Chapter 8 is the first of three chapters in the systems design phase of the SDLC. This chapter explains how to design an effective user interface, and how to handle data output, input, and security issues. The chapter stresses the importance of user feedback and involvement in all design decisions.

INTRODUCTION

User interface design is the first task in the systems design phase of the SDLC. Designing the interface is extremely important, because everyone wants a system that is easy to learn and use.

After discussing user interface evolution, principles, and design techniques, the chapter describes output design, input design, and data security issues.

OBJECTIVES

When you finish this chapter, you will be able to:

• Explain the concept of user interface design and human-computer interaction, including basic principles of user-centered design
• List user interface design guidelines
• Describe user interface components, including screen elements and controls
• Discuss output design and technology issues
• Design effective source documents
• Explain input design and technology issues
• Discuss guidelines for data entry screen design
• Use input masks and validation rules to reduce input errors
• Describe output and input controls and security
CHAPTER INTRODUCTION CASE: Mountain View College Bookstore

Background: Wendy Lee, manager of college services at Mountain View College, wants a new information system that will improve efficiency and customer service at the three college bookstores.

In this part of the case, Tina Allen (systems analyst) and David Conroe (student intern) are talking about user interface design issues.

Participants: Tina and David
Location: Mountain View College Cafeteria, Monday afternoon, November 28, 2011
Project status: Tina and David have examined development strategies for the new bookstore system. After performing cost-benefit analysis, they recommended in-house development of the new bookstore system. Now they are ready to begin the systems design phase by working on user interface design for the new system.
Discussion topics: User interface design concepts and principles

Tina: Hi, David. Ready to start work on user interface design?
David: Sure. Will we start with output, because it’s important to users?
Tina: Output is very important, but the most important issue for users is the interface itself. For example, is it easy to learn? Is it easy to work with? We’ll try to design everything — output, input, and all the other elements — from a user’s point of view.
David: How do we do that?
Tina: Well, many sources of information about effective design concepts and principles are available. We’ll study those, and then ask our own users for their input and suggestions.
David: What about input and data entry?
Tina: Good question. You’ve heard the old saying, “garbage in, garbage out.” User interface principles apply to user input generally, but repetitive data entry deserves special attention. We need to create screen forms that are logical and easy to understand, as well as input masks and data entry validation rules. We also need to review any source documents that will be filled in manually.
David: Anything else?
Tina: Yes. The bookstore system probably will have some confidential data regarding budgets and markup policies, so we’ll have to consider output and input control and security. If you’re ready, here’s a task list to get us started:

FIGURE 8-1 Typical user interface design tasks.
What Is a User Interface?

A user interface (UI) describes how users interact with a computer system, and consists of all the hardware, software, screens, menus, functions, output, and features that affect two-way communications between the user and the computer.

Figure 8-2 suggests an interesting viewpoint that interface designers should keep in mind: Industry leader IBM believes that the best interfaces are the ones that users do not even notice — they make sense because they do what users expect them to do.

Evolution of the User Interface

When developing older systems, analysts typically designed all the printed and screen output first, then worked on the inputs necessary to produce the results. Often, the user interface mainly consisted of process-control screens that allowed the user to send commands to the system. That approach worked well with traditional systems that simply transformed input data into structured output.

As information management evolved from centralized data processing to dynamic, enterprise-wide systems, the primary focus also shifted — from the IT department to the users themselves. The IT group became a supplier of information technology,
rather than a supplier of information. Today, the main focus is on users within and outside the company, how they communicate with the information system, and how the system supports the firm’s business operations. Figure 8-3 compares a traditional, processing-centered information system with a modern, user-centered system. Notice that the IT department, which was the main interface for user information requests, has become a system facilitator that maintains and supports the system for its users.

In a user-centered system, the distinction blurs between input, output, and the interface itself. Most users work with a varied mix of input, screen output, and data queries as they perform their day-to-day job functions. Because all those tasks require interaction with the computer system, the user interface is a vital element in the systems design phase. Ergosoft laboratories is one of many firms that offer consulting services and software solutions to help companies develop successful user interfaces, as shown in Figure 8-4 on the next page.

User interface design requires an understanding of human-computer interaction and user-centered design principles, which are discussed in the next section. Input and output design topics are covered later in this chapter.
Chapter 8  User Interface Design

Human-Computer Interaction

A user interface is based on basic principles of human-computer interaction. Human-computer interaction (HCI) describes the relationship between computers and people who use them to perform their jobs, like the worker shown in Figure 8-5. HCI concepts apply to everything from PC desktops to global networks. In its broadest sense, a user interface includes all the communications and instructions necessary to enter input to the system and to obtain output in the form of screen displays or printed reports.

The human-computer interface started in the 1980s with users typing complex commands in green text on a black screen. Then came the graphical user interface (GUI), which was a huge improvement, because it used icons, graphical objects, and pointing devices. Today, designers strive to translate user behavior, needs, and desires into an interface that users don’t really notice. As IBM points out in Figure 8-2 on page 336, the best user interfaces are “almost transparent — you can see right though the interface to your own work.”

As a systems analyst, you will design user interfaces for in-house developed software and customize interfaces for various commercial packages and user productivity applications. Your main objective is to create a user-friendly design that is easy to learn and use.

Industry leaders Microsoft and IBM both devote considerable resources to user interface research. Figure 8-6 describes Microsoft’s Redmond labs, where engineers observe volunteers who participate in software usability studies.
At its Almaden Research Center, IBM conducts usability testing and studies human-computer interaction, as shown in Figure 8-7. According to IBM, its User Sciences & Experience Research (USER) lab focuses on improving ease of use and exploring new ways of using computers.
Chapter 8  User Interface Design

What Is a User Interface?

CASE IN POINT 8.1: CASUAL OBSERVER SOFTWARE

Casual Observer Software’s main product is a program that monitors and analyzes user keystrokes and mouse clicks to learn more about the way employees use their computer systems. The problem is that some users feel this is an unwarranted intrusion into their privacy, and they prefer not to be observed. Some even fear that the data would be used for other reasons, including performance appraisal. You are a consultant who has been hired by a client firm that is trying to decide whether or not to use this software.

Before you advise the client, go back and review the Microsoft usability lab shown in Figure 8-6 on the previous page, where the users being studied in the Redmond labs were willing participants. Then, refer to Chapter 4, Requirements Modeling, page 165, and consider the Hawthorne Effect, which suggests that employees might behave differently when they know they are being observed. Finally, think about the ethical issues that might be involved in this situation. What will you advise your client, and why?

IBM believes that the user interface evolution will lead to computers that truly are consumer products that are simple and natural for the general population to use. This will occur, in IBM’s view, because computers will function in a friendlier, more predictable way — much like a telephone or video player. Most important, the interface will be based on the perspective of a user rather than a computer engineer, programmer, or systems analyst. To understand the magnitude of this shift in thinking, consider the powerful statement shown in Figure 8-8, where IBM usability expert Dr. Clare-Marie Karat notes that “in this new computer age, the customer is not only right, the customer has rights.” Those rights are listed in Figure 8-9.
User Rights

1. **Perspective:** The user always is right. If there is a problem with the use of the system, the system is the problem, not the user.
2. **Installation:** The user has the right to install and uninstall software and hardware systems easily without negative consequences.
3. **Compliance:** The user has the right to a system that performs exactly as promised.
4. **Instruction:** The user has the right to easy-to-use instructions (user guides, online or contextual help, and error messages) for understanding and utilizing a system to achieve desired goals and recover efficiently and gracefully from problem situations.
5. **Control:** The user has the right to be in control of the system and to be able to get the system to respond to a request for attention.
6. **Feedback:** The user has the right to a system that provides clear, understandable, and accurate information regarding the task it is performing and the progress toward completion.
7. **Dependencies:** The user has the right to be informed clearly about all systems requirements for successfully using software or hardware.
8. **Scope:** The user has the right to know the limits of the system’s capabilities.
9. **Assistance:** The user has the right to communicate with the technology provider and receive a thoughtful and helpful response when raising concerns.
10. **Usability:** The user should be the master of software and hardware technology, not vice versa. Products should be natural and intuitive to use.

**Figure 8-9** User rights suggested by IBM’s Dr. Clare-Marie Karat.

**Principles of User-Centered Design**

Although IT professionals have different views about interface design, most would agree that good design depends on seven basic principles, which are described in the following sections.

**Understand the Business**

The interface designer must understand the underlying business functions and how the system supports individual, departmental, and enterprise goals. The overall objective is to design an interface that helps users to perform their jobs. A good starting point might be to analyze a functional decomposition diagram (FDD). As you learned in Chapter 4, an FDD is a graphical representation of business functions that starts with major functions, and then breaks them down into several levels of detail. An FDD can provide a checklist of user tasks that you must include in the interface design.

**Maximize Graphical Effectiveness**

Studies show that people learn better visually. The immense popularity of Apple Mac OS and Microsoft Windows is largely the result of their graphical user interfaces that are easy to learn and use. A well-designed interface can help users learn a new system rapidly, and be more productive. Also, in a graphical environment, a user can display and work with multiple windows on a single screen and transfer data between programs. If the interface supports data entry, it must follow the guidelines for data entry screen design that are discussed later in this chapter.

**Think Like a User**

A systems analyst should understand user experience, knowledge, and skill levels. If a wide range of capability exists, the interface should be flexible enough to accommodate novices as well as experienced users.

To develop a user-centered interface, the designer must learn to think like a user and see the system through a user’s eyes. The interface should use terms and metaphors that are familiar to users. Users are likely to have real-world experience with many other
machines and devices that provide feedback, such as automobiles, ATM machines, and microwave ovens. Based on that experience, users will expect useful, understandable feedback from a computer system.

**Use Models and Prototypes**

From a user’s viewpoint, the interface is the most critical part of the system design because it is where he or she interacts with the system — perhaps for many hours each day. It is essential to construct models and prototypes for user approval. An interface designer should obtain as much feedback as possible, as early as possible. You can present initial screen designs to users in the form of a storyboard, which is a sketch that shows the general screen layout and design. The storyboard can be created with software, or drawn freehand. Users must test all aspects of the interface design and provide feedback to the designers. User input can be obtained in interviews, via questionnaires, and by observation. Interface designers also can obtain data, called **usability metrics**, by using software that can record and measure user interaction with the system.

**Focus on Usability**

The user interface should include all tasks, commands, and communications between users and the information system. The screen in Figure 8-10 shows the main options for a student registration system. Each screen option leads to another screen, with more options. The objective is to offer a reasonable number of choices that a user easily can comprehend. Too many options on one screen can confuse a user — but too few options increase the number of submenu levels and complicate the navigation process. Often, an effective strategy is to present the most common choice as a default, but allow the user to select other options.

**Invite Feedback**

Even after the system is operational, it is important to monitor system usage and solicit user suggestions. You can determine if system features are being used as intended by observing and surveying users. Sometimes, full-scale operations highlight problems that were not apparent when the prototype was tested. Based on user feedback, Help screens might need revision and design changes to allow the system to reach its full potential.

