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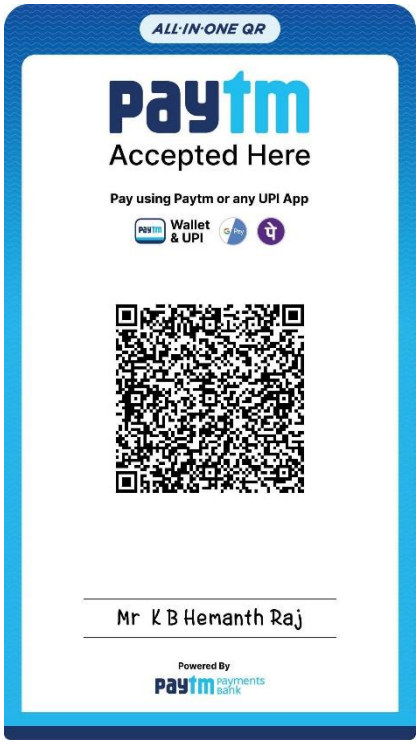

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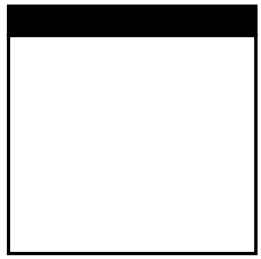

The Essential Guide to User Interface Design

An Introduction to GUI Design Principles and Techniques

Third Edition

Wilbert O. Galitz

Wiley Publishing, Inc.

STEP

8

Write Clear Text and Messages

The wording of the interface and its screens is the basic form of communication with the user. Clear and meaningfully crafted words, messages, and text lead to greatly enhanced system usability and minimize user confusion that leads to errors and possibly even system rejection. In this step, general guidelines for choosing the proper words and writing clear messages and text will be presented. Topics to be covered are as follows:

- The concept of readability.
- Choosing the proper words.
- Writing sentences and messages.
- Kinds of messages.
- Presenting and writing text.
- Window title, conventions, and sequence control guidance.

These general guidelines will be followed by a discussion of Web-specific guidelines, including

- Presenting and writing page text.
- Writing links and headings.
- Writing instructions and error messages.

Words, Sentences, Messages, and Text

All communications should simply, clearly, and politely provide the information one must have to effectively use a system. The design of these communications must take into account the user's experience and knowledge of the system topic, and how much information the user actually needs to efficiently interact with the system. Like all aspects of interface design, knowing the user is the first step in choosing the proper words and creating acceptable messages and text. Let's begin by reviewing one concept by which the understandability of written materials can be measured — readability.

Readability

The degree to which prose can be understood, based upon the complexity of its words and sentences, is called readability. Readability is determined by many factors, including word length, word commonality, sentence length, and the number of syllables in a sentence. Information organization, layout, and formatting also impact ease in document reading. To measure the readability of text, readability formulas began to be developed almost 100 years ago. The initial goal of these formulas was to aid classroom teachers in choosing textbooks for their students. Hence, the measure they derive is a reading level based upon school grade level, from first grade through college. A fourth grader, for example, is assumed to read at a fourth grade level, a twelfth grader at a twelfth grade level.

Today several computer-based readability formulas are available, including the *Automated Readability Index*, the *Gunning-Fog Index* and, included in Microsoft Word, the *Dale-Chall-Flesch Reading Ease* and *Flesch-Kincaid Grade Level*. Most reading formulas include only two factors:

- The number of syllables or (letters) in a word.
- The number of words in a sentence.

The other important attributes of writing that contribute to reading ease still await quantification but, fortunately, these factors are highly correlated with the aforementioned easily measured factors. The results generated by these various formulas are not always in agreement. Flesch-Kincaid often yields a score two to three grades lower than those of other formulas. Osborne (2000) suggests that scores are accurate only by plus or minus 1.5 grade levels. It is important to always keep in mind that these scores do not reflect the content of the writing or how it is presented. A paragraph of text written in gobbledygook will yield a grade-level readability score, as will a paragraph in type too tiny to read. So these measures should always be interpreted with caution. Studies have also shown that applying readability measures to technical documents is generally a waste of time (Barnett 2005). Like all aspects of interface design, presented text should also be subjected to the testing process to verify its readability.

In general, people with more education do have better reading skills. Readability measures on actual Web content have found that presented reading levels ranged from tenth to fourteenth grade (Baker et al., 1997), and were at the tenth grade level (Graber et al., 1999). Reading level can often be inferred from one's education level. As previously described, a recent study summarized, however, that:

- The average reading level in North America is at the eighth to ninth grade level.
- About one-fifth of all adults read at the fifth grade level or below.
- Adults tend to read at least one or two grades below the last school grade completed (D'Allesandro et al., 2001).

Readability Guidelines

- Write at a readability level below the reading skill level of the intended audience.
- Apply all the other principles for clear writing and text presentation.

Writing at a level below the intended audience's reading skill satisfies more users, and also considers formula measurement inaccuracies. Because this measure does not address "does it make sense" and "is it legible," all the other principles for clear writing, organization, and formatting must also be followed. Incidentally, according to the Flesch-Kincaid Readability Index, this step is written at grade level 8.9.

