16

Input Design and Prototyping

Overview

Chapter 16 is a technique chapter. It teaches students the important skill of input design and prototyping. Students learn the underlying system concepts that apply to input design, and then they learn how to design on-line inputs. The chapter focuses on the design of the increasingly more common graphical user interface screen designs (including those for the Web). Focus is placed on a new trend called repository-driven programming, which is explained in the chapter. The chapter stresses the importance of focusing on finalizing the content of inputs and the screen-based controls used to input data. Unlike approaches used to design traditional text-based screens, GUI input screens are not designed in isolation. Thus, the final input screen designs are appropriately deferred to Chapter 17, User Interface Design, where the overall look and feel of the application is addressed.

Chapter to Course Sequencing

The sequencing of input and output design is a classic "chicken or egg" problem. We have designed Chapters 15 (output design) and 16 (input design) to be interchangeable. We elected to present output design first because that is the classical approach as follows:

1. Database design (Chapter 14) precedes output design to ensure that the source data will be available to produce desired outputs.
2. Output design (Chapter 15) validates the database design. In other words, output design seeks to ensure that all the data needed for the outputs is available in the database.
3. Input design (this chapter) validates both the output and database design. In other words, input design seeks to ensure that all the data needed to produce the outputs has been input to the database.
4. User interface design (Chapter 17) ties the inputs and outputs together (regardless of the order in which you designed those outputs and inputs).

It should be noted that, in practice, most systems analysts integrate the design of outputs and inputs.

Regardless of how you sequence Chapters 15 and 16, students should first read Chapter 10 to provide perspective for where output design fits into total systems design. It is also recommended that this chapter follow Chapters 13 and 14. Chapter 13 determines the application framework or general system

design that serves as an outline for detailed design, inclusive of outputs. Chapter 14 covers database design. Input design and prototyping loads the database. If you are taking an object-oriented approach, you could cover Chapter 18 either before or after Chapters 15-17.

What's Different Here and Why?

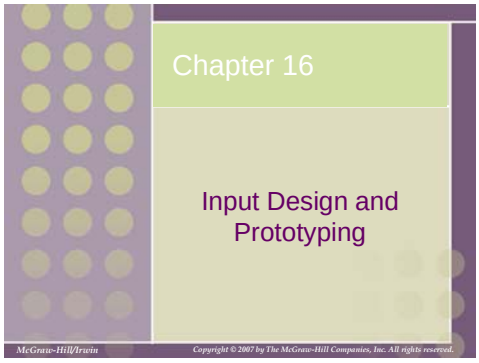
This chapter did not necessitate many changes from the sixth edition.

1. As with all chapters, we have streamlined the SoundStage episode into a quick narrative introduction to the concepts presented the chapter.
2. We updated all technology references throughout the chapter.

Lesson Planning Notes for Slides

The following instructor notes, keyed to slide images from the PowerPoint repository, are intended to help instructors integrate the slides into their individual lesson plans for this chapter.

Slide 1

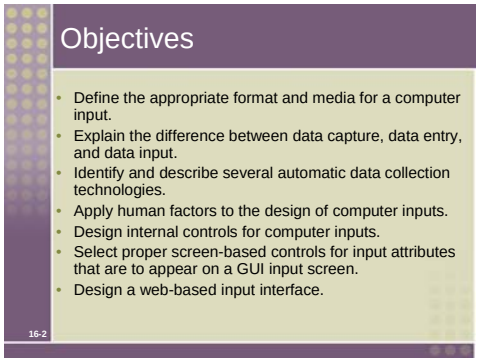


slide appearance after initial mouse click in slide show mode

This repository of slides is intended to support the named chapter. The slide repository should be used as follows:
Copy the file to a unique name for your course and unit.
Edit the file by deleting those slides you don't want to cover, editing other slides as appropriate to your course, and adding slides as desired.
Print the slides to produce transparency masters or print directly to film or present the slides using a computer image projector.

