Every primary key in a relational table must have a non-null value.]
c. normalization rule [Incorrect. The text does not discuss a normalization rule.]
d. relational data model rule [Incorrect. The text does not discuss a relational data model rule.]

9. The constraint that all foreign keys must have either null values or the value of a primary key in another table is referred to as which of the following?
► **a.** referential integrity rule [Correct. The referential integrity rule stipulates that foreign keys must have values that correspond to the value of a primary key in another table or be empty.]
b. entity integrity rule [Incorrect. This rule states that every primary key in a relational table must have a nonnull value.]
c. foreign key value rule [Incorrect. The text does not discuss a foreign key value rule.]
d. null value rule [Incorrect. The text does not discuss a null value rule.]

10. Which of the following attributes in the Cash Receipts table [representing payments received from customers] would most likely be a foreign key?
a. cash receipt number [Incorrect. A cash receipt number is a good candidate for the primary key of the Cash Receipts table.]
b. customer check number [Incorrect. Because there is no reason to store customer check numbers in a separate table, it is not a good candidate for a foreign key.]
► **c.** customer number [Correct. Customer number would be a foreign key in the Cash Receipts table and would link the Cash Receipts table to the Customer Table.]
d. cash receipt date [Incorrect. Dates usually are not good candidates for foreign k eys. The cash receipt date would likely be an attribute in the Cash Receipts table.]

COMPREHENSIVE PROBLEM SOLUTION

Since Lender and Appraiser data are repeated throughout Table 4-14, the spreadsheet contains update, insert, and delete anomalies. To eliminate anomaly problems and reduce redundancy, we break the spreadsheet into three smaller tables: Borrowers (Table 4-20), Lenders (Table 4-21), and Appraisers (Table 4-22).

Borrower number, lender number, and appraiser number are the primary k eys because each uniquely identifies the rows in their respective tables. The primary keys from the Lender and Appraiser tables are added to the Borrower table as foreign keys so that the Lender and Appraiser tables will have a direct link to the Borrower table.

Creating smaller tables with primary and foreign keys solves the three anomaly problems:

TABLE 4-20 Borrower Table

BORROWER NUMBER (PRIMARY KEY)	LAST NAME	FIRST NAME	CURRENT ADDRESS	REQUESTED MORTGAGE AMOUNT	LENDER NUMBER (FOREIGN KEY TO LENDER TABLE)	PROPERTY APPRAISER NUMBER (FOREIGN KEY TO APPRAISER TABLE)
450	Adams	Jennifer	450 Peachtree Rd.	$245,000	13	8
451	Adamson	David	500 Loop Highway	$124,688	13	9
452	Bronson	Paul	312 Mountain View Dr.	$345,000	14	10
453	Brown	Marietta	310 Loop Highway	$57,090	15	10
454	Charles	Kenneth	3 Commons Blvd.	$34,000	16	8
455	Coulter	Tracey	1367 Peachtree Rd.	$216,505	13	8
456	Foster	Harold	678 Loop Highway	$117,090	12	9
457	Frank	Vernon	210 Bicayne Blvd.	$89,000	12	10
458	Holmes	Heather	1121 Bicayne Blvd.	$459,010	16	10
459	Johanson	Sandy	817 Mountain View Dr.	$67,900	15	9
460	Johnson	James	985 Loop Highway	$12,000	12	10
461	Jones	Holly	1650 Washington Blvd.	$67,890	15	9

TABLE 4-21 Lender Table

LENDER NUMBER (PRIMARY KEY)	LENDER NAME	LENDER OFFICE ADDRESS
12	National Mortgage	750 16 St.
13	Excel Mortgage	6890 Sheridan Dr.
14	CCY	28 Buckhead Way
15	Advantage Lenders	3345 Lake Shore Dr.
16	Capital Savings	8890 Coral Blvd.