**Document Everything**

You should document all screen designs for later use by programmers. If you are using a CASE tool or screen generator, number the screen designs and save them in a hierarchy similar to a menu tree. User-approved sketches and storyboards also can be used to document the user interface. By applying basic user-centered design principles, a systems analyst can plan, design, and deliver a successful user interface.

**Designing the User Interface**

It is important to design a user interface that is easy to use, attractive, and efficient. When you create a user interface, you should follow eight basic guidelines. These guidelines also apply to data entry screen design, which is discussed later in this chapter.
1. Design a transparent interface.
2. Create an interface that is easy to learn and use.
3. Enhance user productivity.
4. Make it easy for users to obtain help or correct errors.
5. Minimize input data problems.
6. Provide feedback to users.
7. Create an attractive layout and design.
8. Use familiar terms and images.

Good user interface design is based on a combination of ergonomics, aesthetics, and interface technology. **Ergonomics** describes how people work, learn, and interact with computers; **aesthetics** focuses on how an interface can be made attractive and easy to use; and **interface technology** provides the operational structure required to carry out the design objectives. As shown in Figure 8-11, Cognetics Corporation offers user interface design services. Cognetics stresses that an interface must be effective, efficient, engaging, error tolerant, and easy to learn.

The following sections provide examples of the basic user interface design guidelines. As mentioned earlier, many of the specific points also apply to data entry screen design, which is discussed later in this chapter.

**Design a Transparent Interface**

- Facilitate the system design objectives, rather than calling attention to the interface.
- Create a design that is easy to learn and remember.
- Design the interface to improve user efficiency and productivity.
- Write commands, actions, and system responses that are consistent and predictable.
- Minimize data entry problems.
- Allow users to correct errors easily.
- Create a logical and attractive layout.
Create an Interface that Is Easy to Learn and Use

- Clearly label all controls, buttons, and icons.
- Select only those images that users can understand easily, and provide on-screen instructions that are logical, concise, and clear. Users become very frustrated when they see images or messages that are confusing or misleading. For example, the top screen in Figure 8-12 shows four control buttons, but many of them do not have an obvious meaning. In the bottom screen, notice the difference in the messages: The first five provide little or no information. The last message is the only one that is easy to understand.
- Show all commands in a list of menu items, but dim any commands that are not currently available.
- Make it easy to navigate or return to any level in the menu structure.

Enhance User Productivity

- Organize tasks, commands, and functions in groups that resemble actual business operations. You should group functions and submenu items in a multilevel menu hierarchy, or tree, that is logical and reflects how users typically perform the tasks. Figure 8-13 shows an example of a menu hierarchy for an order tracking system.
- Create alphabetical menu lists or place the selections used frequently at the top of the menu list. No universally accepted approach to menu item placement exists. The best strategy is to design a prototype and obtain feedback from users. Some applications even allow menus to show recently used commands first. Some users like that feature, but others might find it distracting. The best approach is to offer a choice, and let users decide.
- Provide shortcuts so experienced users can avoid multiple menu levels. You can create shortcuts using hot keys that allow a user to press the alt key + the underlined letter of a command.
- Use default values if the majority of values in a field are the same. For example, if 90% of the firm’s customers live in Albuquerque, use Albuquerque as the default value in the City field.
- Use a duplicate value function that enables users to insert the value from the same field in the previous record.
- Provide a fast-find feature that displays a list of possible values as soon as users enter the first few letters.
- Use a natural language feature that allows users to type commands or requests in normal English phrases. For example, many applications allow users to request Help by typing a question into a dialog box. The software then uses natural language technology to retrieve a list of topics that match the request. Most users like natural language features because they do not have to memorize a series of complex commands and syntax. According to the American Association for Artificial Intelligence (AAAI), the value of being able to communicate with computers in everyday “natural” language cannot be overstated. Natural language technology is used in speech recognition systems, text-to-speech synthesizers, automated voice response systems, Web search engines, text editors, and language instruction materials.
Make It Easy for Users to Obtain Help or Correct Errors

- Ensure that help is always available. Help screens should provide information about menu choices, procedures, shortcuts, and errors.
- Provide user-selected help and context-sensitive help. User-selected help displays information when the user requests it. By making appropriate choices through the menus and submenus, the user eventually reaches a screen with the desired information. Figure 8-14 shows the main Help screen for the student registration system. Context-sensitive help offers assistance for the task in progress. Figure 8-15 on the next page shows a Help dialog box that is displayed if a user requests help while entering data into the ADVISOR ASSIGNED field. Clicking the Close button returns the user to the current task.
- Provide a direct route for users to return to the point from where help was requested. Title every help screen to identify the topic, and keep help text simple and concise. Insert blank lines between paragraphs to make Help easier to read, and provide examples where appropriate.
- Include contact information, such as a telephone extension or e-mail address if a department or help desk is responsible for assisting users.
- Require user confirmation before data deletion (Are you sure?) and provide a method of recovering data that is deleted inadvertently. Build in safeguards that prevent critical data from being changed or erased.
- Provide an Undo key or a menu choice that allows the user to eradicate the results of the most recent command or action.
- When a user-entered command contains an error, highlight the erroneous part and allow the user to make the correction without retyping the entire command.
- Use hypertext links to assist users as they navigate through help topics.

**FIGURE 8-13** This menu hierarchy shows tasks, commands, and functions organized into logical groups and sequences. The structure resembles a functional decomposition diagram (FDD), which is a model of business functions and processes.

**FIGURE 8-14** The main Help screen for a student registration system.
Chapter 8  User Interface Design

Minimize Input Data Problems

- Create input masks, which are templates or patterns that make it easier for users to enter data. Also use data validation rules, which limit the acceptable values that users can enter. More information on input masks and data validation rules is provided in the section on input design later in the chapter.

- Display event-driven messages and reminders. Just as context-sensitive help is important to users, it is desirable to display an appropriate message when it is time for the user to perform a certain task. For example, when exiting the system, a message might ask users if they want a printed report of the data entered during the recent session.

- Establish a list of predefined values that users can click to select. Predefined values prevent spelling errors, avoid inappropriate data in a field, and make the user’s job easier — the input screen displays a list of acceptable values and the user simply points and clicks the choice.

- Build in rules that enforce data integrity. For example, if the user tries to enter an order for a new customer, the customer must be added before the system will accept the order data.

Provide Feedback to Users

- Display messages at a logical place on the screen, and be consistent.

- Alert users to lengthy processing times or delays. Give users an on-screen progress report, especially if the delay is lengthy.

- Allow messages to remain on the screen long enough for users to read them. In some cases, the screen should display messages until the user takes some action.

- Let the user know whether the task or operation was successful or not. For example, use messages such as Update completed, All transactions have been posted, or ID Number not found.

- Provide a text explanation if you use an icon or image on a control button. This helps the user to identify the control button when moving the mouse pointer over the icon or image.

- Use messages that are specific, understandable, and professional. Avoid messages that are cute, cryptic, or vague, such as: ERROR — You have entered an unacceptable value, or Error DE4-16. Better examples are: Enter a number between 1 and 5; Customer number must be numeric. Please re-enter a numeric value; or Call the Accounting Department, Ext. 239 for assistance.
Create an Attractive Layout and Design

- Use appropriate colors to highlight different areas of the screen; avoid gaudy and bright colors.
- Use special effects sparingly. For example, animation and sound might be effective in some situations, but too many special effects can be distracting and annoying to a user, especially if he or she must view them repeatedly.
- Use hyperlinks that allow users to jump to related topics.
- Group related objects and information. Visualize the screen the way a user will see it, and simulate the tasks that the user will perform.
- Screen density is important. Keep screen displays uncluttered, with enough white space to create an attractive, readable design.
- Display titles, messages, and instructions in a consistent manner and in the same general locations on all screens.
- Use consistent terminology. For example, do not use the terms delete, cancel, and erase to indicate the same action. Similarly, the same sound always should signal the same event.
- Ensure that commands always will have the same effect. For example, if the BACK control button returns a user to the prior screen, the BACK command always should perform that function throughout the application.
- Ensure that similar mouse actions will produce the same results throughout the application. The results of pointing, clicking, and double-clicking should be consistent and predictable.
- When the user enters data that completely fills the field, do not move automatically to the next field. Instead, require the user to confirm the entry by pressing the ENTER key or TAB key at the end of every fill-in field.

Use Familiar Terms and Images

- Remember that users are accustomed to a pattern of red = stop, yellow = caution, and green = go. Stick to that pattern and use it when appropriate to reinforce on-screen instructions.
- Provide a keystroke alternative for each menu command, with easy-to-remember letters, such as File, Exit, and Help.
- Use familiar commands if possible, such as Cut, Copy, and Paste.
- Provide a Windows look and feel in your interface design if users are familiar with Windows-based applications.
- Avoid complex terms and technical jargon; instead, select terms that come from everyday business processes and the vocabulary of a typical user.

Add Control Features

The designer can include many features, such as menu bars, toolbars, dialog boxes, text boxes, toggle buttons, list boxes, scroll bars, drop-down list boxes, option buttons, check boxes, command buttons, and calendar controls, among others. Figure 8-16 on the next page shows a data entry screen for the student registration system. The screen design uses several features that are described in the following section.
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Designing the User Interface

The menu bar at the top of the screen displays the main menu options. Some software packages allow you to create customized menu bars and toolbars. You can add a shortcut feature that lets a user select a menu command either by clicking the desired choice or by pressing the alt key + the underlined letter. Some forms also use a toolbar that contains icons or buttons that represent shortcuts for executing common commands.

A command button initiates an action such as printing a form or requesting help. For example, when a user clicks the Find Student command button in Figure 8-16, a dialog box opens with instructions, as shown in Figure 8-17.

Other design features include dialog boxes, text boxes, toggle buttons, list boxes, scroll bars, drop-down list boxes, option or radio buttons, check boxes, and calendar controls. These features are described as follows:

- A dialog box allows a user to enter information about a task that the system will perform.
- A text box can display messages or provide a place for a user to enter data.
- A toggle button is used to represent on or off status — clicking the toggle button switches to the other status.
- A list box displays a list of choices that the user can select. If the list does not fit in the box, a scroll bar allows the user to move through the available choices.
- A drop-down list box displays the current selection; when the user clicks the arrow, a list of the available choices displays.
- An option button, or radio button, represents one choice in a set of options. The user can select only one option at a time, and selected options show a black dot.
- A check box is used to select one or more choices from a group. Selected options are represented by a checkmark or an X.
- A calendar control allows the user to select a date that the system will use as a field value.

Screen design requires a sense of aesthetics as well as technical skills. You should design screens that are attractive, easy to use, and workable. You also should obtain user feedback early and often as the design process continues.

The opening screen is especially important because it introduces the application and allows users to view the main options. When designing an opening screen, you can use a main form that functions as a switchboard. A switchboard uses command buttons that enable users to navigate the system and select from groups of related...
tasks. Figure 8-18 shows the switchboard and a data entry screen for a project management system. Notice the drop-down list box that allows users to enter a status code simply by clicking a selection.

FIGURE 8-18 An example of a switchboard and data entry screen for a project management system.

CASE IN POINT 8.2: BOOLEAN TOYS

When should a systems analyst decide a design issue, and when should users be allowed to select what works best for them? The field of ergonomics is concerned with improving the work environment and studying how users interact with their environment.