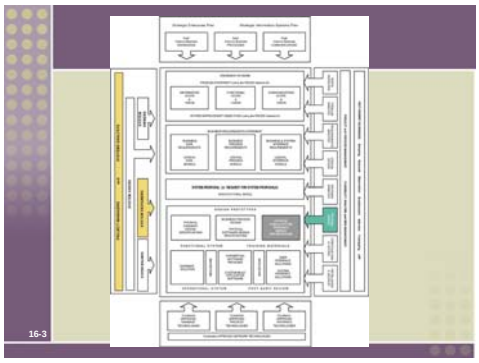
Each slide includes instructor notes. To view those notes in PowerPoint, click-left on the View Menu; then click left on Notes View sub-menu. You may need to scroll down to see the instructor notes.
The instructor notes are also available in hard-copy as the Instructor Guide to Accompany Systems Analysis and Design Methods, 6/ed.

Slide 2



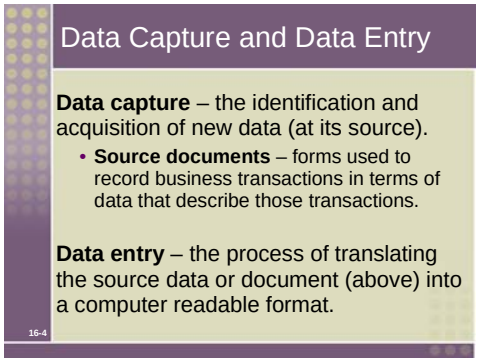
No additional notes.

Slide 3



Teaching Notes
This slide shows the how this chapter's content fits with the building blocks framework used throughout the textbook. The emphasis of this chapter is with the physical design phase, focusing on the communication building blocks. It involves system designers and systems analysts.

Slide 4



No additional notes.

Slide 5

Data Processing

Data processing is all processing that occurs on the data after it is input from a machine readable form.

- In **batch processing**, the entered data is collected into files called batches and processed as a complete batch.
- In **on-line processing**, the captured data is processed immediately
- In **remote batch processing**, data is entered and edited on-line, but collected into batches for subsequent processing.

16-5

No additional notes.

Slide 6

Input Implementation Methods

- Keyboard
- Mouse
- Touch Screen
- Point-of-sale terminals
- Sound and speech
- Automatic data capture
  - Optical mark recognition (OMR)
    - Bar codes
  - Optical character recognition (OCR)
  - Magnetic Ink
  - Electromagnetic transmission
  - Smart cards
  - Biometric

16-6

Teaching Notes
We tend to think of input solely in terms of keyboard and mouse on a PC. But as this slide points out, there are many kinds of input and many kinds of input terminals (i.e. the Blackberry device shown here).

Slide 7

Taxonomy for Computer Inputs

Process Method	Data Capture	Data Entry	Data Processing
Keyboard	Data is usually captured on a business form that becomes the source document for input. Data can be collected real-time.	Data is entered via keyboard. This is the most common input method but also the most prone to errors.	OLD: Data can be collected into batch files (disk) for processing as a batch. NEW: Data is processed as soon as it has been keyed.
Mouse	Same as above.	Used in conjunction with keyboard to simplify data entry. Mouse serves as a pointing device for a screen.	Same as above, but the use of a mouse is most commonly associated with online and real-time processing.
Touch Screen	Same as above.	Data is entered o a touch screen display or handheld device. Data entry users either touch commands and data choices or enter data using handwriting recognition.	On PCs, touch screen choices are processed same as above. On handheld computers, data is sorted on the handheld for later processing as a remote batch.

Teaching Notes
The categories are not necessarily mutually exclusive.

Slide 8

Taxonomy for Computer Inputs (continued)

Process Method	Data Capture	Data Entry	Data Processing
Point of Sale	Data captured as close to the point of sale as humanly possible. No source documents.	Data is often entered directly by the customer or by an employee directly interacting with the customer.	Data is almost always processed immediately as a transaction or inquiry.
Sound	Data is captured as close to the source as possible, even when the customer is remotely located.	Data is entered using touch-tones (typically from a telephone). Usually requires rigid command menu structure and limited input options.	Data is almost always processed immediately as a transaction or inquiry.
Speech	Same as sound.	Data (and commands) is spoken. This technology is not as mature and is much less reliable and common than other techniques.	Data is almost always processed immediately as a transaction or inquiry.
Optical Mark	Data is recorded on optical scan sheets as marks or precisely formed letter, numbers, and punctuation.	Eliminates the need for data entry.	Data is almost always processed as a batch.