TABLE 4-22 Appraiser Table

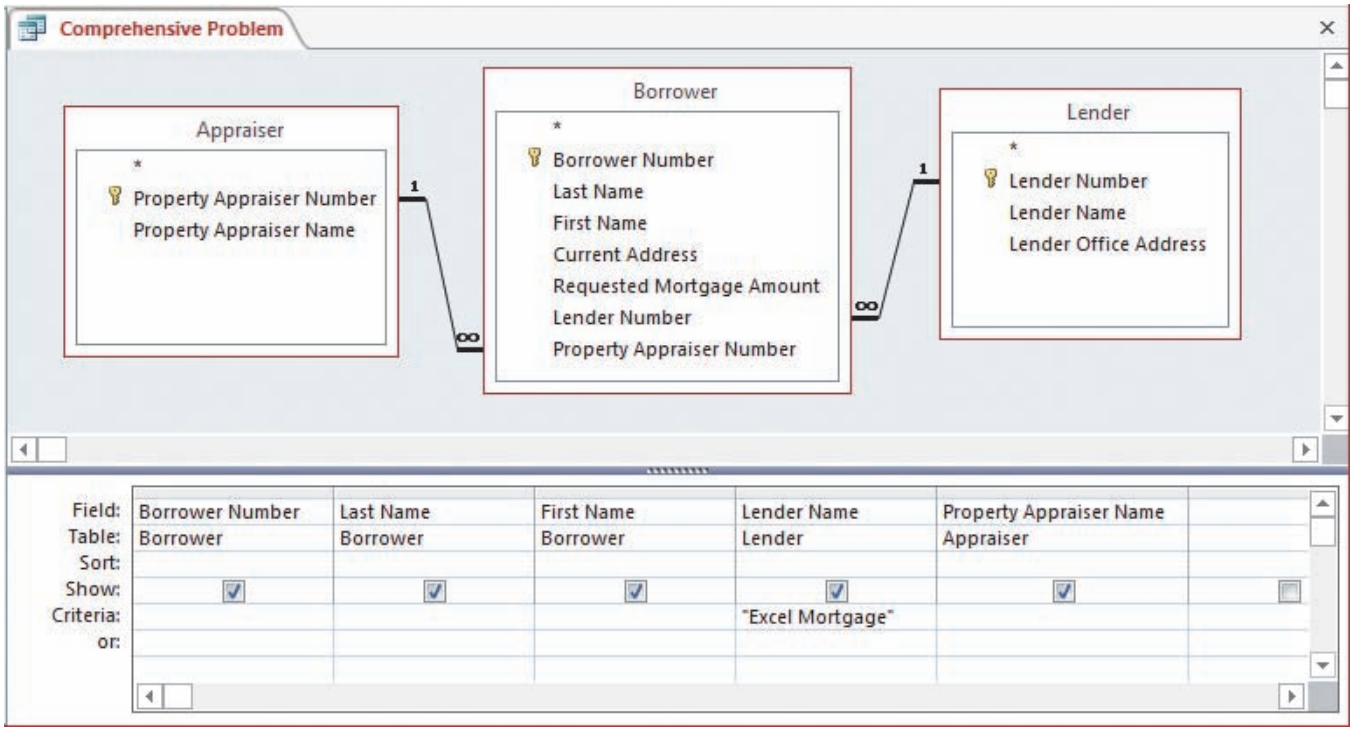
PROPERTY APPRAISER NUMBER (PRIMARY KEY)	PROPERTY APPRAISER NAME
8	Advent Appraisers
9	Independent Appraisal Service
10	Jones Property Appraisers