Choosing the Proper Words

- Do not use
  - — Jargon, words, or terms
    - Unique to the computer profession.
    - With different meanings outside of the computer profession.
    - Made up to describe special functions or conditions.
  - — Abbreviations or acronyms
    - Unless the abbreviation or acronym is as familiar as a full word or phrase.
  - — Word contractions, suffixes, and prefixes.
- Use
  - — Short, familiar words.
  - — Standard alphabetic characters.
  - — Complete words.
  - — Positive terms.
  - — Simple action words; avoid noun strings.
  - — The "more" dimension when comparing.
  - — Consistent words.
- Do not
  - — Stack words.
  - — Hyphenate words.
- Include punctuation for abbreviations, mnemonics, and acronyms.

Jargon. Never use jargon that a typical user may not understand. Jargon may take several forms. It may be words or terms that are unique to the computer profession such as *filespec*, *abend*, or *spool*; words with different meanings outside of information systems such as *boot* or *abort*; or made-up words used to describe special functions or actions such as *ungroup* or *de-archive*. Jargon may also be found within a business or profession. Avoid jargon because it will have to be learned, and it may be interpreted incorrectly. A glossary of jargon (or abbreviations or acronyms) can be provided, but do not make the assumption that it will always be used.

Abbreviations or acronyms. Never assume a user will understand what an acronym or abbreviation stands for. Avoid using abbreviations and acronyms unless they are as familiar as the fully spelled-out word or phrase. (An example of a familiar acronym is IBM for International Business Machines.) The reason, again, is that it must be understood and learned. Abbreviations and acronyms, if used, adhere to the following guidelines.

Always use the fully spelled-out form the first time it is encountered in the interface. Present the abbreviation or acronym in parentheses following the fully spelled-out form. Use the abbreviation or acronym in any subsequent locations in the dialog reached directly, and only directly, from the place where it is defined. If these subsequent locations can be reached from places in the dialog other than the location where the abbreviation or acronym was defined (as in Web page design), then do not use the abbreviation or acronym without the fully spelled-out form.

Also, only use an abbreviation if it is significantly shorter than the fully spelled out word, and if it saves needed screen space.

Contractions or short forms. While contractions (*won't* instead of *will not*) save space and lend an informal tone to the interface, be cautious in their use. Never form a contraction from a subject and it's verb, *he'll* instead of *he will*. Words can also be more difficult to understand if they contain prefixes and suffixes, like "un-," or "-ness." A study found that word comprehension often involves a person decomposing more complex terms to establish their basic root meaning and then modifying the meaning to account for the various prefixes and suffixes. Structural complexity hinders comprehension.

Short, familiar words. Use words that are familiar to and frequently used by people. Shorter words tend to be used more often in everyday conversation, so they are more familiar and easier to understand. However, the most important factor is familiarity, not length. A longer but familiar word is better than a short, unfamiliar word.

Standard alphabetic characters. Standard alphabetic characters are most familiar to screen viewers. Never use restricted alphabetic sets. Symbols should be used only if they are familiar to all who are using the screen. Common symbols that may be considered as substitutes for alphabetic characters are # for number, % for percent, and $ for dollar. Again, all potential screen users must be familiar with a symbol if it is used as a substitute for alphabetic characters.

Complete words. Instead of contractions or short forms, use complete words. Complete words are understood better and faster.

Positive terms. It is generally easier to understand positive, affirmative information than the same information expressed in a negative way. Therefore, avoid the prefixes "ir-," "in-," "dis-," and "un-." Implicitly negative terms, such as "decrease," should be replaced with positive terms, such as "increase."

Simple action words. Replace noun strings with simple action words. For example, instead of saying "Project Status Listing," say "*List* Project Status."

"More" dimension. When you are using comparative terms, the "more" dimension is easier to deal with. The opposite of the "more" is usually considered the "negative." So, use "longer" rather than "shorter," "bigger" rather than "smaller."

Consistency. Words chosen for use in an interface should be used consistently throughout the interface. Never use different words to describe identical functions.

Stacking words. Multiple-word phrases are more readable if the entire phrase is on one line, not stacked vertically.

Hyphenating words. Again, for better readability, never break a word between two lines. Hyphenation was created for ease in production, not ease in comprehension.

Punctuation. Abbreviations, mnemonics, and acronyms should not include punctuation. This permits better readability and avoids confusion between the punctuation and other screen elements.

Some words to forget. Words should be meaningful to, understandable by, and acceptable to all users. As mentioned previously, words perceived as "computerese" may confuse or place unnecessary intellectual demands on the user. Other words may have a particularly harsh meaning or invoke unpleasant associations (abort, execute, kill), or have vague meanings (abend, boot). These problem words, summarized in Table 8.1, should be avoided in communications whenever possible. Suggested alternative words are presented.