Teaching Notes
The categories are not necessarily mutually exclusive.

Slide 9

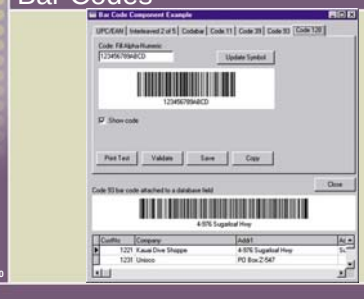
Taxonomy for Computer Inputs (concluded)

Process Method	Data Capture	Data Entry	Data Processing
Magnetic Ink	Data usually prerecorded on forms that are completed by the customer. The customer records additional information on the form.	A magnetic ink reader reads the magnetized data. The customer-added data must be entered using another input method.	Data is almost always processed as a batch.
Electromagnetic	Data is recorded directly on the object to be described by data.	Data is transmitted by radio frequency.	Data is almost always processed immediately.
Smart Card	Data is recorded directly on a device to be carried by the customer, employee, or other individual that is described by that data.	Data is read by smart card readers.	Data is almost always processed immediately.
Biometric	Unique human characteristics become data	Data read by biometric sensors. Primary applications are security and medical monitoring	Data is processed immediately.

Teaching Notes
The categories are not necessarily mutually exclusive.

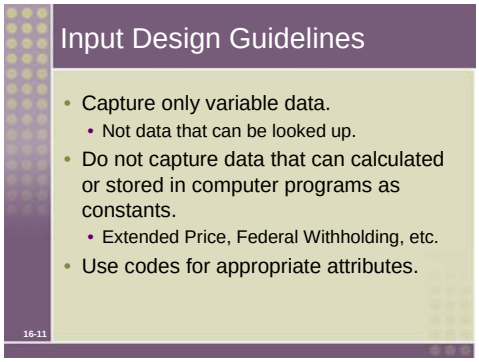
Slide 10

Automatic Identification: Bar Codes



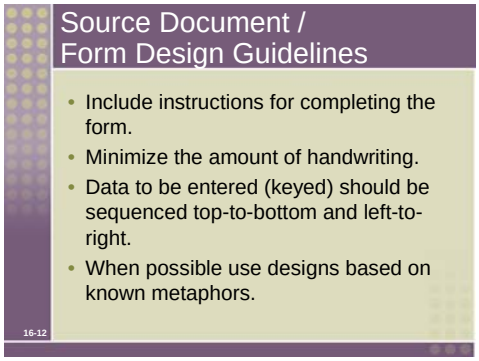
Teaching Notes
This screen shot shows two different bar codes, each with the data equivalent shown below. Point out that bar codes can represent letters as well as numbers. In other words, you name could be represented by a bar code.
This screen shot mentions "Code 93." This is one of several different symbologies that bar codes can support.
Reading a bar code is a simple as attaching a bar code devices to a computer and setting it for the correct symbology. When a bar code is scanned, the alphanumeric value is entered to the computer just as if a user typed that value on the keyboard.
Printing bar codes is more complex, requiring special software.

Slide 11



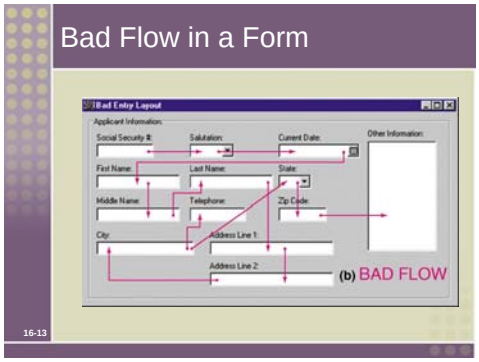
No additional notes.