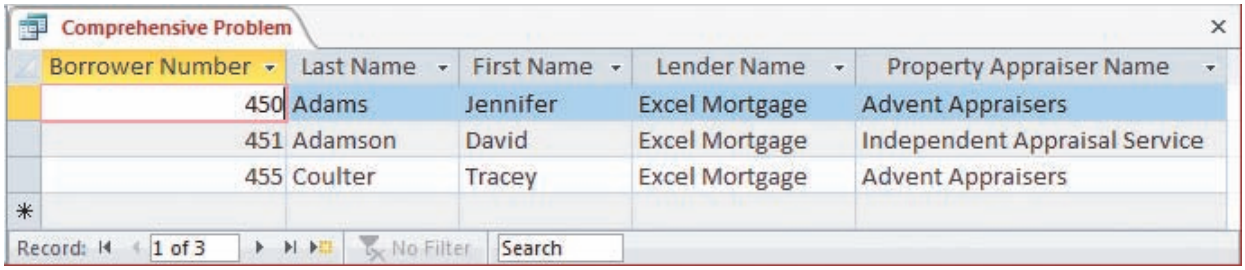
- The insert anomaly is solved because a new lender and appraiser can be added without requiring a borrower.
- The delete anomaly is solved because deleting a borrower that decides not to pursue a mortgage does not delete information about the lender and appraiser.
- The update anomaly is solved because there is only one row in one table to update when a lender moves and changes its address, instead of changing all spreadsheet rows that store the lender address.

After the data are entered into the Microsoft Access tables, we can query the database. The query in Table 4-23, which finds the borrowers and appraisers associated with loans from Excel Mortgage, is created as follows:

- From the Query menu option, select "Create Query in Design View."
- Add all three tables to your Query Design. Access automatically links the primary and foreign keys.

TABLE 4-23 Borrowers with Loans from Excel Mortgage





- Select the following fields: Borrower Number, Last Name, First Name, Lender Name, and Property Appraiser Name.
- Specify "Excel Mortgage" as the criteria in the Lender Name column.
- Run the query.

Appendix: Data Normalization[1]

As indicated in the accompanying chapter, if all data is put into one big file, it is difficult to add, delete, and change data. For example, when the database contains redundant data (the same data is repeated in different places in the database) that needs to be changed, each instance of the data must be found and changed or errors will be introduced into the data. This problem is solved by organizing the database such that data redundancy is reduced or eliminated. This appendix discusses data normalization, which is the process of analyzing data to create the most efficient database structure. In other words, it is breaking a big data table into smaller tables in order to reduce data redundancy.

To normalize unorganized data, data is taken through three different forms, called first normal form (1NF), second normal form (2NF), and third normal form (3NF). The flowchart in Figure A4-1 graphically describes the normalization process.

To help explain data normalization, we will walk you through a simple example, and in doing so we will define all data normalization terms. Suppose the records for a student information system are kept on a sheet of paper as shown in Figure A4-2.

A student's personal information remains relatively constant (names and student numbers seldom change). However, the student's course schedule will change each semester and a student can take many different classes. The GPA will change each time a student completes a course.

FIGURE A4-1
A Graphical Representation of the Normalization Process

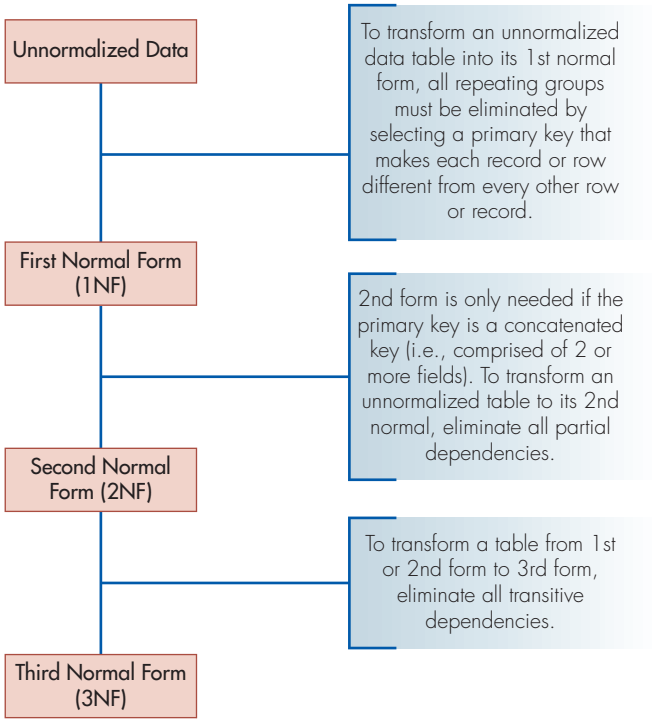


FIGURE A4-2
Student Record

Student Record

Student Name: *Stephanie Moore*
Student Number: *86432*
Student Major: *Information Systems*