Suppose you are a systems analyst studying the order processing system at Boolean Toys, a fast-growing developer of software for preschool children. You know that many data entry users have complained about the input screens. Some users would prefer to rearrange the order of the fields; others would like to change the background color on their screens; still others want shortcuts that would allow them to avoid a series of introductory screens.

What if Boolean’s users could customize their own data entry screens without assistance from the IT staff by using a menu-driven utility program? What would be the pros and cons of such an approach?

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OUTPUT DESIGN

Before designing output, ask yourself several questions:

- What is the purpose of the output?
- Who wants the information, why is it needed, and how will it be used?
- What specific information will be included?
- Will the output be printed, viewed on-screen, or both? What type of device will the output go to?
- When will the information be provided, and how often must it be updated?
- Do security or confidentiality issues exist?

The design process should not begin until you have answered those questions. Some of the information probably was gathered during the systems analysis phase. To complete your understanding, you should meet with users to find out exactly what kind of output is needed. You can use prototypes and mock-ups to obtain feedback throughout the design process. Your answers will affect your output design strategies, as you will see in the next section.

In today’s interconnected world, output from one system often becomes input for another system. For example, within a company, production data from the manufacturing system becomes input to the inventory system. The same company might transmit employee W-2 tax data to the IRS system electronically. A company employee might use tax preparation software to file a tax return online, receive a refund deposited directly into his or her bank account, and see the deposit reflected on the bank’s information system.

Although digital technology has opened new horizons in business communications, printed material still is a common type of output, and specific considerations apply to it. For those reasons, printed and screen reports are discussed in a separate section, which follows.

Overview of Report Design

Although many organizations strive to reduce the flow of paper and printed reports, few firms have been able to eliminate printed output totally. Because they are portable, printed reports are convenient, and even necessary in some situations. Many users find it handy to view screen output, then print the information they need for a discussion or business meeting. Printed output also is used in turnaround documents, which are output documents that are later entered back into the same or another information system. In some areas, your telephone or utility bill, for example, might be a turnaround document printed by the company’s billing system. When you return the required portion of the bill with your check, the bill is scanned into the company’s accounts receivable system to record the payment accurately.

Designers use a variety of styles, fonts, and images to produce reports that are attractive and user friendly. Whether printed or viewed on-screen, reports must be easy to read and well organized. Rightly or wrongly, some managers judge an entire project by the quality of the reports they receive.

Database programs such as Microsoft Access include a variety of report design tools, including a Report Wizard, which is a menu-driven feature that designers can use to create reports quickly and easily. Microsoft Access also provides a comprehensive guide to designing reports, as shown in Figure 8-19.

In addition to built-in design tools, popular software packages such as Crystal Reports offer powerful features that help designers deal with professional-level design issues across the enterprise, as shown in Figure 8-20.
FIGURE 8-19 Microsoft offers suggestions, tips, and a video that can help you design better forms and reports.

FIGURE 8-20 Crystal Reports is a popular, powerful, report design package.
Although the vast majority of reports are designed graphically, some systems still produce one or more character-based reports that use a character set with fixed spacing. Printing character-based reports on high-speed impact printers is a fast, inexpensive method for producing large-scale reports, such as payroll or inventory reports, or registration rosters at a school. This is especially true if multiple copies are required.

### Types of Reports

To be useful, a report must include the information that a user needs. From a user’s point of view, a report with too little information is of no value. Too much information, however, can make a report confusing and difficult to understand. When designing reports, the essential goal is to match the report to the user’s specific information needs. Depending on their job functions, users might need one or more of the reports described in the following sections.

#### DETAIL REPORTS

A detail report produces one or more lines of output for each record processed. Each line of output printed is called a detail line. Figure 8-21 shows a simple detail report of employee hours for a chain of retail stores. Notice that one detail line prints for each employee. All the fields in the record do not have to be printed, nor do the fields have to be printed in the sequence in which they appear in the record. An employee paycheck that has multiple output lines for a single record is another example of a detail report.

Because it contains one or more lines for each record, a detail report can be quite lengthy. Consider, for example, a large auto parts business. If the firm stocks 3,000 parts, then the detail report would include 3,000 detail lines on approximately 50 printed pages. A user who wants to locate any part in short supply has to examine 3,000 detail lines to find the critical items. A much better alternative is to produce an exception report.

![Figure 8-21](image)

**FIGURE 8-21** A detail report with one printed line per employee.

#### EXCEPTION REPORTS

An exception report displays only those records that meet a specific condition or conditions. Exception reports are useful when the user wants information only on records that might require action, but does not need to know the details. For example, a credit manager might use an exception report to identify only those customers with past due accounts, or a customer service manager might want a report on all packages that were not delivered within a specified time period. Figure 8-22 shows an exception report that includes information only for those employees who worked overtime, instead of listing information for all employees.
FIGURE 8-22 An exception report that shows information only for employees who worked overtime.

SUMMARY REPORTS Upper-level managers often want to see total figures and do not need supporting details. A sales manager, for example, might want to know total sales for each sales representative, but not want a detail report listing every sale made by them. In that case, a summary report is appropriate. Similarly, a personnel manager might need to know the total regular and overtime hours worked by employees in each store but might not be interested in the number of hours worked by each employee. For the personnel manager, a summary report such as the one shown in Figure 8-23 would be useful. Generally, reports used by individuals at higher levels in the organization include less detail than reports used by lower-level employees.

FIGURE 8-23 A summary report displays totals without showing details.

User Involvement in Report Design

Printed reports are an important way of delivering information, so users should approve all report designs in advance. The best approach is to submit each design for approval as you complete it, rather than waiting until you finish all report designs.

When designing a report, you should prepare a sample report, called a mock-up, or prototype, for users to review. The sample should include typical field values and contain enough records to show all the design features. Depending on the type of printed output, you can create a Word document or use a report generator to create mock-up reports. After a report design is approved, you should document the design by creating a report analysis form, which contains information about the layout, fields, frequency, distribution, data security considerations, and other issues.
Report Design Principles

Printed reports must be attractive, professional, and easy to read. For example, a well-designed detail report should provide totals for numeric fields. Notice that the report shown in Figure 8-21 on page 352 lacked subtotals and grand totals for regular hours, overtime hours, and total hours. Figure 8-24 shows the same report with subtotals and grand totals added. In the example, the Store Number field is called a control field because it controls the output.

When the value of a control field changes, a control break occurs. A control break usually causes specific actions, such as printing subtotals for a group of records. That type of detail report is called a control break report. To produce a control break report, the records must be arranged, or sorted, in control field order. The sorting can be done by the report program itself, or in a previous procedure.

Good report design requires effort and attention to detail. To produce a well-designed report, the analyst must consider design features such as report headers and footers, page headers and footers, column headings and alignment, column spacing, field order, and grouping of detail lines. The report shown in Figure 8-24 shows examples of these design features.

REPORT HEADERS AND FOOTERS Every report should have a report header and a report footer. The report header, which appears at the beginning of the report, identifies the report, and contains the report title, date, and other necessary information. The report footer, which appears at the end of the report, can include grand totals for numeric fields and other end-of-report information, as shown in Figure 8-24.

<table>
<thead>
<tr>
<th>Store Number</th>
<th>Employee Name</th>
<th>Position</th>
<th>Regular Hours</th>
<th>Overtime Hours</th>
<th>Total Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Andres, Marguerite</td>
<td>Clerk</td>
<td>20.0</td>
<td>0.0</td>
<td>20.0</td>
</tr>
<tr>
<td>8</td>
<td>Bogema, Michelle</td>
<td>Clerk</td>
<td>12.5</td>
<td>0.0</td>
<td>12.5</td>
</tr>
<tr>
<td>8</td>
<td>Davenport, Kim</td>
<td>Asst Mgr</td>
<td>40.0</td>
<td>5.0</td>
<td>45.0</td>
</tr>
<tr>
<td>8</td>
<td>Lemka, Susan</td>
<td>Clerk</td>
<td>32.7</td>
<td>0.0</td>
<td>32.7</td>
</tr>
<tr>
<td>8</td>
<td>Ramirez, Rudy</td>
<td>Manager</td>
<td>40.0</td>
<td>8.5</td>
<td>48.5</td>
</tr>
<tr>
<td>8</td>
<td>Ullery, Ruth</td>
<td>Clerk</td>
<td>20.0</td>
<td>0.0</td>
<td>20.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Store 8 totals:</th>
<th>165.2</th>
<th>13.5</th>
<th>178.7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store 17 totals:</td>
<td>172.0</td>
<td>19.4</td>
<td>191.4</td>
</tr>
</tbody>
</table>

Grand totals: 337.2 32.9 370.1

**FIGURE 8-24** The Employee Hours report is a detail report with control breaks, subtotals, and grand totals. Notice that a report header identifies the report, a page header contains column headings, a group footer contains subtotals for each store, a report footer contains grand totals, and a page footer identifies the page number.
OUTPUT DESIGN

PAGE HEADERS AND FOOTERS Every page should include a page header, which appears at the top of the page and includes the column headings that identify the data. The headings should be short but descriptive. Avoid abbreviations unless you know that users will understand them clearly. Either a page header or a page footer, which appears at the bottom of the page, is used to display the report title and the page number.

COLUMN HEADING ALIGNMENT Figure 8-25 shows several column heading alignment options. In Example 1, the left-justified column headings do not work well with numeric fields because the amount 1.25 would print past the right edge of the AMOUNT heading. In Example 2, the right-justified headings cause a problem with alphanumeric fields, because none of the characters in a short name would print under any part of the NAME heading. Centering headings over maximum field widths, as shown in Example 3, is not ideal when many of the actual values are shorter than the maximum width. Many designers prefer Example 4, where headings are left-justified over alphanumeric fields and right-justified over numeric fields.

COLUMN SPACING You should space columns of information carefully. A crowded report is hard to read, and large gaps between columns make it difficult for the eye to follow a line. Columns should stretch across the report, with uniform spacing and suitable margins at top, bottom, right, and left. Some report designers use landscape orientation when working with a large number of columns; others prefer to break the information into more than one report. In some cases, a smaller point size will solve the problem, but the report must remain readable and acceptable to users.

FIELD ORDER Fields should be displayed and grouped in a logical order. For example, the report shown in Figure 8-24 shows the detail lines printed in alphabetical order within store number, so the store number is in the left column, followed by the employee name. The employee position relates to the employee’s name, so the items are adjacent. The three hours fields also are placed together.

GROUPING DETAIL LINES Often, it is meaningful to arrange detail lines in groups, based on a control field. For example, using the department number as a control field, individual employees can be grouped by department. You can print a group header.
above the first detail line and a **group footer** after the last detail line in a group, as shown in Figure 8-24.

Database programs such as Microsoft Access make it easy to create groups and subgroups based on particular fields. You also can have the report calculate and display totals, averages, record counts, and other data for any group or subgroup. For example, in a large company, you might want to see total sales and number of sales broken down by product within each of the 50 states. The screen shown in Figure 8-26 is an Access Help screen that refers to a step-by-step process for creating multilevel grouping.