Slide 12



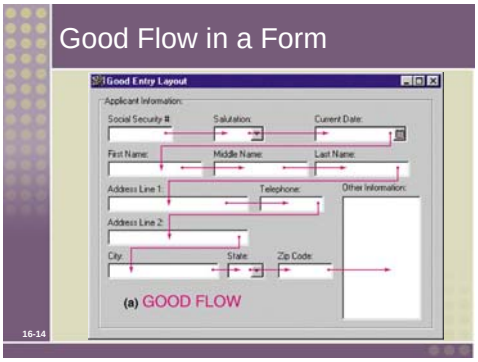
No additional notes.

Slide 13



Teaching Notes
Experienced users often tab around a form. The tab order should be set correctly.

Slide 14

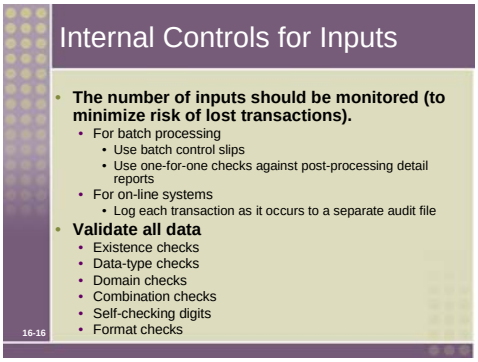


No additional notes.

Slide 15

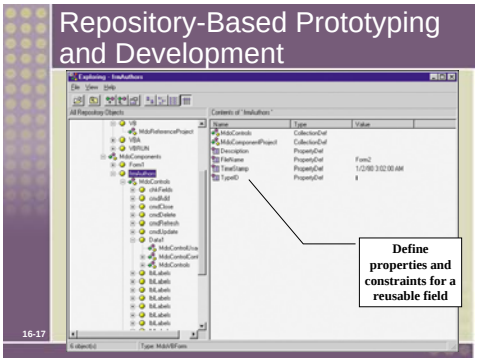
Teaching Notes
Other useful metaphors include a check, a register, and a calendar.
Pictures of objects can also be metaphors. For example, many Web sites use a picture of each credit card accepted instead of the names.

Slide 16



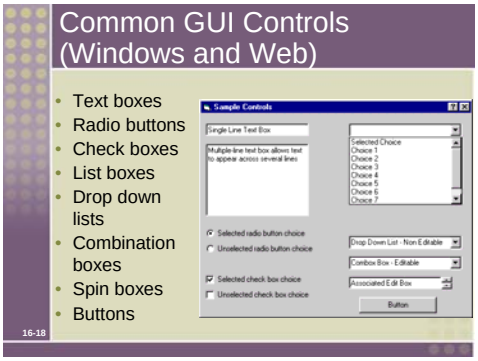
No additional notes.

Slide 17



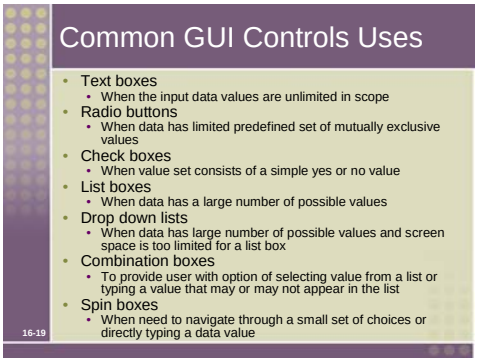
No additional notes.

Slide 18



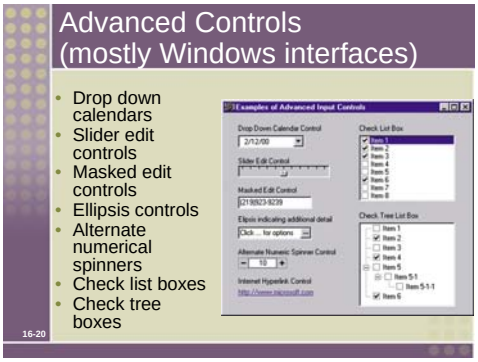
No additional notes.

Slide 19



Teaching Notes
It would be helpful to also go over the guidelines discussed in the text for each.