Courses

Course	Description	Grade
IS 315	Database	A
Accounting 324	International Accounting	B
Management 401	Finance	C-

GPA 3.2

[1]Adapted from a document originally prepared by Bill Heninger at Brigham Young University

TABLE A4-1 Student Table (Unnormalized Form)

STUDENT NUMBER	STUDENT NAME	STUDENT MAJOR	COURSE	COURSE GRADE
86432	Stephanie Moore	Information Systems	IS 315	A
			Accounting 324	B
			Management 401	C–
86789	Bob Archer	Management	Management 101	B+
			History 201	A–
98653	Haley Mills	Music	Music 371	C+
			Math 212	B–
			Management 101	B

Table A4-1 represents what a simple computer file for three students might look like. There are data fields for each of the following: student number, name, major, courses, and course grade. This is an unnormalized table because it has repeating groups of data; that is, one or more attributes includes more than one value. The Course and Course Grade attributes are a repeating group (more than a single entry) for each student.

A table is in 1NF when the following is done:

- Repeating groups have been removed.
- A unique primary key exists for each record.

A primary key is a data field or a combination of data fields that makes each record in the table unique. If a record cannot be uniquely identified using a single data field, a concatenated key (two or more data fields which, when combined, uniquely identify each record) is used.

Table A4-2 shows the data in 1NF. Notice that as we moved from unnormalized to 1NF, we had to replicate the Student Name and Major in order to create a unique and complete row for each record. The primary keys are denoted with a PK.

The Student Number alone does not uniquely identify each record because the same student can take more than one class. However, a combination of the Student Number and the Course uniquely identifies each record. In other words, Student# 86432 (Stephanie Moore) taking IS 315 is a different record than Student# 86432 (Stephanie Moore) taking Accounting 324.

A table is in 2NF when the following is done:

- Already in 1NF form (each record is uniquely identified and therefore unique).
- No nonprimary key attribute depends on only a portion of the primary key (partial dependency).

Second normal form only occurs when the primary key is concatenated (made up of more than one data field). If there is no concatenated key, you can skip 2NF and go directly to 3NF.

TABLE A4-2 Student Table (1NF)

STUDENT NUMBER (PK)	COURSE (PK)	STUDENT NAME	STUDENT MAJOR	COURSE GRADE
86432	IS 315	Stephanie Moore	Info Systems	A
86432	Accounting 324	Stephanie Moore	Info Systems	B
86432	Management 401	Stephanie Moore	Info Systems	C–
86789	Management 101	Bob Archer	Management	B+
86789	History 201	Bob Archer	Management	A–
98653	Music 371	Haley Mills	Music	C+
98653	Math 212	Haley Mills	Music	B–
98653	Management 101	Haley Mills	Music	B

In Table A4-2, the primary key of the Student table is the combination of Student Number and Course. However, since Student Name and Major only describe and are dependent on the Student, and not the Course, we have a "partial dependency." This partial dependency must be eliminated by breaking the table down into smaller tables.

In Tables A4-3 and A4-4 the 1NF table in Table A4-2 is broken into two tables by grouping the student data together and by grouping the student's course data together. This eliminates the partial dependency (Student Name and Student Major only depend on Student Number, not on Course). The only field that depends on both the Student Number and Course together is the Course Grade. Data redundancy is reduced, as a student's name and major are only listed once in the Student table.

A table is in 3NF when the following is done:

- Already in 1NF or 2NF.
- No transitive dependencies exist. That is, all data fields functionally depend on the primary key and only the primary key.

A transitive dependency occurs when a data field can be better identified by another field than the existing primary key. That is, when a non-key attribute is functionally dependent upon one or more other non-key attributes.