![FIGURE 8-26 Microsoft Access includes an easy-to-use tool for grouping data.](image)

**REPEATING FIELDS** Report design is an art, not a science. User involvement is essential, but users often don't know what they want without seeing samples. For example, consider the issue of repeating fields. The sample report in Figure 8-21 on page 352 repeats the store number on every row. Is that a good thing? The best advice is to ask users what they think, and be guided accordingly. A similar issue exists with regard to the overtime hours column. Is it better to print the zero overtime data, or only print actual hours, so the data stands out clearly? Again, the best answer is usually the one that works best for users.

**CONSISTENT DESIGN** Look and feel are important to users, so reports should be uniform and consistent. When a system produces multiple reports, each report should share common design elements. For example, the date and page numbers should print in the same place on each report page. Abbreviations used in reports also should be consistent. For example, when indicating a numeric value, it is confusing for one report to use #, another NO, and a third NUM. Items in a report also should be consistent. If one report displays the inventory location as a shelf number column followed by a bin number column, that same layout should be used on all inventory location reports.
CASE IN POINT 8.3: LAZY EDDIE

Lynn Jennings is the IT manager at Lazy Eddie, a chain that specializes in beanbag chairs and recliners. She asked Jan Lauten, a senior systems analyst, to review the large number of printed reports that are distributed to Lazy Eddie’s 35 store managers. “Jan, I just can’t believe that our people really read all of those reports,” Lynn said. “We constantly add new reports, and we never seem to eliminate the old ones. Sometimes I think all we’re doing is keeping the paper companies in business!” Jan replied, “I agree, but what can we do? The managers say they want the reports, but I always see them stacked on top of file cabinets. I’ve never seen anyone read a report.”

“I have an idea,” Lynn said. “I want you to come up with a procedure that requires users to review and justify their information needs to see if they really use the reports we send them. You could design a form that asks if the information still is required, and why. Try to get users to decide if a report is worth the cost of producing it. Do you think you can do it?”

“Sure I can,” Jan replied. When Jan returned to her office, she wondered where to begin. What advice would you give to Jan?

Output Technology

Although business information systems still provide most output as screen displays and printed matter, technology is having an enormous impact on how people communicate and obtain information. This trend is especially important to firms that use information technology to lower their costs, improve employee productivity, and communicate effectively with their customers.

In addition to screen output and printed matter, output can take many forms. The system requirements document probably identified user output needs. Now, in the systems design phase, you will create the actual forms, reports, documents, and other types of output. During this process, you must consider the format and how it will be delivered, stored, and retrieved. The following sections explain various output types and the technologies that are available to systems developers.

INTERNET-BASED INFORMATION DELIVERY

Millions of firms use the Internet to reach new customers and markets around the world. To support the explosive growth in e-commerce, Web designers must provide user-friendly screen interfaces that display output and accept input from customers. For example, a business can link its inventory system to its Web site so the output from the inventory system is displayed as an online catalog. Customers visiting the site can review the items, obtain current prices, and check product availability.

Another example of Web-based output is a system that provides customized responses to product or technical questions. When a user enters a product inquiry or requests technical support, the system responds with appropriate information from an on-site knowledge base. Web-based delivery allows users to download a universe of files and documents to support their information needs. For example, the Web provides consumers with instant access to brochures, product manuals, and parts lists; while prospective home buyers can obtain instant quotes on mortgages, insurance, and other financial services.

To reach prospective customers and investors, companies also use a live or prerecorded Webcast, which is an audio or video media file distributed over the Internet. Radio and TV stations also use this technique to broadcast program material to their audiences.

E-MAIL

E-mail is an essential means of internal and external business communication. Employees send and receive e-mail on local or wide area networks, including the Internet. Companies send new product information to customers via e-mail, and financial services
companies use e-mail messages to confirm online stock trades. Employees use e-mail to exchange documents, data, and schedules and to share business-related information they need to perform their jobs. In many firms, e-mail has virtually replaced traditional memos and printed correspondence.

**BLOGS**  Web-based logs, called blogs, are another form of Web-based output. Because blogs are journals written from a particular point of view, they not only deliver facts to Web readers, but also provide opinions. Blogs are useful for posting news, reviewing current events, and promoting products.

**INSTANT MESSAGING**  This popular form of communication is another way for individuals and companies to communicate effectively over the Internet. Although some users feel that it can be a distraction, others like the constant flow of communication, especially as a team member in a collaborative situation.

**WIRELESS DEVICES**  Messages and data can be transmitted to a wide array of mobile devices, including PDAs, handheld computers, smart cell phones, and similar wireless products that combine portable computing power, multimedia capability, and Internet access.

**DIGITAL AUDIO, IMAGES, AND VIDEO**  Sounds, images, and video clips can be captured, stored in digital format, and transmitted as output to users who can reproduce the content.

Audio or video output can be attached to an e-mail message or inserted as a clip in a Microsoft Word document, as shown in Figure 8-27. Businesses also use automated systems to handle voice transactions and provide information to customers. For example, using a telephone keypad, a customer can confirm an airline seat assignment, check a credit card balance, or determine the current price of a mutual fund.

If a picture is worth a thousand words, then digital images and video clips certainly are high-value output types that offer a whole new dimension. For example, an insurance adjuster with a digital camera phone can take a picture, submit the image via a wireless device, and receive immediate authorization to pay a claim on the spot. If images are a valuable form of output, video clips are even better in some situations. For example, video clips provide online virtual tours that allow realtors to show off the best features of homes they are marketing. The user can zoom in or out, and rotate the image in any direction.

**PODCASTS**  A podcast is a specially formatted digital audio file that can be downloaded by Internet users from a variety of content providers. Many firms use podcasts as sales and marketing tools, and to communicate with their own employees. Using software such as iTunes, you can receive a podcast, launch the file on your computer, and store it on your portable player. Podcasts can include images, sounds, and video.

**AUTOMATED FAXSIMILE SYSTEMS**  An automated facsimile or faxback system allows a customer to request a fax using e-mail, via the company Web site, or by telephone. The response is transmitted in a matter of seconds back to the user's fax machine. Although most users prefer to download documents from the Web, many organizations, including the U.S. Department of Transportation, still offer an automated faxback service as another way to provide immediate response 24 hours a day.

**COMPUTER OUTPUT TO MICROFILM (COM)**  Computer output to microfilm (COM) is often used by large firms to scan and store images of original documents to provide high-quality records management and archiving. COM systems are especially important for legal reasons, or where it is necessary to display a signature, date stamp, or other visual features of a document.
Output Design

Phase 3  Systems Design

COMPUTER OUTPUT TO DIGITAL MEDIA  This process is used when many paper documents must be scanned, stored in digital format, and retrieved quickly. For example, if an insurance company stores thousands of paper application forms, special software can treat the documents as data and extract information from a particular column or area on the form. Digital storage media can include magnetic tape, CDs, DVDs, and high-density laser disks.

SPECIALIZED FORMS OF OUTPUT  An incredibly diverse marketplace requires many forms of specialized output and devices such as these:

- Portable, Web-connected devices that can run applications, handle multimedia output, and provide powerful, multipurpose communication for users
- Retail point-of-sale terminals that handle computer-based credit card transactions, print receipts, and update inventory records
- Automatic teller machines (ATMs) that can process bank transactions and print deposit and withdrawal slips
- Special-purpose printers that can produce labels, employee ID cards, driver’s licenses, gasoline pump receipts, and, in some states, lottery tickets
- Plotters that can produce high-quality images such as blueprints, maps, and electronic circuit diagrams
- Electronic detection of data embedded in credit cards, bank cards, and employee identification cards

FIGURE 8-27  Audio or video clips can be attached to an e-mail message or inserted in a document. The recipient can double-click the link or icon and a media player opens the file.
INPUT DESIGN

No matter how data enters an information system, the quality of the output is only as good as the quality of the input. The term garbage in, garbage out (GIGO), is familiar to IT professionals, who know that the best time to avoid problems is when the data is entered. The objective of input design is to ensure the quality, accuracy, and timeliness of input data.

Good input design requires attention to human factors as well as technology issues. This section includes a discussion of source documents, data entry screen design, input masks, and data validation rules. The final topic, input technology, examines devices and techniques that can speed up the input process, reduce costs, and handle new forms of data.

Source Documents and Forms

A source document collects input data, triggers or authorizes an input action, and provides a record of the original transaction. During the input design stage, you develop source documents that are easy to complete and use for data entry. Source documents generally are paper-based, but also can be provided online. Either way, the design considerations are the same.

Consider a time when you struggled to complete a poorly designed form. You might have encountered insufficient space, confusing instructions, or poor organization, all symptoms of incorrect form layout. Good form layout makes the form easy to complete and provides enough space, both vertically and horizontally, for users to enter the data. A form should indicate data entry positions clearly using blank lines or boxes and descriptive captions. Figure 8-28 shows several techniques for using line and boxed captions in source documents, and an example of check boxes, which are effective when a user must select choices from a list.

The placement of information on a form also is important. Source documents typically include most of the zones shown in Figure 8-29. The heading zone usually contains the company name or logo and the title and number of the form. The control zone contains codes, identification information, numbers, and dates that are used for storing completed forms.

**FIGURE 8-28** Examples of caption techniques for source documents.
The **instruction zone** contains instructions for completing the form. The main part of the form, called the **body zone**, usually takes up at least half of the space on the form and contains captions and areas for entering variable data. If totals are included on the form, they appear in the **totals zone**. Finally, the **authorization zone** contains any required signatures.

Information should flow on a form from left to right and top to bottom to match the way users read documents naturally. That layout makes the form easy to use for the individual who completes the form, and for users who enter data into the system using the completed form. You can review samples of source document design that appear in the SWL case study on pages 382–387.

The same user-friendly design principles also apply to printed forms such as invoices and monthly statements, except that heading information usually is preprinted. You should make column headings short but descriptive, avoid nonstandard abbreviations, and use reasonable spacing between columns for better readability.

The order and placement of printed fields should be logical, and totals should be identified clearly. When designing a preprinted form, you should contact the form’s vendor for advice on paper sizes, type styles and sizes, paper and ink colors, field placement, and other important form details. Your goal is to design a form that is attractive, readable, and effective.

Layout and design also are important on Web-based forms, and you can find many resources that will help you design efficient, user-friendly forms. For example, Figure 8-30 describes a book by Luke Wroblewski, a well-known author and consultant. His Web site offers valuable suggestions, guidelines, and examples.

A major challenge of Web-based form design is that most people read and interact differently with on-screen information compared to paper forms. In the view of Dr. Jakob Nielsen, a pioneer in Web usability design, users simply do not read on the Web,
as shown in Figure 8-31. Dr. Nielsen believes that users scan a page, picking out individual words and sentences. As a result, Web designers must use scannable text to capture and hold a user’s attention. On his site, Dr. Nielsen offers several suggestions for creating scannable text. Also notice that Dr. Nielsen employs various usability metrics to measure user responses, comprehension, and recall.

FIGURE 8-31 Dr. Jakob Nielsen believes that users scan Web material rather than reading it. He suggests that Web designers must use scannable text and employ usability metrics to measure the results.