Slide 20

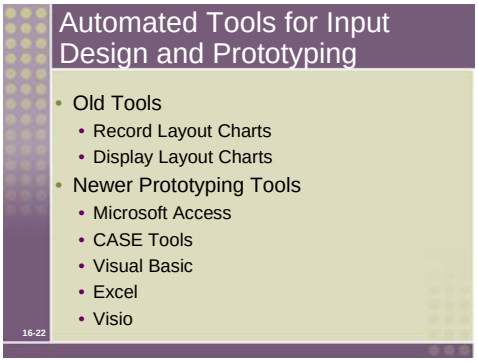


No additional notes:

Slide 21

No additional notes:

Slide 22



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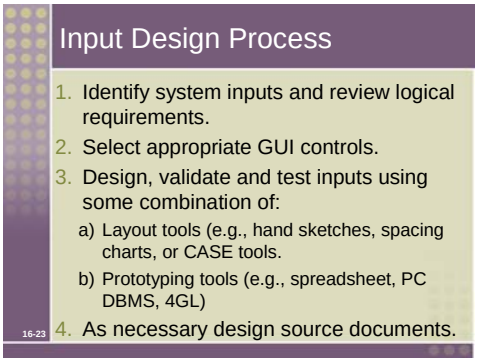
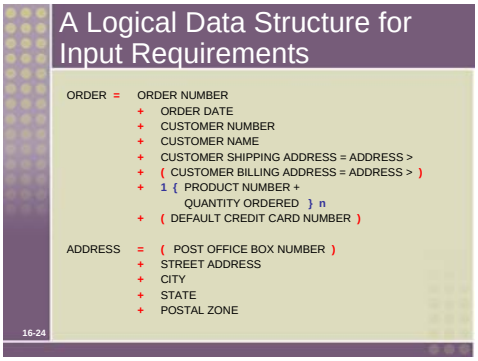
Slide 23



No additional notes.

Slide 24

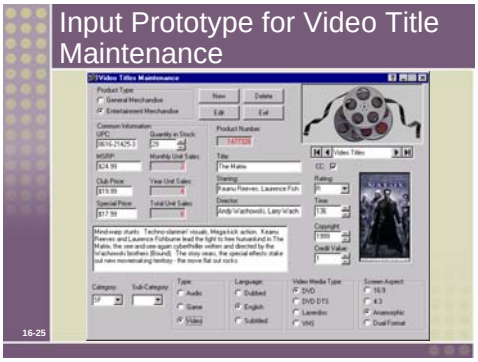


Teaching Notes
It may be useful to walk through this technique for specifying "logical" output requirements.
The red and blue symbols are relational operators, that is, they specify the relationship between attributes to be included in the output in terms of

Sequence	+
Selection	[data attributes]
Iteration	min { data attributes } max
Optionality	(data attributes)

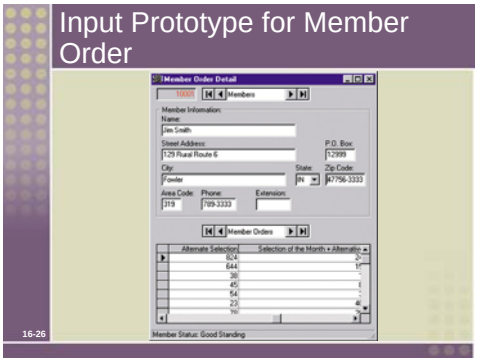
Many CASE tools support this logical notation.

Slide 25



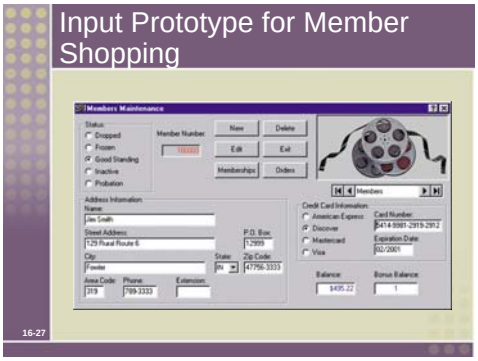
No additional notes.

Slide 26



No additional notes.