Table 8.1: Some Words to Forget

AVOID	USE
Abend	End, Cancel, Stop
Abort	End, Cancel, Stop
Access	Get, Ready, Display
Available	Ready
Boot	Start, Run
Error	—
Execute	Complete
Hit	Press, Depress
Implement	Do, Use, Put Into

(continued)

Table 8.1 *(continued)*

AVOID	USE
Invalid	Not Correct, Not Good, Not Valid
Key	Type, Enter
Kill	End, Cancel
Output	Report, List, Display
Return Key	Enter, Transmit
Terminate	End, Exit

Writing Sentences and Messages

- Sentences and messages must be
  - — Brief and simple.
  - — Limited to no more than twenty words per sentence.
  - — Limited to no more than six sentences per paragraph.
  - — Written at an eighth grade level or less for the general population.
  - — Directly and immediately usable.
  - — An affirmative statement.
  - — In an active voice.
  - — In the temporal sequence of events.
  - — Structured so that the main topic is near the beginning.
  - — Of parallel construction.
- Sentences and messages must be of the proper tone:
  - — Nonauthoritarian.
  - — Nonthreatening.
  - — Nonanthropomorphic.
  - — Nonpatronizing.
  - — Nonpunishing.
  - — Cautious in the use of humor.

A sentence and a message must minimize ambiguity and confusion, allowing easy, correct, and fast interpretation. They must also have the proper tone, reflecting the needs of the users. Threatening, rude, or impolite messages most often evoke negative responses. The following guidelines lead to easy, correct, and fast message interpretation and acceptance. A study restructuring error messages along such guidelines has found higher success rates in problem resolution, lower error rates, and improved user satisfaction.

Brief and simple. A message that has to be explained does not communicate. It fails as a message. Brief, simple sentences are more readily understood than longer sentences containing multiple clauses. Research indicates that sentences over 20

words in length cause a loss in reading comprehension with each additional sentence word. It is also recommended that the number of sentences in a paragraph should not exceed six. Another research study created messages at three levels of reading ability (fifth-, tenth-, and fifteenth-grade) and tested them on people of varying verbal abilities. The fifth-grade version was found to be best for all levels. People of high verbal ability did not perceive the fifth-grade version as insulting, as some had feared. So, break long sentences into two or more simple sentences if this can be done without changing the meaning. Always write at the eighth grade level or less for the general population.

Directly and immediately usable. Searching through reference material to translate a message is unacceptable, as are requirements for transposing, computing, interpolating, or mentally translating messages into other units.

Affirmative statement. Affirmative statements are easier to understand than negative statements. For example, "Complete entry before returning to menu" is easier to grasp than "Do not return to menu before completing entry." Tell a person what to do rather than what to avoid. There is an exception, of course. The user may be told how to avoid a situation with disastrous consequences.

Active voice. Provide simple and direct language. The active voice is easier to understand and usually more concise than passive voice. For example, "Send the message by pressing TRANSMIT" is more understandable than "The message is sent by pressing TRANSMIT."

Temporal sequence. If a sentence describes a temporal sequence of events, the order of words should correspond to this sequence. A prompt should say, "Complete address and page forward" rather than "Page forward after completing address."

Main topic at beginning. Information that must be remembered should be placed at the beginning of a message or sentence. A person can remember something longer if it appears at the start. Items in the middle of a sentence or message are hardest to remember.

Parallel construction. Use the same grammatical structure for elements of sentences or messages that provide the same kind of information. For example, say "Use this control to select one choice" and "Use this menu to select one option," not, "To select one choice use this control," and "This menu is used to select one option."

Nonauthoritarian. Imply that the system is awaiting the user's direction, not that the system is directing the user. For example, phrase a message as "Ready for the next command," not "Enter the next command."

Nonthreatening. Negative tones or actions, or threats, are not very friendly. Because errors are often the result of a failure to understand, mistakes, or trial-and-error behavior, the user may feel confused, inadequate, or anxious. Blaming the user for problems can heighten anxiety, making error correction more difficult and increasing the chance of more errors. Therefore, harsh words like "illegal," "bad," or "fatal" should be avoided.

Also, avoid using the word "error" in messages when it implies a user error. "Error" tends to focus the attention on the person involved rather than on the

problem. For example, instead of saying "Error — Numbers are illegal," say "Months must be entered by name." Because the computer does not have an ego to be bruised, an excellent design approach would be to have it assume the blame for all miscommunications.

Nonanthropomorphic. Having the computer "talk" like a person should be avoided for several reasons. First, an attribution of knowledge or intelligence implies a much higher level of computer "knowledge" than actually exists, creating shattered user expectations. Second, this attribute eliminates the distinction that actually exists between people and computers. People "control" computers; they "respect the desires" of other human beings. Third, many people express anxiety about using computers by saying things like "They make you feel dumb." The feeling of interacting with another person who is evaluating your proficiency can heighten this anxiety. There is also some research evidence that a nonanthropomorphic approach is best, being seen as more honest, preferred, and easier to use.

The best advice at this moment is do not give a human personality to a machine. Imply that the system is awaiting the user's direction, not vice versa. Say, for example, "What do you need?" not "How can I help you?"

Nonpatronizing. Patronizing messages can be embarrassing. "Very good, you did it right" may thrill a fourth grader, but would be somewhat less than thrilling to an adult. Being told "You forgot again" once may be acceptable, but being told three or four times in one minute is another story. In a commonly available video golf game, after a player makes a high score on a golf hole, the program returns with the suggestion to the player to "Try another sport." A golf professional that played this game took great offense to this advice and walked away. Would Tiger Woods appreciate this kind of suggestion? A person may disagree with patronizing conclusions, so why risk the offense?