CASE IN POINT 8.4: TRUSTWORTHY INSURANCE COMPANY

Trustworthy Insurance maintains its headquarters in a large Midwestern city. Right now, a debate is raging in the IT department. Several analysts want to use standard, company-wide desktop screen layouts and icons. Others want to allow users to set up their screens any way they choose. Those who argue for standardization point out that Trustworthy employs a number of part-time employees, who fill in for employees on vacation. Without a standard interface, these people would have to reorient to every workstation, and the proponents of standardization claim that would reduce productivity and increase costs. Those opposed to standardization believe that employees are most productive when they have control over their workplace, including the ability to design an interface they feel is attractive, even if no one else does.

You are on a committee that was charged with resolving this issue, and yours is the tie-breaking vote. What will you decide, and why?
Data Entry Screens

During input design, you determine how data will be captured and entered into the system. **Data capture** uses an automated or manually operated device to identify source data and convert it into computer-readable form. Examples of data capture devices include credit card scanners and bar code readers. **Data entry** is the process of manually entering data into the information system, usually in the form of keystrokes, mouse clicks, touch screens, or spoken words.

Some users work with many features of the user interface; others spend most of their time entering data. This section discusses design guidelines and concepts that primarily relate to repetitive data entry. Notice that many of the guidelines are based on general principles of interface design discussed in this chapter.

The most effective method of online data entry is **form filling**, in which a blank form that duplicates or resembles the source document is completed on the screen. The user enters the data and then moves to the next field. The following guidelines will help you design data entry screens that are easy to learn and use.

1. Restrict user access to screen locations where data is entered. For example, when the screen in Figure 8-32 appears, the system should position the insertion point in the first data entry location. After the operator enters a Customer ID, the insertion point should move automatically to the entry location for the next field (Item). A user should be able to position the insertion point only in places where data is entered on the form.

![FIGURE 8-32](image)

In this data screen for customer orders, the system generates an order number and logs the current date and time. The user enters a customer ID. If the entry is valid, the system displays the customer name so the user can verify it. The user then enters the item and quantity. Note that the description, price, extended price, total price, sales tax, and grand total are retrieved automatically or calculated by the system.
2. Provide a descriptive caption for every field, and show the user where to enter the data and the required or maximum field size. Typically, white boxes show the location and length of each field. Other methods used to indicate field locations are video highlighting, underscores, special symbols, or a combination of these features.

3. Display a sample format if a user must enter values in a field in a specific format. For example, provide an on-screen instruction to let users know that the date format is MMDDYY, and provide an example if the user must enter separators, such as slashes. It is better to use an input mask, so users simply can enter 112711 to represent November 27, 2011.

4. Require an ending keystroke for every field. Pressing the enter key or the tab key should signify the end of a field entry. Avoid a design that moves automatically to the next item when the field is full. The latter approach requires an ending keystroke only when the data entered is less than the maximum field length. It is confusing to use two different data entry procedures.

5. Do not require users to type leading zeroes for numeric fields. For example, if a three-digit project number is 045, the operator should be able to type 45 instead of 045 before pressing the enter key. An exception to that rule might occur when entering a date, where a leading zero is needed to identify single-digit months or days, such as 06-04-2011.

6. Do not require users to type trailing zeroes for numbers that include decimals. For example, when a user types a value of 98, the system should interpret the value as 98.00 if the field has been formatted to include numbers with two decimal places. The decimal point is needed only to indicate nonzero decimal places, such as 98.76.

7. Display default values so operators can press the enter key to accept the suggested value. If the default value is not appropriate, the operator can change it.

8. Use a default value when a field value will be constant for successive records or throughout the data entry session. For example, if records are input in order by date, the date used in the first transaction should be used as the default date until a new date is entered, at which time the new date becomes the default value.

9. Display a list of acceptable values for fields, and provide meaningful error messages if the user enters an unacceptable value. An even better method, which was described in the user interface design section, is to provide a drop-down list box containing acceptable values that allows the user to select a value by clicking.

10. Provide a way to leave the data entry screen at any time without entering the current record. This feature is available in the screen shown in Figure 8-33, which is an enhanced version of the data entry screen shown in Figure 8-32 on the previous page. Notice that the new version has command buttons that provide flexibility and allow the user to perform various functions. For example, clicking the Cancel Order Without Entering button cancels the current order and moves the insertion point back to the beginning of the form.

11. Provide users with an opportunity to confirm the accuracy of input data before entering it by displaying a message such as, Add this record? (Y/N). A positive response (Y) adds the record, clears the entry fields, and positions the insertion point in the first field so the user can input another record. If the response is negative (N), the current record is not added and the user can correct the errors.

12. Provide a means for users to move among fields on the form in a standard order or in any order they choose. For example, when a user opens the form shown in Figure 8-33, the insertion point automatically will be in the first field. After the user fills in each field and confirms the entry, the insertion point moves to the next field, in a
FIGURE 8-33 This is an enhanced version of the data entry screen shown in Figure 8-32. The new version has command buttons that allow the user to perform various functions.

predetermined order. In a graphical user interface (GUI), the user can override the standard field order and select field locations using the mouse or arrow keys.

13. Design the screen form layout to match the layout of the source document. If the source document fields start at the top of the form and run down in a column, the input screen should use the same design.

14. Allow users to add, change, delete, and view records. Figure 8-33 shows a screen that can be used for entering orders, finding items, and finding customers. After the operator enters a customer identification code, the order form displays current values for all appropriate fields. Then the operator can view the data, make changes, enter the order, or cancel without ordering. Messages such as: Apply these changes? (Y/N) or Delete this record? (Y/N) should require users to confirm the actions. Highlighting the letter N as a default response will avoid problems if the user presses the ENTER key by mistake.

15. Provide a method to allow users to search for specific information, as shown in Figure 8-33.

Input Masks

Use input masks, which are templates or patterns that restrict data entry and prevent errors. Microsoft Access 2010 provides standard input masks for fields such as dates, telephone numbers, postal codes, and Social Security numbers. In addition, you can create custom input masks for any type of data, as shown in Figure 8-34 on the next page. Notice that a mask can manipulate the input data and apply a specific format. For example, if a user enters text in lowercase letters, the input mask >L<???????????????? will automatically capitalize the first letter.
FIGURE 8-34 Microsoft Access 2010 provides various input masks for dates, phone numbers, and postal codes, among others. In addition, it is easy to create a custom mask using the characters shown here.

Validation Rules

Reducing the number of input errors improves data quality. One way to reduce input errors is to eliminate unnecessary data entry. For example, a user cannot misspell a customer name if it is not entered, or is entered automatically based on the user entering the customer ID. Similarly, an outdated item price cannot be used if the item price is retrieved from a master file instead of being entered manually.
The best defense against incorrect data is to identify and correct errors before they enter the system by using data validation rules, as shown in Figure 8-35. A **data validation rule** improves input quality by testing the data and rejecting any entry that fails to meet specified conditions. You can design at least eight types of data validation rules. For example:

1. **A sequence check** is used when the data must be in some predetermined sequence. If the user must enter work orders in numerical sequence, for example, then an out-of-sequence order number indicates an error, or if the user must enter transactions chronologically, then a transaction with an out-of-sequence date indicates an error.

2. An **existence check** is used for mandatory data items. For example, if an employee record requires a Social Security number, an existence check would not allow the user to save the record until he or she enters a suitable value in the Social Security number field.

3. A **data type check** tests to ensure that a data item fits the required data type. For example, a numeric field must have only numbers or numeric symbols, and an alphabetic field can contain only the characters A through Z (or a through z).

4. A **range check** tests data items to verify that they fall between a specified minimum and maximum value. The daily hours worked by an employee, for example, must fall within the range of 0 to 24. When the validation check involves a minimum or a maximum value, but not both, it is called a **limit check**. Checking that a payment amount is greater than zero, but not specifying a maximum value, is an example of a limit check.

5. A **reasonableness check** identifies values that are questionable, but not necessarily wrong. For example, input payment values of $.05 and $5,000,000.00 both pass a simple limit check for a payment value greater than zero, and yet both values could be errors. Similarly, a daily hours worked value of 24 passes a 0 to 24 range check; however, the value seems unusual, and the system should verify it using a reasonableness check.

6. A **validity check** is used for data items that must have certain values. For example, if an inventory system has 20 valid item classes, then any input item that does not match one of the valid classes will fail the check. Verifying that a customer number on an order matches a customer number in the customer file is another type of validity check. Because the value entered must refer to another value, that type of check also is called **referential integrity**, which is explained in Chapter 9, Data Design. Another validity check might verify that a new customer number does not match a number already stored in the customer master file.

![FIGURE 8-35 Validation rules can improve data quality by requiring the input to meet specific requirements or conditions.](image)
7. A combination check is performed on two or more fields to ensure that they are consistent or reasonable when considered together. Even though all the fields involved in a combination check might pass their individual validation checks, the combination of the field values might be inconsistent or unreasonable. For example, if an order input for 30 units of a particular item has an input discount rate applicable only for purchases of 100 or more units, then the combination is invalid; either the input order quantity or the input discount rate is incorrect.

8. Batch controls are totals used to verify batch input. Batch controls might check data items such as record counts and numeric field totals. For example, before entering a batch of orders, a user might calculate the total number of orders and the sum of all the order quantities. When the batch of orders is entered, the order system also calculates the same two totals. If the system totals do not match the input totals, then a data entry error has occurred. Unlike the other validation checks, batch controls do not identify specific errors. For example, if the sum of all the order quantities does not match the batch control total, you know only that one or more orders in that batch were entered incorrectly or not input. The batch control totals often are called hash totals, because they are not meaningful numbers themselves, but are useful for comparison purposes.

**Input Technology**

Input technology has changed dramatically in recent years. In addition to traditional devices and methods, there has been a rapid expansion of new hardware and ways to capture and enter data into a system, some of which are shown in Figure 8-36. Businesses are using the new technology to speed up the input process, reduce costs, and capture data in new forms, such as the digital signature shown in Figure 8-37.

The following sections discuss input and data entry methods, and the impact of input volume reduction.

**Batch Input** Using batch input, data entry usually is performed on a specified time schedule, such as daily, weekly, monthly, or longer. For example, batch input occurs when a payroll department collects time cards at the end of the week and enters the
data as a batch. Another example is a school that enters all grades for the academic term in a batch.

**ONLINE INPUT** Although batch input is used in specific situations, most business activity requires **online data entry**. The online method offers major advantages, including the immediate validation and availability of data. A popular online input method is **source data automation**, which combines online data entry and automated data capture using input devices such as **RFID tags** or **magnetic data strips**. Source data automation is fast and accurate, and minimizes human involvement in the translation process.

Many large companies use a combination of source data automation and a powerful communication network to manage global operations instantly. Some common examples of source data automation are:

- Businesses that use point-of-sale (POS) terminals equipped with bar code scanners and magnetic swipe scanners to input credit card data.
- Automatic teller machines (ATMs) that read data strips on bank cards.
- Factory employees who use magnetic ID cards to clock on and off specific jobs so the company can track production costs accurately.
- Hospitals that imprint bar codes on patient identification bracelets and use portable scanners when gathering data on patient treatment and medication.
- Retail stores that use portable bar code scanners to log new shipments and update inventory data.
- Libraries that use handheld scanners to read optical strips on books.