Slide 27

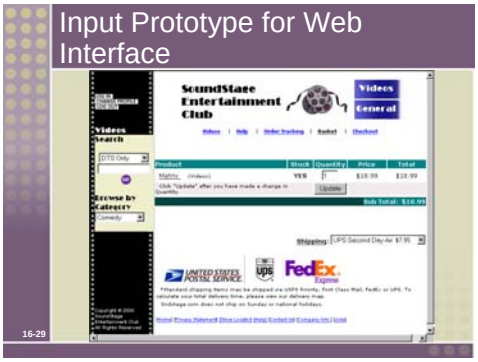


No additional notes.

Slide 28

No additional notes.

Slide 29



No additional notes.

Answers to End of Chapter Questions and Exercises

Review Questions

1. The goal of input design is to capture the data and translate it into an appropriate format that can be read by the computer.

2. Source documents are hardcopy forms that are used to record business transactions by capturing the data that characterizes the transaction. Data entry is the process in which the data from the source document is transformed into a format that can be used by the computer application.

3. The next step is data processing. The three kinds of processing are batch processing, online processing, and remote batch processing. In online processing, the data is processed at the time the data is captured, while batch processing and remote batch processing store the data in batches until it is processed at a later point.

4. Keyboard, mouse, touch screen, point of sale, sound, speech, optical mark, magnetic ink, electromagnetic, smart card, and biometric.

5. OMR is optical mark recognition. The technology is used for batch processing. It is also used commonly in surveys and questionnaires. One characteristic of OMR is that the data being entered is very structured. An example will be the optical mark forms (scantron form) used for examinations.

   OCR is optical character recognition. It is used to recognize the handwritten input data by users. It can be any letters or numbers. Also, when using this technology, users need to input the handwritten data very clearly, so that the OCR reader can process the input without intervention.

6. Data is read and processed by biometric sensors. In this case, unique human characteristics become the data. Since the primary applications for biometric are security and medical monitoring, data is often processed immediately.

7. A smart card, which is a bit larger than a typical credit card, can store a great deal of information because the card itself contains a microprocessor, memory circuits, and a battery. It is a portable storage media containing information that can be accessed virtually everywhere.

   It can be used to store health records, such as blood type and medical history, passport data, and could also be used as a hybrid debit card.

8. Human factors are important because data input is initiated by system users. The needs of system users must be considered to facilitate system use and to reduce errors.

   The principles are:

   - Capture only variable data
   - Do not capture data that can be calculated or stored in computer programs
   - Use codes for appropriate attributes

9. - Existence checks
     It makes sure all the required fields have data entered.
   - Data-type checks
     It verifies the data input is of the correct type.
   - Domain checks
     It verifies the data input is within the range of the values defined.
   - Combination checks
     It ensures the relationships between two fields are correct, if a relationship exists.
   - Self-checking digits
     It ensures there is no data entry error on primary keys.
   - Format checks
     It makes sure the data being entered comply with the format identified.

10. Radio buttons are used when the values from which system users choose are mutually exclusive, limited, and pre-defined. For example, gender will contain a set of values—male, female, or unknown—that are mutually exclusive, limited, and pre-defined.

    Check boxes, on the other hand, are used when the users need to enter a simple yes or no value. For example, users may be asked to answer if they are senior citizens, if they have ever been convicted of fraud, or if their previous employer may be contacted as a reference. All of these items involve only a yes or no value.

11. Both drop-down lists and combo boxes have a hidden list of values. Unless requested, the hidden values will not show at all. There is a downward-pointing arrow on both of the drop-down lists and combo boxes. When clicked, the hidden values will be shown. When the user selects a value from the list of values, the values will be hidden again.

12. Drop-down calendar
    Slider edit calendar
    Masked edit control

Ellipsis control
Alternate numeric spinner
Internet hyperlink
Check list box
Check tree list box
(Please refer to the illustrations on p. 633)

13. First, designers need to find out the inputs of the system and evaluate the logical requirements. After that, based on the inputs identifies, designers should use the suitable GUI controls for the inputs. Then, designers need to design, authenticate, and test the inputs using layout and prototyping tools. Finally, if necessary, the source document may be designed.

14. When designing a source document, it is generally necessary to split the documents into different zones. Each zone should have its own purpose. For example, some zones should be used for identification; others may include the transaction data or the authorization zone for signatures.