Table A4-5 is an example of a transitive dependency.

Since Course# is the primary key, it appears to determine the value of all other attributes. However, Instructor Phone depends on the Instructor attrib ute. To eliminate this transitive dependency, Table A4-5 is split into a Course table (Table A4-6) and an Instructor table (Table A4-7).

The FK in Table A4-6 stands for foreign key. Since we may need to reconnect these tables sometime in the future, we always leave a field "in common" between the two tables we have created. That field is usually the primary key of one of the newly created tables.

TABLE A4-3 Student Table

STUDENT NUMBER (PK)	STUDENT NAME	STUDENT MAJOR
86432	Stephanie Moore	Info Systems
86789	Bob Archer	Management
98653	Haley Mills	Music

TABLE A4-4 Student-Course Table (2NF)

STUDENT NUMBER (PK)	COURSE (PK)	COURSE GRADE
86432	IS 315	A
86432	Accounting 324	B
86432	Management 401	C–
86789	Management 101	B+
86789	History 201	A–
98653	Music 371	C+
98653	Math 212	B–
98653	Management 101	B

TABLE A4-5 Example of a Transitive Dependency

COURSE# (PK)	COURSE DESCRIPTION	INSTRUCTOR	INSTRUCTOR PHONE
IS 315	Database	Gibson	378-5555
Math 215	Calculus	Ryan	378-4444

TABLE A4-6 Course Table

COURSE# (PK)	COURSE DESCRIPTION	INSTRUCTOR (FK)
IS 315	Database	Gibson
Math 215	Calculus	Ryan

TABLE A4-7 Instructor Table

INSTRUCTOR (PK)	INSTRUCTOR PHONE
Gibson	378-5555
Ryan	378-4444

One way to remember the criteria for the third form is to think of Perry Mason. When Perry Mason called someone to testify in court, the witness always had to swear to "tell the whole truth and nothing but the truth." A 2NF table is like the "whole truth" part of the oath (each attribute or data field depends on the whole primary key, not just part of the primary key). The 3NF table is like the "nothing but the truth" part of the oath (each attribute depends on nothing but the primary key (on the primary key and on no other attribute or data field). In 3NF, an attribute must depend on the "whole primary key" and "nothing but the primary key."

If data tables are not broken down to 3NF, problems or anomalies occur. These problems are called the update, insert, and delete anomalies and are explained in the chapter. If an unnormalized table is broken down to 3NF, the update, insert, and delete anomalies disappear.

Summary

When starting with an unnormalized table, here are the steps in the normalization process:

1. Remove all repeating groups of data to create the 1NF and select the primary key.
2. Remove partial dependencies (attributes dependent on part of the primary key) to create the 2NF. This applies only when the 1NF table has a concatenated key.
3. Remove all transitive dependencies (nonprimary key attributes, or data fields, dependent on other nonprimary key attributes, or data fields) to create the 3NF.

Second Normalization Example

As a further help in understanding data normalization, a second example is provided. Table A4-8 represents an unnormalized table of student grades with redundant or repeating data. The three steps mentioned above will be used to normalize the data.

Step 1: Remove Repeating Groups

To remove repeating groups from Table A4-8, select an attribute or a combination of attributes that make each row or record unique. Student# is not a good candidate because it repeats for every course a student takes. Course is a possibility, but more than one student can take the same course. As in our prior example, combining these two fields results in a unique identifier for each record. (This assumes a student cannot take the same course twice.) Now, each row or record in Table A4-9 is uniquely identified, or different from all other records.

One problem with Table A4-9 is that if a student changed his or her major (it is listed every time the Student Number is listed), we would have to find every record for that student and change the major. This increases the likelihood of making mistakes (this is an update anomaly example).

We solve this by taking the redundant student data out of Table A4-9 and creating Table A4-10, which shows each student once, with the accompanying name and major. The remaining data is shown in the Course-Grade table (Table A4-11).