Punishment and humor. Until an optimal computer personality is developed, messages should remain factual and informative, and should not attempt humor or punishment. Humor is a transitory and changeable thing. What is funny today may not be funny tomorrow, and what is funny to some may not be to others. Punishment is never a desirable way to force a change in behavior, especially among adults.

Kinds of Messages

Messages are communications provided on the screen to the screen viewer. Several different types of messages exist, and they may be displayed in different forms and locations. A message should possess the proper tone and style and be consistent within itself and with other messages.

Screen messages fall into two broad categories: system and instructional. *System* messages are generated by the system to keep the user informed of the system's state and activities. They are customarily presented within message boxes. They reflect the

system state, as it exists at that moment in time. *Instructional* messages, sometimes referred to as *prompting* messages, are messages that tell the user how to work with, or complete, the screen displayed. They may be provided in messages boxes and also within the screen itself.

System messages. System messages are of several types, each reflecting a different purpose. The various platforms have developed standard message boxes, with standard components, for these different types. Message box elements include a standard icon to assist in fast recognition of message kind, the message itself, and standard command buttons. The types of message boxes in Microsoft Windows are shown in Figures 8.1, 8.2, and 8.3.

Figure 8.1: Informational message box from Microsoft Windows with icon, text, and button.

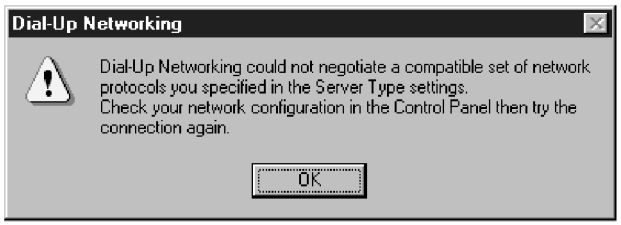

Figure 8.2: Warning message box from Microsoft Windows with icon, text, and button.

Figure 8.3: Critical message box from Microsoft Windows with icon, text, and button.

Common message types are:

Status messages. A status message is used for providing information concerning the progress of a lengthy operation. It usually contains a progress indicator and a short message describing the kind of operation being performed. It typically only possesses a Cancel button, to stop the operation being performed. Pause and Resume buttons may also be included, if desired.

Informational messages. Informational messages, also called *notification* messages, provide information about the state of the system when it is not immediately obvious to the user. They may confirm that non-obvious processing is taking place or is completed. They may also be used to provide intermediate feedback when normal feedback is delayed. This kind of message is usually identified by an "i" icon to the left of the message. In Microsoft Windows "i" is in a balloon. No user actions are normally necessary with these kinds of messages, although confirmation that the message has been seen can be requested. A Microsoft Windows informational message box is shown in Figure 8.1.

Warning messages. Warning messages call attention to a situation that may be undesirable. They are usually identified by an "!" icon to the left of the message. The user must determine whether the situation is in fact a problem and may be asked to advise the system whether or not to proceed. A deletion request by a user is an action that commonly generates a warning message. When a user requests a deletion, a message asking for confirmation of the deletion is usually presented. A warning message can also be used for field edit error messages. A Microsoft Windows warning message box is illustrated in Figure 8.2.

Critical messages. Critical messages, sometimes called *action* messages, call attention to conditions that require a user action before the system can proceed. A message describing an erroneous situation is usually presented as a critical message. Some inconsistency currently exists in the icons used to designate this kind of message. Some products use a "Do Not" symbol while others use a "Stop" sign. An X in a circle is used by Microsoft Windows. Additionally, one platform provides the option of using a "?" icon if the user's attention to the problem may not be immediately needed (for example, "Printer is out of paper"). Critical messages require a user action to continue. A Microsoft Windows critical message box is illustrated in Figure 8.3.

Question messages. Question messages are another kind of message type sometimes seen. A question message asks a question and offers a choice of options for selection. It is designated by a "?" icon preceding the message text. This type may be used when there is a question to be asked and the message does not appear to be suited to the preceding types. Before using a question message, remember that one platform uses the "?" icon for certain kinds of critical messages. Also, Microsoft Windows no longer recommends the "?" icon because of possible confusion with help dialogs.

Messages that are too generic or poorly written frustrate users, increase support costs, and ultimately reflect poorly on the quality of the product. Therefore, it is worthwhile to design effective message boxes. It is even better to avoid creating situations that require displaying such a message. For example, if the user does not have suffi-

cient disk space to perform an operation, check for available disk space before the user attempts the operation and disable the command if necessary. A balloon tip or status bar message can be used to notify the user about why the command is unavailable.