15. In designing web interfaces, designers need to ensure the interfaces are appealing. It is because web interfaces are like the window of a physical store. In order to attract customers to purchase products, making the web interfaces attractive is essential.

Problems and Exercises

1. To capture the necessary data – and only the necessary data – in as efficient, accurate and user-friendly manner as possible, and to get it into required computer-readable format.

2. You may come up with a unique idea (in which case you may want to market it), but one method, with many possible variations, would be to use a POS terminal programmed with the restaurant's menu and a card reader at each table. Customers could come in, sit down, key in their order (which would go directly to the kitchen), and pay with a debit or credit card. This would reduce their waiting time, as well as reducing restaurant labor costs.

3. Yes. To reduce input time and to reduce errors, a general principle of system design is that system users and customers should not have to enter constant or redundant data, i.e., only variable data should be captured through data entry. The technician # and part # should be the only data items they need to enter. The technician name and part description can then be obtained from a look-up table, and auto-filled on the data entry screen for verification instead.

4. Your answer may vary, but some of the most common complaints include the following:

   - POS terminal screens that are difficult to read in bright sunlight, such as those built into gas pumps, or at outside ATMs.
   - POS terminals that are too high for many short people to use comfortably.
   - POS terminal screen prompts that, like other forms of screen-based prompting, are confusing, too cryptic, use too small a font, and/or that do not follow generally accepted principles for good screen design.
   - POS card readers that do not follow a standard method for inserting or swiping.
   - POS terminals where the screen prompts you with an arrow on which button to press on the keypad, but the arrow points to the wrong key!

5. 1. False, provided the code is well-chosen and/or has the legend readily accessible through a pick list or on screen.
   2. True, under certain circumstances. At one time, it was the only option; now, most information systems find online processing more advantageous to use in most situations.
   3. False, the sooner data is captured after origination, the more accurate it tends to be.
   4. False, the computer mouse was invented years before these operating systems
   5. False, using metaphor-based screen design is an excellent method to increase user-friendliness, which in turn tends to increase accuracy and reduce input time.
   6. True; radio buttons are optimally used only when all of these conditions are met.

6. To reduce errors and data entry time, the following input screen requirements and/or principles are generally considered to be the extremely important:
   1. Don't have users input calculated data if the calculation can be programmed into the system.
   2. Use codes where appropriate.
   3. When using a source document, reduce as much as possible the number of data elements that require a handwritten entry.
   4. Data entry should flow left to right, top to bottom, just like a book; ideally, there should be no need to jump around the form.
   5. Use metaphoric screen designs where possible, or at least screen designs that follow the same sequence of data as the source document.
   6. Required fields should be clearly labeled or coded to indicate to the user that they are required.

7. As a general principle, data should be edited and validated at the point of data entry, even if the server-side DBMS performs its own data edits and validations. By requiring edits at point of data entry, network traffic is reduced, as well as the amount of follow-up human interaction, labor and subsequent errors.

   At a minimum, validation checks should include existence checks, data-type checks, domain checks, and combination checks (also called relational edits).

8. A6, B13, C9, D8, E10, F2, G12, H11, I4, J3, K1, L7, M5

9. - The caption should be meaningful and appropriately descriptive.
   - The caption should not use abbreviations if possible, and like a sentence or phrase, only the first character should be capitalized.
   - In order to help the user to visually associate a caption with the correct text box, the caption should be placed either to the left or if on top, left-aligned.
   - A colon should follow the caption, in order to visually separate the colon from the text box itself.

10. 1. Source documents should be portioned into different zones for identification, transaction data, authorization(s), and depending upon the form, for data that identifies a unique occurrence of the form.
    2. After identifying system inputs and reviewing logical requirements, the next step in the input design process is to select the appropriate GUI controls.
    3. "Intelligent" GUI controls allow a vertical scroll bar to automatically appear if the number of entries exceeds the allotted space for that pane.

    4. Although technically buttons are not input controls, they enable users to commit to or cancel a transaction.
    5. The most common data input control is the text box, which is best used when the scope of input data values is unlimited.

11. Is there a data input repository that can be checked to see if that data attribute already has a specific GUI control associated with it? If so, the decision for that data attribute has already been made. If not, then:

    Are the input data values that can be input non-editable or unlimited in scope? If so, a text box (also called a memo box) should be used.