**TRADEOFFS** Although online input offers many advantages, it does have some disadvantages. For example, unless source data automation is used, manual data entry is slower and more expensive than batch input because it is performed at the time the transaction occurs and often done when computer demand is at its highest.

The decision to use batch or online input depends on business requirements. For example, hotel reservations must be entered and processed immediately, but hotels can enter their monthly performance figures in a batch. In fact, some input occurs naturally in batches. A cable TV provider, for example, receives customer payments in batches when the mail arrives.
Input Volume Reduction

To reduce input volume, you must reduce the number of data items required for each transaction. Data capture and data entry require time and effort, so when you reduce input volume, you avoid unnecessary labor costs, get the data into the system more quickly, and decrease the number of errors. The following guidelines will help reduce input volume:

1. Input necessary data only. Do not input a data item unless it is needed by the system. A completed order form, for example, might contain the name of the clerk who took the order. If that data is not needed by the system, the user should not enter it.

2. Do not input data that the user can retrieve from system files or calculate from other data. In the order system example shown in Figure 8-33 on page 365, the system generates an order number and logs the current date and time. Then the user enters a customer ID. If the entry is valid, the system displays the customer name so the user can verify it. The user then enters the item and quantity. Note that the description, price, extended price, total price, sales tax, and grand total are retrieved automatically or calculated by the system.

3. Do not input constant data. If orders are in batches with the same date, then a user should enter the order date only once for the first order in the batch. If orders are entered online, then the user can retrieve the order date automatically using the current system date.

4. Use codes. Codes are shorter than the data they represent, and coded input can reduce data entry time. You will learn more about various types of codes in Chapter 9, Data Design.

Security and Control Issues

A company must do everything in its power to protect its data. This includes not only the firm’s own information, but that of its customers, employees, and suppliers. Most assets have a value, but corporate data is priceless, because without safe, secure, accurate data, a company cannot function.

The following sections discuss output and input data security and control.

Output Security and Control

Output must be accurate, complete, current, and secure. Companies use various output control methods to maintain output integrity and security. For example, every report should include an appropriate title, report number or code, printing date, and time period covered. Reports should have pages that are numbered consecutively, identified as Page nn of nn, and the end of the report should be labeled clearly. Control totals and record counts should be reconciled against input totals and counts. Reports should be selected at random for a thorough check of correctness and completeness. All processing errors or interruptions must be logged so they can be analyzed.

Output security protects privacy rights and shields the organization’s proprietary data from theft or unauthorized access. To ensure output security, you must perform several important tasks. First, limit the number of printed copies and use a tracking procedure to account for each copy. When printed output is distributed from a central location, you should use specific procedures to ensure that the output is delivered to authorized recipients only. That is especially true when reports contain sensitive information, such as payroll data. All sensitive reports should be stored in secure areas. All pages of confidential reports should be labeled appropriately.
As shown in Figure 8-38, it is important to shred sensitive reports, out-of-date reports, and output from aborted print runs. Blank check forms must be stored in a secure location and be inventoried regularly to verify that no forms are missing. If signature stamps are used, they must be stored in a secure location away from the forms storage location.

In most organizations, the IT department is responsible for output control and security measures. Systems analysts must be concerned with security issues as they design, implement, and support information systems. Whenever possible, security should be designed into the system by using passwords, shielding sensitive data, and controlling user access. Physical security always will be necessary, especially in the case of printed output that is tangible and can be viewed and handled easily.

Enterprise-wide data access creates a whole new set of security and control issues. Many firms have responded to those concerns by installing diskless workstations. A *diskless workstation* is a network terminal that supports a full-featured user interface, but limits the printing or copying of data, except to certain network resources that can be monitored and controlled. This concept worked well with terminals that had limited hardware and software features.

However, over time, the number of removable media devices has expanded greatly, along with a wide variety of physical interfaces such as USB, FireWire, and PCMCIA, as well as wireless interfaces such as Wi-Fi and Bluetooth. A popular security solution is the use of a network-based application, often called a *port protector*, that controls access to and from workstation interfaces. The SafeGuard® PortProtector is shown in Figure 8-39.

### Input Security and Control

**Input control** includes the necessary measures to ensure that input data is correct, complete, and secure. You must focus on input control during every phase of input design, starting with source documents that promote data accuracy and quality. When a batch input method is used, the computer can produce an input log file that identifies and documents the data entered.

Every piece of information should be traceable back to the input data that produced it. That means that you must provide an *audit trail* that records the source of each data item and when it entered the system.

In addition to recording the original source, an audit trail must show how and when data is accessed or changed, and by whom. All those actions must be logged in an audit trail file and monitored carefully.

A company must have procedures for handling source documents to ensure that data is not lost before it enters the system. All source documents that originate from outside the organization should be logged when they are received. Whenever source documents pass between departments, the transfer should be recorded.

**Data security** policies and procedures protect data from loss or damage, which is a vital goal in every organization. If the safeguards
are not 100% effective, data recovery utilities should be able to restore lost or damaged
data. Once data is entered, the company should store source documents in a safe loca-
tion for some specified length of time. The company should have a *records retention*
*policy* that meets all legal requirements and business needs.

Audit trail files and reports should be stored and saved. Then, if a data file is dam-
aged, you can use the information to reconstruct the lost data. Data security also
involves protecting data from unauthorized access. System sign-on procedures should
prevent unauthorized individuals from entering the system, and users should change
their passwords regularly. Having several levels of access also is advisable. For example,
a data entry person might be allowed to *view* a credit limit, but not *change* it. Sensitive
data can be *encrypted*, or coded, in a process called *encryption*, so only users with
decoding software can read it.

### A QUESTION OF ETHICS

Jacob thought that he did a good job of designing the company’s tech support Web page, but
Emily, his supervisor, isn’t so sure. She is concerned that Jacob’s design is very similar to a page
used by the company’s major competitor; and she asked him whether he had used any HTML
code from that site in his design. Although Jacob didn’t copy any of the code, he did examine it
in his Web browser to see how they handled some design issues.

Emily asked Jacob to investigate Web page copyright issues, and report back to her. In his
research, he learned that outright copying would be a copyright violation, but merely viewing
other sites to get design ideas would be permissible. What is not so clear is the gray area in
the middle. Jacob asked you, as a friend, for your opinion on this question: Even if no actual
copying is involved, are there ethical constraints on how far you should go in using the
creative work of others? How would you answer Jacob?

## Chapter Summary

The purpose of systems design is to create a physical model of the system that satisfies
the design requirements that were defined during the systems analysis phase. The chapter
began with a discussion of user interface design and human-computer interaction
(HCI) concepts. A graphical user interface (GUI) uses visual objects and techniques that
allow users to communicate effectively with the system. User-centered design principles
include: understanding the business, maximizing graphic effectiveness, thinking like a
user, using models and prototypes, focusing on usability, inviting feedback, and docu-
menting everything.

When you design the interface itself, you should try to make it transparent; create an
interface that is easy to learn and use; enhance user productivity; make it easy to obtain
help or correct errors; minimize input data problems; provide feedback; create an attrac-
tive layout and design; and use familiar terms and images. You also can add control fea-
tures, such as menu bars, toolbars, drop-down list boxes, dialog boxes, toggle buttons,
list boxes, option buttons, check boxes, and command buttons. Controls are placed on
a main switchboard, which is like a graphical version of a main menu.

The chapter described various types of printed reports, including detail, exception,
and summary reports. You learned about the features and sections of reports, including
control fields, control breaks, report headers and footers, page headers and footers, and
group headers and footers. You also learned about other types of output, such as Web-based information delivery, audio output, instant messaging, podcasts, e-mail, and other specialized forms of output.

The discussion of input design began with a description of source documents and the various zones in a document, including the heading zone, the control zone, the instruction zone, the body zone, the totals zone, and the authorization zone. The discussion of data entry screen design explained the use of input masks and validation rules to reduce data errors. Input masks are like templates that only permit certain combinations of characters, and data validation rules can provide checks to ensure that inappropriate data is prevented from entering the system. These checks can include data sequence, existence, range and limit, reasonableness, and validity, among others.

You also learned about batch and online input methods, input media and procedures, and input volume. Input methods include data capture and data entry. Data capture, which may be automated, involves identifying and recording source data. Data entry involves converting source data into a computer-readable form and entering it into the system. New technology offers optical and voice recognition systems, biological feedback devices, motion sensors, and a variety of graphical input devices.

Finally, you learned about security and control. Output control includes physical protection of data and reports, and control of unauthorized ports or devices that can extract data from the system. Input controls include audit trails, encryption, password security, data security, and the creation of access levels to limit persons authorized to view or use data.
Key Terms and Phrases

aesthetics 343
audit trail 371
authorization zone 361
automated facsimile 358
batch 369
batch control 368
batch input 368
blog 358
body zone 361
calendar control 348
character-based report 352
check box 348
combination check 368
command button 348
computer output to microfilm (COM) 358
context-sensitive 345
control break 354
control break report 354
control field 354
control field order 354
control zone 360
data capture 363
data entry 363
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data type check 367
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option button 348
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page header 355
podcast 358
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separator 364
sequence check 367
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source document 360
storyboard 342
summary report 353
switchboard 348
text box 348
toggle button 348
toolbar 348
totals zone 361
turnaround document 350
usability metrics 342
user-centered 337
user interface (UI) 336
user-selected 345
validity check 367
Webcast 357
Instructions: To complete the Learn It Online exercises, visit the Management Information Systems CourseMate Web site at www.cengagebrain.com, navigate to the resources for this chapter, and click the link for the exercise you want to complete.

1 Chapter Reinforcement
   TF, MC, and SA
   Click one of the Chapter Reinforcement links for Multiple Choice, True/False, or Short Answer. Answer each question and submit to your instructor.

2 Flash Cards
   Click the Flash Cards link and read the instructions. Type 20 (or a number specified by your instructor) in the Number of playing cards text box, type your name in the Enter your Name text box, and then click the Flip Card button. When the flash card is displayed, read the question and then click the ANSWER box arrow to select an answer. Flip through the Flash Cards. If your score is 15 (75%) correct or greater, click Print on the File menu to print your results. If your score is less than 15 (75%) correct, then redo this exercise by clicking the Replay button.

3 Practice Test
   Click the Practice Test link. Answer each question, enter your first and last name at the bottom of the page, and then click the Grade Test button. When the graded practice test is displayed on your screen, click Print on the File menu to print a hard copy. Continue to take practice tests until you score 80% or better.

4 Who Wants To Be a Computer Genius?
   Click the Computer Genius link. Read the instructions, enter your first and last name at the bottom of the page, and then click the Play button. When your score is displayed, click the PRINT RESULTS link to print a hard copy.

5 Wheel of Terms
   Click the Wheel of Terms link. Read the instructions, and then enter your first and last name and your school name. Click the PLAY button. When your score is displayed on the screen, right-click the score and then click Print on the shortcut menu to print a hard copy.