TABLE A4-8 Unnormalized Student Data Table

STUDENT#	STUDENT NAME	MAJOR	COURSE	COURSE DESCRIPTION	INSTRUCTOR NAME	OFFICE HOURS	OFFICE LOCATION	PHONE	COURSE GRADE
86432	Stethi	Acct	Acc 315	Fin Acct	Ray	9–11	442	378-4545	A
			Acc 324	Mgt Acct	Paul	8–10	448	378-8945	A
			Mgt 401	Finance	Gibson	12–1	501	378-5555	B
86789	Archer	Mgt	Mgt 101	Intro Mgt	Bueli	4–6	463	378-2345	C
			Hist 201	US Hist	Rockly	1–2	558	378-5987	B
98653	Mills	Acct	Acc 371	Ind Study	Knox	8–11	443	378-4543	B
			Math 212	Calculus	Geluski	3–4	158	378-7848	B
			Mgt 101	Intro Mgt	Bueli	4–6	463	378-2345	C

TABLE A4-9 Student-Course-Grade (1NF)

STUDENT# (PK)	STUDENT	MAJOR	COURSE (PK)	COURSE DESCRIPTION	INSTRUCTOR	OFFICE HOURS	OFFICE LOCATION	PHONE	COURSE GRADE
86432	Stethi	Acct	Acc 315	Fin Acct	Ray	9–11	442	378-4545	A
86432	Stethi	Acct	Acc 324	Mgt Acct	Paul	8–10	448	378-8945	A
86432	Stethi	Acct	Mgt 401	Fin	Schoals	12–1	501	378-5555	B
86789	Archer	Mgt	Mgt 101	Intro Mgt	Bueil	4–6	463	378-2345	C
86789	Archer	Mgt	Hist 201	US Hist	Rockly	1–2	558	378-5987	B
98653	Mills	Acct	Acc 371	Ind Study	Knox	8–11	443	378-4543	B
98653	Mills	Acct	Math 212	Calculus	Geluski	3–4	158	378-7848	B
98653	Mills	Acct	Mgt 101	Intro Mgt	Bueli	4–6	463	378-2345	C

With Table A4-10 in 3NF, we can change a student's name or major without affecting any other data in the Course-Grade table. We only need to update one student record rather than searching for all the redundant student data in the unnormalized table.

We copied the primary key attribute (Student#) into the Student table but left a copy in the Course-Grade table (Table A4-11) because some information in the Course-Grade table depends on that unique identifier for each student. For example, a Course Grade only makes sense when it is tied to a specific student and a specific course. So we need to keep both a student identifier and a course identifier to maintain the grade a student received for a particular course.

Table A4-11 is in 1NF but still presents some problems that require it to be decomposed further. The Course-Grade table still exhibits the three normalization anomalies:

1. Update Anomaly: To change the description of Mgt 101 from Intro Mgt (Introduction to Management) to MgtPrin (Management Principles), each record in the Course-Grade table would need to be searched for any students taking that course.

TABLE A4-10 Student Table (3NF)

STUDENT# (PK)	STUDENT	MAJOR
84632	Stethi	Acct
86789	Archer	Mgt
98653	Mills	Acct

TABLE A4-11 Course-Grade (1NF)

STUDENT# (PK)	COURSE (PK)	COURSE DESCRIPTION	INSTRUCTOR	OFFICE HOURS	OFFICE LOCATION	PHONE	COURSE GRADE
86432	Acc 315	Fin Acct	Ray	9–11	442	4545	A
86432	Acc 324	Mgt Acct	Paul	8–10	448	8945	A
86432	Mgt 401	Fin	Schoals	12–1	501	5555	B
86789	Mgt 101	Intro Mgt	Bueil	4–6	463	2345	C
86789	Hist 201	US Hist	Rockly	1–2	558	5987	B
98653	Acc 371	Ind Study	Knox	8–11	443	4543	B
98653	Math 212	Calculus	Geluski	3–4	158	7848	B
98653	Mgt 101	Intro Mgt	Bueli	4–6	463	2345	C

2. Insert Anomaly: A new course could not be added to this table because no students are enrolled in the course. This dilemma exists because uniquely identifying each record in the table requires the entire primary key, which includes both Student# and Course.
3. Delete Anomaly: Assume only one student is registered for ACC 371, Independent Study. If the student withdrew from the university, and the student's record was deleted, it would also delete the data about the course and the instructor because those data items can not exist in the table without their primary key. Thus, the instructor and the course data should not be identified by the Student# portion of the primary key, but only by the course number part of the primary key.