    Are the input data values limited and predefined? Than a radio button may be the best choice.

Are the input data values limited to Yes/No? If so, then use a check box.

Are the input data values consistently and predictably ordered? If so, a text box with associated spin box might be the best choice.

Are there many predefined input data values? Consider using a drop-down list.

Are the input data values images? Then use an image box.

12. One example of a metaphoric screen design for telephone messages is shown below. (Note: This is a public domain template downloaded from www.office.microsoft.com).

While You Were Out

Name:	**Message**
Time:	
Date:	
Respond By:	
Phone:	
E-mail:	
Fax:	

13. Some of the common similarities and differences include the following:

- Both use graphical user interfaces (GUIs) for most, if not all, contemporary applications.
- Both use the same type of GUI controls for data entry.
- Both can edit and constrain data at the point of data entry in order to "force" the user to make a valid choice.
- Web interfaces tend to make much heavier use of graphics and metaphors than do client/server interfaces. This is particularly true in business to customer web applications, since just like in brick and mortar storefronts, visual appeal plays a large part in whether the business makes the sale or not!
- Web interfaces also tend to be more versatile in their ability to navigate back and forth between different pages.

Projects and Research

1. The purpose of this question is to help drive home the enormous impact that technological changes may have upon organizations and individuals on multiple levels. As such, answers are open-ended, but should indicate a recognition and appreciation of these very real issues.

2. The purpose of this question is to help students think about a device that most probably never think about. The "QWERTY" layout was designed to slow down users of 19th century typewriters in order to keep keys from jamming. The Dvorak keyboard layout is designed to place the most commonly used letters closest to the strongest fingers, and most modern keyboards can be reconfigured for this or similar layouts. However, it is only used by a tiny percentage of typists, probably because of the effort required to learn a new layout. Other forms of tactile input are available, but either haven't really caught on or are used only on a limited basis, such as tablet notebooks. Some alternative devices use "chords" or key combinations. One example of a "chord" device is the FrogPad, which uses combinations of about 15 keys to produce letters, numbers and punctuation marks, and which allows data entry with one hand. Repetitive stress disorders related to keyboard data entry cost private and public sector agencies is estimated in the billions of dollars per year, and can make life miserable for millions of individuals. As for redesigning the keyboard, the answer is open-ended, but should indicate an understanding of the technological and human dynamics.

3. The intent of this question is to help students understand and acquire more detailed information regarding voice recognition technology. Unless there is a breakthrough in the very near future, responses should indicate that the technology continues to advance and definitely has potential for the future, but is still limited and "immature" in terms of speed and accuracy.

4. The intent of this question is to have students research and better understand what many consider to be one of the most exciting and power technologies of the decade. The explanation of how RFID devices work should be consistent with the description in the book. Student should have no problems finding numerous articles on RFID applications, particularly regarding WalMart, one of the early adopters. Likewise, students should not have any problems finding articles on the social, economic and political implications of RFID technology; responses should cover a broad spectrum, particularly regarding individual privacy. As to the applications that RFID technology could be used, responses should include a broad range of possibilities.

5. This question is designed to give students real world experience. Responses regarding design problems and processes should be consistent with the information in this chapter and in previous chapters. The redesigned form and/or screen should also be consistent with the general principles discussed in this chapter.

6. As with the preceding question, this question is intended to help students design a form based upon a real world situation. The content of this form is open-ended, but the processes employed and the principles used in the design should be consistent with those described in this chapter and preceding chapters.

Minicases

1. Some examples (but certainly not all!) are: spaces, the '@' sign, the '&' sign, negative numbers and decimals, numbers when letter were expected, and vice-versa.

2. Remind students that there are appropriate uses for each, and that each input method is not appropriate for all types of input. For example, you wouldn't use a radio button for each state!

3. This will vary, obviously, but take notice of the thoughtfulness and thoroughness of the students' work. Regardless of the solution, it should be complete, clear, thoughtful, and professional.

4. No set answer to this minicase.

Team and Individual Exercises

There are no answers to this section.