MYTH **If the users need an explanation, they'll always read the documentation.**

Writing Message Box Text

- Title bar:
  - — Clearly identify the source of the message.
    - The name of the object to which it refers.
    - The name of the application to which it refers.
  - — Do not include an indication of message type.
  - — Use mixed case in the headline style.
- Message box:
  - — Provide a clear and concise description of the condition causing the message box to be displayed.
    - Use complete sentences with ending punctuation.
    - State the problem, its probable cause (if known), and what the user can do about it.
    - Avoid contractions.
    - Avoid technical jargon and system-oriented information.
    - Provide only as much background information as necessary for the message to be understood.
    - Show only one message box about the cause of condition in a single message.
    - Make the solution an option offered in the message.
    - Avoid multistep solutions.
    - Use consistent words and phrasing for similar situations.
    - Use the word *please* conservatively.
  - — Do not exceed two or three lines.
  - — Include the relevant icon identifying the type of message to the left of the text.
  - — Center the message text in window.

Microsoft recommends these message box guidelines.

Title bar text. Clearly identify the source of the message in the message box title bar. This may be the name of the object to which it refers, or the name of the application to which it refers. A clear title is particularly important in the Windows multitasking environment because message boxes that appear might not always be the result of current user interaction. In addition, because objects supported by different applications can be embedded in the same document, different application code may be running when the user activates the object for editing. Therefore, the title of a message box plays a vital role in communicating the source of a message.

Do not include in the title an indication of message type (*warning* or *caution*, for example). The icon contained within the message box conveys the nature of

the message. Never include the word "error" in the title, for reasons previously mentioned. Use mixed case in the headline style to present the message box title.

Message box text. Provide a clear and concise description of the condition causing the message box to be displayed, in terminology the user understands. Use complete sentences with ending punctuation. State the problem, its probable cause (if known), and what the user can do about it, no matter how obvious the solution. To aid user comprehension, avoid contractions, technical jargon, and system-oriented information.

Provide only as much background information as necessary for the message to be understood. To supplement the amount of information in the message box text, include a Help button to access more complete descriptive information.

Make messages as specific as possible. Show only one message box regarding a condition in a single message; avoid combining two or more conditions in a single message. For example, if something cannot be done for several reasons, provide a specific message describing each reason.

Make the solution an option offered in the message. For example, if an object such as a string of text will not fit within a certain boundary, and another boundary is available within which it will fit, provide the option to switch to the larger boundary. Do not simply say "The text will not fit."

Avoid multistep solutions. People have difficulty remembering more than two or three simple steps after a message box closes. If multiple steps are necessary, provide general instructions or add a Help button that displays a relevant Help topic. Always present the steps in the order they should be completed. Use consistent words and phrasing for similar situations.

Use the word *please* conservatively. Overuse will diminish its effectiveness. Consider using it in the following situations:

- When the user is asked to wait while the program completes an action.
- When the user is asked to retype information that is required before the user can continue.
- When the user is inconvenienced in some other way.

Do not exceed two or three lines of text. Include the relevant icon identifying the type of message to the left of the text, and center the message text in window.

Message Box Controls

- Command buttons:
  - — If a message requires no choices to be made but only acknowledgment,
    - Include an OK button.
  - — If a message requires a choice to be made, provide a command button for each option.
    - Include OK and Cancel buttons only when the user has the option of continuing or stopping the action.
    - Include Yes and No buttons when the user must decide how to continue.
    - If these choices are too ambiguous, label the command buttons with the names of specific actions.

— If a message allows initiation of an action to correct the situation described,
  • Include a properly labeled button initiating the corrective action.
— If a message describes an interrupted process whose state cannot be restored,
  • Provide a Stop button.
— If a message offers an opportunity to cancel a process as well as to perform or not perform an action,
  • Provide a Cancel button.
— If more details about a message topic must be presented,
  • Provide a Help button.
— Designate the most frequent or least destructive option as the default.
— Display a message box only when the window of an application is active.
— Display only one message box for a specific condition.

■ Close box:
— Enable the title bar Close box only if the message includes a Cancel button.

Command buttons. A user response to a message box is usually accomplished though a command button. The kind, or kinds, of command buttons included depend upon the reason the message box was presented. If a message requires no user choices to be made but only an acknowledgment of the message, include an OK button. If the message requires the user to make a choice, include a command button for each option. Include OK and Cancel buttons only when the user has the option of continuing or stopping the action. Use Yes and No buttons when the user must decide how to continue. If these choices are too ambiguous, label the command buttons with the names of specific actions to be performed (Save and Delete, for example).

If a message allows initiation of a user action to correct the situation described, include a properly labeled button initiating the corrective action. If, for example, the message indicates that the user must switch to another application window to take corrective action, include a button that opens that application window. Be sure to clearly label the button and the results the user can expect from pressing it. If a message describes an interrupted process whose state cannot be restored, provide a Stop button. (Cancel implies restoring the state of the process or task that initiated the message.) If a message offers an opportunity to cancel a process as well as to perform or not perform an action, provide a Cancel button. Clearly label the button and the results the user can expect from selecting it. If more details about a message topic must be presented, provide a Help button. This enables the message text to be succinctly presented.

Designate the most frequent or least destructive command option as the default. Because a message box disrupts the user's current task, it is best to display a message box only when the window of the application to which the message refers is active. If the application's window is not active, use the application's button entry on the taskbar to alert the user. After the user activates the application, the message box can be displayed. Display only one message box for a specific condition. Displaying a sequential set of message boxes tends to confuse users.