6 Crossword Puzzle Challenge
   Click the Crossword Puzzle Challenge link. Read the instructions, and then click the Continue button. Work the crossword puzzle. When you are finished, click the Submit button. When the crossword puzzle is redisplayed, submit it to your instructor.
Overview

The SCR Associates case study is a Web-based simulation that allows you to practice your skills in a real-world environment. The case study transports you to SCR’s intranet, where you complete 12 work sessions, each aligning with a chapter. As you work on the case, you will receive e-mail and voice mail messages, obtain information from SCR’s online libraries, and perform various tasks.

How do I use the case?

- Review the SCR background material in Chapter 1.
- Read the Preview for this session and study the Task List.
- Visit the Management Information Systems CourseMate Web site at www.cengagebrain.com, navigate to the SCR Case Simulation, and locate the intranet link.
- Enter your name and the password sad9e. An opening screen will display the 12 sessions.
- Select this session. Check your e-mail and voice mail carefully, and then work on the tasks.

Preview: Session 8

Now that the overall data design is complete, Jesse Baker wants you to work on output and user interface design. You will consider user needs, and apply principles of human-computer interaction to build a user-centered interface that is easy to learn and use. You also will consider data validation checks, source documents, forms, and reports.

Task List

1. Create a detail report that will display all SCR courses in alphabetical order, with the course name and the instructor name in a group header; the Social Security number, name, and telephone number of each current student in the detail section; and the student count in a group footer.

2. Create a switchboard design with control buttons that lead to students, instructors, courses, course schedules, and course rosters. Allow a user to add, update, or delete records in each area. Jesse wants to see storyboards that show the proposed screens.

3. Suggest data validation checks for data entry screens.

4. Create a source document for an SCR mail-in registration form. Also need a design for a Web-based course registration form.

FIGURE 8-40 Task list: Session 8.
Chapter Exercises

Review Questions

1. Explain the concept of human-computer interaction (HCI).
2. Explain the concept of a GUI and a switchboard. How does a GUI design differ from a character-based screen design?
3. Describe seven principles for a user-centered interface design.
4. Describe six types of user interface controls, and provide an example of how you could use each type in a data entry screen.
5. Define detail reports, exception reports, and summary reports. Explain the concept of a control field and how it is used to produce a control-break report.
6. List and describe various types of output, including technology-based forms of information delivery.
7. Explain each of the data validation rules mentioned in this chapter.
8. What are the main principles of source document design?
9. Explain batch and online input methods. Define source data automation and provide an example.

Discussion Topics

1. Some systems analysts maintain that source documents are unnecessary. They say that all input can be entered directly into the system, without wasting time in an intermediate step. Do you agree? Can you think of any situations where source documents are essential?
2. Some systems analysts argue, “Give users what they ask for. If they want lots of reports and reams of data, then that is what you should provide. Otherwise, they will feel that you are trying to tell them how to do their jobs.” Others say, “Systems analysts should let users know what information can be obtained from the system. If you listen to users, you’ll never get anywhere, because they really don’t know what they want and don’t understand information systems.” What do you think of these arguments?
3. Suppose your network support company employs 75 technicians who travel constantly and work at customer sites. Your task is to design an information system that provides technical data and information to the field team. What types of output and information delivery would you suggest for the system?
4. A user interface can be quite restrictive. For example, the interface design might not allow a user to exit to a Windows desktop or to log on to the Internet. Should a user interface include such restrictions? Why or why not?

Projects

1. Visit the administrative office at your school or a local company. Ask to see examples of output documents, such as computer-printed invoices, form letters, or class rosters. Analyze the design and appearance of each document, and try to identify at least one possible improvement for each.
2. Search the Web to find an example of an attractive user interface. Document your research and discuss it with your class.
3. Examine various application software packages to find examples of good (or bad) user interface design. Document your research and discuss it with your class.
4. Search your own files or review other sources to find good (or bad) examples of source document design. Document your research and discuss it with your class.
Apply Your Knowledge

The Apply Your Knowledge section contains four mini-cases. Each case describes a situation, explains your role in the case, and asks you to respond to questions. You can answer the questions by applying knowledge you learned in the chapter.

1 North Shore Boat Sales

Situation:
North Shore Boat Sales sells new and used boats and operates a Web-based boat brokerage business in Toronto. The company has grown, and North Shore needs a new information system to manage the inventory, the brokerage operation, and information about prospective buyers and sellers. Dan Robeson, the owner, asked you to design samples of computer screens and reports that the new system might produce.

1. Design a switchboard that includes the main information management functions that North Shore might require. Create a storyboard with a design layout that allows customers to perform the following functions: Obtain information about new boats, obtain information about used boats, send an e-mail to North Shore, learn more about the company, or review links to other marine-related sites.
2. Prospective buyers might want to search for boats by type, size, price range, or manufacturer. Develop a screen design that would permit those choices.
3. Suggest reports that might be useful to North Shore’s management.
4. Suggest the general layout for a Web-based source document that prospective sellers could use to describe their boats. The information should include boat type (sail or power), manufacturer, year, length, type of engine, hull color, and asking price.

2 Terrier News

Situation:
Terrier News is a monthly newsletter devoted to various breeds of terriers and topics of interest to terrier owners and breeders. Annie West, the editor and publisher, asked you to help her design a system to enter and manage the hundreds of classified ads that Terrier News publishes. Some ads are for dogs wanted; some are for dogs for sale; and some offer products and services.

1. Design a suitable source document for ads that are telephoned or mailed in.
2. Explain user-centered design principles in a brief memo to Annie.
3. Suggest at least four user interface design guidelines that could be used for the new system.
4. Suggest several types of controls that might be used on the switchboard you plan to design. Explain why you chose each control, and create a storyboard that shows the switchboard layout.
3 **Sky-High Internet Services**

**Situation:**
Sky-High Internet Services is a leading Internet service provider in a metropolitan area. The new customer billing system has caused an increase in complaints. Tammy Jones, the office manager, asked you to investigate the situation. After interviewing data entry operators and observing the online data input process, you are fairly certain that most errors occur when data is entered.

1. Write a brief memo to Tammy explaining the importance of data validation during the input process.
2. Suggest at least three specific data validation checks that might help reduce input errors.
3. Would a batch input system offer any advantages? Write a brief memo to Tammy stating your views.
4. Suppose that Sky-High is predicting 25% annual growth, on a current base of 90,000 customers. If the growth pattern holds, how many customers will Sky-High have in three years? If it takes about 12 minutes to enter a new customer into the system, how many additional data entry operators will be needed to handle the growth next year? Assume that an operator works about 2,000 hours per year. Also assume a 30% annual attrition rate for existing customers.

4 **Castle Point Antique Auction**

**Situation:**
Castle Point Antique Auction operates a successful Web site that offers an auction forum for buyers and sellers of fine antiques. Monica Creighton, the owner, asked you to help her design some new documents and reports.

1. Suggest the general layout for a Web-based source document that prospective bidders would submit. The information should include user ID, password, name, address, telephone, e-mail address, item number, bid offered, and method of payment (money order, check, American Express, MasterCard, or Visa).
2. Suggest the general layout for a Web-based source document that prospective sellers could use to describe their antiques. The information should include the user ID, password, item, dimensions, origin, condition, and asking price.
3. Write a brief memo to Monica explaining the difference between detail reports, exception reports, and summary reports. Suggest at least one example of each type of report that she might want to consider.
4. Suggest several types of data validation checks that could be used when input data is entered.
Case studies allow you to practice specific skills learned in the chapter. Each chapter contains several case studies that continue throughout the textbook, and a chapter capstone case.

New Century Health Clinic

The associates at New Century Health Clinic approved your recommendations for a new computer system. Your next step is to develop a design for the new system, including output and user interface issues.

Background

To complete the output and user interface design for the new information system at New Century, you should review the DFDs and object-oriented diagrams you prepared previously, and the rest of the documentation from the systems analysis phase. Perform the following tasks.

Assignments

1. Dr. Jones has asked you to create a monthly Claim Status Summary report. He wants you to include the insurance company number, the patient number and name, the procedure date, the procedure code and description, the fee, the date the claim was filed, the amount of the claim, the amount of reimbursement, and the amount remaining unpaid. He wants you to group the data by insurance company number, with subtotals by company and grand totals for each numeric field. When you design the report, make sure to include a mock-up report and a report analysis form.
2. Design the daily appointment list and a monthly statement to make it readable and visually attractive. Include a mock-up report and a report analysis form for each report.
3. Determine the data required for a new patient. Design an input source document that will be used to capture the data and a data entry screen to input the information.
4. What data validation checks would the clinic need for the new patient data entry screen? Write a brief memo with your recommendations.

PERSONAL TRAINER, INC.

Personal Trainer, Inc., owns and operates fitness centers in a dozen Midwestern cities. The centers have done well, and the company is planning an international expansion by opening a new “supercenter” in the Toronto area. Personal Trainer’s president, Cassia Umi, hired an IT consultant, Susan Park, to help develop an information system for the new facility. During the project, Susan will work closely with Gray Lewis, who will manage the new operation.

Background

Following the decision to use an in-house team to develop a design prototype, Susan began to work on the physical design for Personal Trainer’s new information system. At this stage, she is ready to begin working with Gray on the output and user interface design. Together, Susan and Gray will seek to develop a user-centered design that is easy to learn and use. Personal Trainer users will include managers, fitness instructors, support staff, and members themselves.
Assignments

1. Create a detail report that will display all Personal Trainer courses in alphabetical order, with the course name and the instructor name in a group header; the Social Security number, name, and telephone number of each current student in the detail section; and the student count in a group footer.

2. Create a switchboard design with control buttons that lead to members, fitness instructors, activities and services, schedules, and fitness class rosters. Allow a user to add, update, or delete records in each area.

3. Suggest context-sensitive and specific Help for the switchboard and lower-level menus and forms. Prepare storyboards that show the proposed screens. Also suggest at least six types of data validation rules for data entry screens.

4. Design a mail-in source document that members can use to register for fitness classes. Also design a Web-based registration form.

VIDEO SUPERSTORE

Video Superstore has hired you to design two online data entry screens. Based on what you know about the operation of a video rental store, complete the following assignments.

Assignments

1. Design a weekly operations summary report that will include overall data on rentals, new customers, late charges, and anything else you think a store manager might want to review. Be sure to include numeric activity and dollar totals.

2. Design a data entry screen for entering new members.

3. Design a video rental input screen. In addition to the video data, the video rental form must include the following fields: Member Number, Name, and Date.

4. Suggest at least three data validation rules that might help reduce input errors for the video rental system.
SoftWear, Limited (SWL), is a continuing case study that illustrates the knowledge and skills described in each chapter. In this case study, the student acts as a member of the SWL systems development team and performs various tasks.

**Background**

SoftWear, Limited, decided to use the payroll package developed by Pacific Software Solutions and customize it by adding its own ESIP system to handle SWL's Employee Savings and Investment Plan.

Because most of the payroll requirements would be handled by Pacific’s payroll package, the IT team decided that Carla Moore would work on the new ESIP modules, and Rick Williams would concentrate on the rest of the payroll system. A new systems analyst, Becky Evans, was assigned to help Rick with the payroll package.