Step 2: Remove the partial dependencies

Before a table in 1NF can be considered in 2NF, partial dependencies must be removed when there is a concatenated key. We can take the Course-Grade data out of Table A4-11, as it is the only data that requires the concatenated key. Separating this data gives us Table A4-12 (Student-Grade table) in 3NF and Table A4-13 (Course-Instructor table) in 2NF.

Step 3: Remove Transitive Dependencies

The insert and delete anomalies are diminished in the Course-Instructor table (Table A4-13, but not eliminated due to transitive dependencies. To eliminate the anomalies, the Course-Instructor table must be decomposed into 3NF.

In the Course-Instructor table, the instructor's office hours, office location, and phone number can only be found by searching for courses that the instructor has taught. In other words, to find Professor Ray's phone number, a student would have to search the Course-Instructor table to find that information instead of looking at a table that contained only instructor information.

TABLE A4-12 Student-Grade (3NF)

STUDENT# (PK)	COURSE (PK)	COURSE GRADE
86432	Acc 315	A
86432	Acc 324	A
86432	Mgt 401	B
86789	Mgt 101	C
86789	Hist 201	B
98653	Acc 371	B
98653	Math 212	B
98653	Mgt 101	C

TABLE A4-13 Course-Instructor (2NF)

COURSE (PK)	COURSE DESCRIPTION	INSTRUCTOR	OFFICE HOURS	OFFICE LOCATION	PHONE
Acc 315	Fin Acct	Ray	9–11	442	378-4545
Acc 324	Mgt Acct	Paul	8–10	448	378-8945
Mgt 401	Fin	Schoals	12–1	501	378-5555
Mgt 101	Intro Mgt	Bueil	4–6	463	378-2345
Hist 201	US Hist	Rockly	1–2	558	378-5987
Acc 371	Ind Study	Knox	8–11	443	378-4543
Math 212	Calculus	Geluski	3–4	158	378-7848
Mgt 101	Intro Mgt	Bueli	4–6	463	378-2345

To get rid of the transitive dependency, we put the instructor information and the course information in separate tables, as shown in Tables A4-14 (Course table) and A4-15 (Instructor table). The Instructor field is also left in the Course table as a foreign key so we know who is teaching each course and so we can link these tables together again when needed.

Because all tables are in 3NF and all anomalies are eliminated, the tables can be effectively used by a relational database. When we finish the normalization process, the unnormalized student data in Table A4-8 has been broken down into four separate tables:

1. Table A4-10: Student Table (3NF)
2. Table A4-12: Student-Grade (3NF)
3. Table A4-14: Course (3NF)
4. Table A4-15: Instructor (3NF)

TABLE A4-14 Course (3NF)

COURSE (PK)	COURSE DESCRIPTION	INSTRUCTOR (FK)
Acc 315	Fin Acct	Ray
Acc 324	Mgt Acct	Paul
Mgt 401	Fin	Schoals
Mgt 101	Intro Mgt	Bueil
Hist 201	US Hist	Rockly
Acc 371	Ind Study	Knox
Math 212	Calculus	Geluski

TABLE A4-15 Instructor (3NF)

INSTRUCTOR (PK)	OFFICE HOURS	OFFICE LOCATION	PHONE
Ray	9–11	442	378-4545
Paul	8–10	448	378-8945
Schoals	12–1	501	378-5555
Bueil	4–6	463	378-2345
Rockly	1–2	558	378-5987
Geluski	3–4	158	378-7848
Knox	8–11	443	378-4543