Command buttons allow the message box interaction to be simple and efficient. If other types of controls are considered, always be aware of the potential increase in interface complexity.

Close box. Enable the title bar Close box only if the message includes a Cancel button. To leave it available in other situations can confuse users.

Message Location

- Use the message line for messages that must not interfere with screen information.
- Pop-up windows may be used for all kinds of messages, if available.
- Pop-up windows should always be used for critical messages.

Messages may also be displayed either in the message line or within pop-up windows, with pop-up windows being the recommended location. All critical messages should be displayed in a pop-up window. A research study compared locating messages in pop-up windows with messages presented in permanently displayed fixed locations, such as at the screen's bottom or top. The study found pop-up windows were detected more often, and faster, than those permanently affixed in standard locations on the screen.

Other Message Considerations

- Abbreviated, more concise versions of messages should be available.
- Something that must be remembered should be at the beginning of the text.
- Do not include code numbers with messages.

Abbreviated versions. People are impatient with uninformative or redundant computer messages. A problem, however, is that the degree of computer-to-person message redundancy depends on the person's experience with the system. And it may vary with different parts of a system. So the availability of abbreviated and detailed messages allows the tailoring of the system to the needs of each user. During system training and early implementation stages, detailed versions can be used. Individuals can switch to abbreviated versions as their familiarity with the system increases. People using abbreviated messages should, however, be able to request detailed messages at any time.

Important items at beginning of text. One can remember something longer if it appears at the beginning of a message. Items in the middle of a message are hardest to remember.

Code numbers. Messages that begin with a strange code number do not meet the user's needs. A code number, if needed at all, is only necessary after reading the message and should, therefore, be placed in parentheses at the end of the message.

Table 8.2: Instructional Interaction Terms

TO INTERACT WITH THIS CONTROL:	USE THIS TERM:
For a command button, to activate.	Click
For a text box, to type or paste information.	Type
For a list box, to select an item, or items.	Select
To either type or select an option.	Enter
For a check box:	
To add a component.	Select
To clear a component.	Clear
For a radio button.	Select
For a slider interaction.	Move
For a tab interaction.	Click

Instructional Messages

- Provide instructional information at the depth of detail needed by the user.
- Locate it at strategic positions on the screen.
- Display it in a manner that visually differentiates it from other screen elements.
- In writing, follow all relevant writing guidelines for words, sentences, and messages.

Instructional or prompting messages are guidance messages that tell the user how to work with, or complete, the screen displayed. They may be permanently affixed to a screen, or they may appear as the result of a help request.

Depth of detail. Instructional messages are of most benefit to the novice or casual system user. Instructions for these kinds of users must be more detailed than for experienced users. Experienced users usually require only cryptic reminders. To balance the needs of a wide range of users with varying experience levels, accessing instructions through a Help function is the best solution.

Location. Locate instructions at strategic points on screens. They should be placed at spots just preceding the controls or elements to which they apply. Never, however, place an instruction on one screen that applies to elements on a following screen. It will not be remembered.

Visual differentiation. Display instructions in a manner that visually differentiates them from all other screen elements. This will allow them to be easily ignored by users who do not need them.

Writing. In writing instructions, follow all relevant writing guidelines recently described for words, sentences, and messages. Also refer to Table 8.2 for the proper terms to use when interacting with a screen control. Guidelines for instruction presentation on a screen are also outlined in Step 3.

In conclusion, the following "error message" was recently encountered using the Web site of a popular cable TV channel:

Error!
Please hit your back button and enter a search.

In this brief 10-word message, the message writer managed to use three nonrecommended words (error, hit, and enter). Wouldn't the following have been much more agreeable?

The Search field did not contain an entry.
Please click the Back button and type a search value.

The original message writer gets one point for including Please, however.

Presenting and Writing Text

Text, by a very general definition, is any textual element that appears on a screen, including field captions, headings, words, sentences, messages, and instructions. Text, in the following discussion, refers to body text, a large compilation of words whose smallest element is a paragraph and whose maximum length is unlimited, its size being governed by the reason for its existence.

Presenting Text

- Display prose text in mixed upper- and lower-case letters.
- Fonts:
  — Use plain and simple fonts.
  — Choose a minimum point size of 12 to 14.
  — Use proportional fonts.
- Justification:
  — Left-justify.
  — Do not right-justify.
  — Do not hyphenate words.
- Line Length:
  — If fast reading is required, use line lengths of about 75-100 characters.
    - If user preference is important, a length of about 50-60 characters is acceptable.
    - Very narrow columns should be avoided.
- Line endings:
  — Coincide with grammatical boundaries.
- Line spacing:
  — Increase line spacing to enhance legibility and readability.
- Content:
  — Use headings to introduce a new topic.
  — Make first sentences descriptive.

— Separate paragraphs by at least one blank line.
— Start a fresh topic on a new page.
— Use lists to present facts.
— Emphasize important things by
  - Positioning.
  - Boxes.
  - Bold typefaces.
  - Indented margins.
— Provide a screen design philosophy consistent with other parts of the system.