Pacific Software Solutions offered free training for new customers, so Rick and Becky attended a three-day train-the-trainer workshop at Pacific’s site in Los Angeles. When they returned, they began developing a one-day training session for SWL users, including people from the accounting, payroll, and human resources departments. The initial training would include the features and processing functions of the new payroll package that was scheduled to arrive the following week.

Carla’s first task was to work on the ESIP outputs. She had to design several reports: the ESIP Deduction Register, the ESIP Payment Summary, and the checks that SWL sends to the credit union and the stock purchase plan. Carla also needed to develop an ESIP Accounting Summary as a data file to be loaded into the accounting system.

Carla learned that standard SWL company checks were used to make the payments to the credit union and stock purchase department. In addition, the output entry to the accounting system had been specified by the accounting department in a standard format for all entries into that system.

To prepare the new ESIP Deduction Register, Carla reviewed the documentation from the systems analysis phase to make sure that she understood the logical design and the available data fields.

Carla decided to use a monthly format because accounting would apply some deductions on a monthly cycle. She started her design with a standard SWL report heading. Then she added a control heading and footing for each employee's Social Security number. The total of employee deductions would be compared with the transferred ESIP funds to make sure that they matched. After preparing a rough layout, Carla prepared the mock-up report shown in Figure 8-41, using test data for the month of May 2011.

During the systems analysis phase, Carla learned that the accounting department required a control report to show the ESIP deduction amounts that were not yet applied. The control report is used to verify the amount of the checks or fund transfers SWL makes to the credit union and stock purchase plan. The accounting department needs the control report to verify the accounting system outputs and balance the ESIP deduction totals against the payroll system's Payroll Register report.

Figure 8-42 on page 384 shows a mock-up of the ESIP Payment Summary report. Carla met with Buddy Goodson, director of accounting, to review the design. Buddy was pleased with the report and felt it would be acceptable to the company’s outside auditors. Buddy met with the auditing firm later that week and secured the team’s approval.

As Carla turned her attention to the user interface for the ESIP system, she realized that she would need to develop two new source documents: an ESIP Option Form and an ESIP Deduction Authorization Form. She also planned to design a main switchboard and all necessary screen forms.
Carla started by designing an ESIP Option Form that could be used for adding new ESIP options and modifying existing ones when authorized by the vice president of human resources.

![ESIP Deduction Register](image)

### SoftWear, Ltd.

#### ESIP Deduction Register

<table>
<thead>
<tr>
<th>Month</th>
<th>Employee SSN</th>
<th>Period Ending</th>
<th>ESIP Option</th>
<th>Deduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>May 2011</td>
<td>111-11-1111</td>
<td>5/6/2011</td>
<td>Stock Purchase Plan</td>
<td>$15.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/6/2011</td>
<td>Credit Union</td>
<td>$20.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/13/2011</td>
<td>Credit Union</td>
<td>$25.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/13/2011</td>
<td>Stock Purchase Plan</td>
<td>$15.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/20/2011</td>
<td>Stock Purchase Plan</td>
<td>$15.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/20/2011</td>
<td>Credit Union</td>
<td>$20.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/27/2011</td>
<td>Stock Purchase Plan</td>
<td>$15.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/27/2011</td>
<td>Credit Union</td>
<td>$20.00</td>
</tr>
<tr>
<td></td>
<td>123-45-6789</td>
<td>5/6/2011</td>
<td>Stock Purchase Plan</td>
<td>$10.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Employee Total</strong></td>
<td>$145.00</td>
<td></td>
</tr>
<tr>
<td></td>
<td>222-22-2222</td>
<td>5/6/2011</td>
<td>Stock Purchase Plan</td>
<td>$10.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/6/2011</td>
<td>Credit Union</td>
<td>$30.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/13/2011</td>
<td>Stock Purchase Plan</td>
<td>$10.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/13/2011</td>
<td>Credit Union</td>
<td>$30.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/20/2011</td>
<td>Stock Purchase Plan</td>
<td>$10.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/20/2011</td>
<td>Credit Union</td>
<td>$30.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/27/2011</td>
<td>Credit Union</td>
<td>$30.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5/27/2011</td>
<td>Stock Purchase Plan</td>
<td>$10.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Employee Total</strong></td>
<td>$39.96</td>
<td></td>
</tr>
</tbody>
</table>

**Summary for Period Ending 5/25/2011 (21 detail records)**

**Monthly Total** $354.96
CHAPTER CAPSTONE CASE: SoftWear, Limited (continued)

Next, Carla worked on a data entry screen based on the ESIP Option Form. Using SWL’s existing screen design standards, she quickly developed the screen mock-up shown in Figure 8-43. Her design allowed users to add, delete, save, clear, or find a record by clicking the appropriate command button.
The ESIP Deduction Authorization Form required more data and several signatures. Carla divided the form into three sections: The employee completes the information in the top section; human resources completes the middle section; and payroll representatives complete the bottom section.

Carla designed a data entry screen based on the ESIP Deduction Authorization Form shown in Figure 8-44 and made the screen consistent with the other ESIP screen designs. Now a user could add, delete, save, clear, or find a record by clicking the appropriate command buttons. Carla also provided instructions to the operator for exiting from the system.

Carla decided to create a series of mock-ups to show users how the new ESIP deduction screen would work. In Figure 8-45 on the next page, the system has retrieved the employee’s name, Joseph J. Smith, so the user can verify it against the source document.

The users approved the new design, with one suggestion — the system date should be added automatically as the entry date. Carla made the change and then designed the switchboard shown in Figure 8-46 on the next page, based on comments that users made during the design process. Now that she had a working model, Carla went back to the users to show them the complete package.

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**FIGURE 8-44** The ESIP Deduction Authorization Form.
SWL Team Tasks

1. Review the mock-up report shown in Figure 8-41 on page 383. When Carla showed this report design to Mike Feiner, director of human resources, he said that he wanted to see the data grouped by the type of ESIP deduction with the appropriate subtotals. Carla wants you to modify the report design to satisfy his request. You can use Microsoft Access, a report generator, or simply construct a sample layout using any word processing or drawing program. Be sure to show the placement and grouping of all fields.

2. Carla Moore also wants employees to have an online information request form that they can use to learn more about ESIP options and request up-to-date balances for their ESIP accounts. Follow the guidelines and suggestions in this chapter, and design an online screen form for Carla.

3. In addition to being available online, Carla wants the information request form to be available as a paper source document, which can be used by employees who do not have easy access to the online form. Follow the guidelines and suggestions in this chapter, and design a paper source document for Carla.

4. Carla wants an update on usability, how users read on the Web. Review the material in this chapter and visit the Web to learn more about this topic. Summarize the results of your research in a memo to Carla.

Manage the SWL Project

You have been asked to manage SWL’s new information system project. One of your most important activities will be to identify project tasks and determine when they will be performed. Before you begin, you should review the SWL case in this chapter. Then list and analyze the tasks, as follows:

LIST THE TASKS Start by listing and numbering at least 10 tasks that the SWL team needs to perform to fulfill the objectives of this chapter. Your list can include SWL Team Tasks and any other tasks that are described in this chapter. For example, Task 3 might be to Find out what output is needed, and Task 6 might be to Design an output screen.
ANALYZE THE TASKS  Now study the tasks to determine the order in which they should be performed. First identify all concurrent tasks, which are not dependent on other tasks. In the example shown in Figure 8-47, Tasks 1, 2, 3, 4, and 5 are concurrent tasks, and could begin at the same time if resources were available.

Other tasks are called dependent tasks, because they cannot be performed until one or more earlier tasks have been completed. For each dependent task, you must identify specific tasks that need to be completed before this task can begin. For example, you would want to find out what output is needed before you could design an output screen, so Task 6 cannot begin until Task 3 is completed, as Figure 8-47 shows.

Chapter 3 describes project management tools, techniques, and software. To learn more, you can use the Features section on your Student Study Tool CD-ROM, or visit the Management Information Systems CourseMate Web site at www.cengagebrain.com and locate the project management resources library for this book. On the Web, Microsoft offers demo versions, training, and tips for using Project 2010. You also can visit the OpenWorkbench.org site to learn more about this free, open-source software.

FIGURE 8-47  Tasks 1, 2, 3, 4, and 5 are concurrent tasks that could be performed at the same time. Task 6 is a dependent task that cannot be performed until Task 3 has been completed.
In additional to technical skills, IT professionals need critical thinking skills such as perception, organization, analysis, problem-solving, and decision-making. The Ready for a Challenge feature can help you learn, practice, and apply critical thinking skills that you can take to the workplace.

This week, the IT team is working on user interface design for the new C³ system. One goal is to reduce input errors by using validation rules and input masks. The team leader has assigned you to do research and develop a recommendation. To perform these tasks, you must navigate to the Microsoft Access Help area, where you will see examples of validation rules and input masks. You should also review Chapter 8 of your systems analysis textbook.

Based on requirements modeling, you know that the new C³ system will store personal data about customers, their buying habits, and their interests. To reduce errors, the C³ user interface will use input masks where possible.

Here are five sample data items, with specific descriptions and examples:

<table>
<thead>
<tr>
<th>Data Item</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Name</td>
<td>Must start with a capital letter followed by at least one, and up to 9 more lowercase letters.</td>
<td>Li Stephanie</td>
</tr>
<tr>
<td>Middle Initial</td>
<td>May have up to one capital letter, or none.</td>
<td>J</td>
</tr>
<tr>
<td>Last Name</td>
<td>Must start with a capital letter followed by at least one, and up to 11 more lowercase letters.</td>
<td>Steinbrenner Ho</td>
</tr>
<tr>
<td>Category</td>
<td>Must start with two capital letters followed by two digits.</td>
<td>AB12 XY01</td>
</tr>
<tr>
<td>Postal Code</td>
<td>Must have five digits, and may be followed by a hyphen and four more digits.</td>
<td>12345 12345-9999</td>
</tr>
</tbody>
</table>

In addition to input masks, the team leader wants you to learn about validation rules and text. Specifically, she wants you to go back to the Microsoft Access Help area and review the explanation of validation rules, and the examples.

**Practice Tasks**

A. Create an input mask for each data item shown in the table.

B. Develop a brief handout that explains the concept of validation rules. Include an example of a validation rule that will only accept the letters A or B.

After you complete the Practice Tasks, to check your work and view sample answers, visit the Management Information Systems CourseMate Web site at [www.cengagebrain.com](http://www.cengagebrain.com), navigate to the resources for this chapter, and locate Ready for a Challenge?.

**The Challenge**

Now that you are familiar with input masks and validation rules, your team leader wants you to review two more data items, as follows:

<table>
<thead>
<tr>
<th>Customer ID</th>
<th>Must include the first capital letter of the customer’s last name, followed by the last four digits of the customer’s Social Security Number.</th>
<th>R0118 B1234</th>
</tr>
</thead>
<tbody>
<tr>
<td>Password</td>
<td>Must include at least six, and no more than 12 letters or digits.</td>
<td>1X2y3Z 123456789999</td>
</tr>
</tbody>
</table>

**Challenge Tasks**

A. Create input masks for the two additional data items shown in the table.

B. Create a validation rule that will only accept numbers greater than 10 and less than 20.

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