Prose Text. Present prose text in the standard sentence style, capitalization to start sentences and to indicate proper nouns and acronyms. To attract attention, display an item in all uppercase, bold, or italics. Be conservative in using these techniques, however, restricting them to one or two words, or a short phrase. Overuse slows reading speed for extended prose.

Fonts. Fonts chosen for text should be plain and simple and of adequate size for easy reading, either 12 or 14 points. Proportional spacing (width governed by actual letter size, when an "l" is narrower than an "m") is preferred to nonproportional spacing.

Justification. Left-justify blocks of text to give the eye a predictable starting point when moving from one line to the next. Text at the right margin is usually best left unjustified to avoid large gaps that justification can cause between words. Studies also find that non-right-justified (or ragged-right edge) text lines are just as legible as justified text lines. Large spaces left in right-justified text interrupt eye movement and impede reading. The reading speed of right-justified text was actually found to be 8 to 10 percent slower than non-right-justified text in one study. Non-right-justified text has another advantage in that word hyphenation is not required. Experts also say that non-right-justified text creates more visual interest, and is best for very narrow columns of text. Full left- and right-justification may be considered for long works that require continuous reading and concentration, such as long text, newspapers, and novels.

Length. The optimum width of a line of text has been the topic of research studies since the late 1800s. The following is a brief summarization of this research. It is derived from an extensive review by Bailey (2002).

The earliest reported studies were by Weber (1881), Javel (1881) and Cohn (1883). The composite of their conclusions was that ideal length was 3.6 to 4 inches in width and their maximum length recommendations did not exceed 6 inches. Tinker and Peterson (1929) found that for 10-point black type on white paper, line lengths between 3 and 3.5 inches yielded the fastest readings and lengths of 7.3 inches yielded the slowest.

The introduction of computer monitors found a reversal in this trend toward shorter line length allowing faster reading. Studies by Duchnicky and Kolers (1983), Dyson and Kipping (1997, 1998), Dyson and Haselgrove (2001), Youngman and Scharff (1998), and Bernard et al., (2002c), most using 12-point type, generally concluded the following:

- Longer line lengths (7.3 to 9.6 inches) yielded faster reading rates than shorter lengths (1.8 to 6.0 inches).
- People, however, preferred shorter lengths (3.3 to 5.7 inches) and a three-column format to a wider and faster-reading one-column format.

  The conclusion: People read faster with longer line lengths, while short line lengths impede rapid reading. In spite of this, people preferred the shorter line lengths (another example of a preference-performance disparity). So, for fast reading, create line lengths in the 75-100 character range. For user preference and acceptance, use lengths of about 50 characters per line. Avoid very narrow line widths because they fragment the text, making it more difficult to construct the meaning.

Line endings. Short lines, if used, are easiest to read and understand if their endings coincide with grammatical boundaries or thoughts. Do not break lines at arbitrary points, whenever possible. For example:

Very short lines are easier to read if line endings occur at grammatical boundaries.	Is much better than	Very short lines are harder to read if the line endings occur at any arbitrary spot.

Line spacing. The legibility and readability of smaller type can be enhanced by increasing line spacing or leading. The longer the line, the wider spacing can be. Too great a line spacing must be avoided, however, to maintain the perception of a unified whole.

Content. *Headings* to introduce new topics provide breaks or pause points for the reader. They provide obvious closure points. *Descriptive first sentences* are achieved by including within them a paragraph's primary theme and the scope of what it covers. People tend to skim the first few sentences of a paragraph to determine content and whether it is worthwhile to read further. *Separating paragraphs* by a blank line results in more cohesive groupings and alleviates the impression of a dense screen. Starting *new topics* on new pages reinforces the needed content breaks.

Use lists to present facts. Lists are convenient, simple, and uncluttered and can effectively break up long strings of text. Designate items in a list with a bullet or other simple symbol.

Emphasize important points. Emphasize important points by placing them in unusual places, drawing boxes around them, using bold typefaces, or providing indented left and right margins. In addition to their emphasizing capabilities, they also make the screen more visually interesting.

Consistency. Provide a writing and presentation philosophy consistent with other parts of the system.

MAXIM **Clear communication does not mean shouting VERY, VERY LOUD.**

Writing Text

- Sentences and paragraphs:
  - — Use short sentences composed of familiar, personal words.
    - Cut the excess words.
    - Try to keep the number of words in a sentence to 20 or less.
  - — Cut the number of sentences.
  - — Use separate sentences for separate ideas.
  - — Keep the paragraphs short.
  - — Restrict a paragraph to only one idea.
- Style:
  - — Use the active writing style.
  - — Use the personal writing style, if appropriate.
  - — Write as you talk.
  - — Use subjective opinion.
  - — Use specific examples.
  - — Read it out loud.

Sentences and paragraphs. Simple words and short sentences are the cornerstones of good writing. As previously mentioned, research indicates that sentences over 20 words in length cause a loss in reading comprehension with each additional sentence word. Long sentences often result from trying to express more than one idea in the sentence, or from using unnecessary words. Table 8.3, derived from Microsoft (2001), lists some common wordy phrases to avoid and their replacement words. It also describes some redundant word pairings to avoid. These redundancies are also known as *baby puppies*, a concept that was graciously explained to me by the editor of my first book many years ago. Use separate sentences for separate ideas. Place multiple items in a list format, and delete all unnecessary words. Short paragraphs are less threatening to the user and more frequently read. They also provide visual breaking points in a screen or page.

Style. The style chosen should reflect the needs and characteristics of the user. The style will affect the readability and comprehensibility of the text. The active writing style is easier to read and understand. It almost always uses fewer words and leaves no unanswered questions (contrast the passive "The customer name should be typed" with the active "Type the customer name"). The personal style, the use of "you" and "I" ("Now you must press the Enter key"), keeps the writing active, makes writing directly relevant to the reader, and is more interesting. Materials read by a wide variety of people for informational purposes only, however, should not use the personal style. Write in the way you would say something to the reader. Also, use subjective opinion ("This screen is not used very often") to reinforce the users' understanding of what they are reading. It does not tell anything specific, but reinforces facts already read or about to be read. Do not

overuse subjective opinion, however, and make sure it is correct. Overuse makes facts harder to find, and an incorrect opinion casts suspicion on all the facts being presented. The best way to explain a general rule is to show how it applies through examples. Examples should be short, relevant, and easy for the reader to relate to. They should also be made visually different from the main text, either through indentation, boxing, or some other technique. Finally, read what you have written out loud to yourself. If it sounds wordy, stilted, or difficult, it will sound this way to the reader, too. Rewrite it.

Window Title, Conventions, and Sequence Control Guidance

A window title, conventions for referring to screen elements, and sequence control guidance must also be created.

Window Title

- All windows must have a title located in a centered position at the top.
  — Exception: Windows containing messages.
- Clearly and concisely describe the purpose of the window.
- Spell it out fully using an uppercase or mixed-case font.
- If title truncation is necessary, truncate it from right to left.
- If presented above a menu bar, display it with a background that contrasts with the bar.

The window title should be positioned at the top center and fully spelled out using either uppercase letters or mixed-case in the headline style. Using an uppercase font will give it the needed moderate emphasis, aiding in setting it off from the screen body (IBM's SAA CUA and Microsoft's Windows guidelines display the title, like all screen components, in mixed-case letters). Windows containing messages, however, need not have a title. The title should clearly and concisely describe the screen's purpose. If the window appears as a result of a previous selection, the title should clearly reflect the wording of the selection made to retrieve it. For small windows, where title truncation is necessary, truncate from right to left.

If the title appears above the menu bar, the title's background should contrast with that of the bar. A recommendation is to use the same background color and caption color as the screen body. A title can always be identified by its topmost location on the screen, so using a color different from other screen components may add to visual confusion.

Table 8.3: Wordy Phrases and Word Redundancies

INSTEAD OF THIS PHRASE:	SAY THIS:	WORD REDUNDANCIES
By means of	By	Surrounding Environment
For the purposes of	For	Absolutely Complete
In many cases	Often	Exactly identical
In the event that	If	Repeat again
Is able to	Can	Final conclusion
The way in which	The way, how	Knowledge and awareness
In order to	To	Each and every
Prior to	Before	Complete overview
Is required to	Must	Advance planning
		Full and complete

Derived from Microsoft (2001).

Conventions

- Establish conventions for referring to
  - — Individual keyboard keys.
  - — Keys to be pressed at the same time.
  - — Field captions.
  - — Names supplied by users or defined by the system.
  - — Commands and actions.

In messages and text it is often necessary to refer to keyboard keys, field captions, filenames, commands, or actions. These components should be described in the same manner whenever referenced. Keyboard keys should always be referenced as they are inscribed on the keyboard. (They usually appear in a mixed-case text format.) A useful convention for referring to keys that should be pressed at the same time is a plus (+) sign between the key descriptions (Alt+F10). Names may be enclosed in quotes ("Pending").

Sequence Control Guidance

- Consider providing a guidance message telling how to continue at points in the dialog when
  - — A decision must be made.
  - — A response needs to be made to continue.

- Consider indicating what control options exist at points in the dialog where several alternatives may be available.
- Permit these prompts to be turned on or off by the user.

Consider providing prompts telling the user how to continue when a decision and response must be made to continue. For example, it might be indicated that

Information is current through August 26, 2001.

Press Enter to continue.

Where several control options exist, consider providing a prompt such as

Press S to Save, D to Delete, or P to Print.

Type C to Create a new file, or E to Edit a new file.

For experienced users, these kinds of prompts can become visual noise. Allow users to turn them on or off as needed.

Content and Text for Web Pages

Because the most important part of a Web site is its content, a well-written site is a necessity. Poorly written content has been found to increase user confusion, increase comprehension errors, increase reading times, and reduce user satisfaction. These problems are amplified for non-native English speakers (Ozok and Salvendy, 2003; Morkes and Nielsen, 1998). Content re-written properly for presentation on a Web site has been found to reduce the time to perform a task by 80 percent, improve one's memory of the content by 100 percent, and increase user satisfaction by 37 percent (Morkes and Nielsen, 1998).

Text for Web pages will generally follow the aforementioned guidelines for words, sentences, messages, instructions, and text. The unique characteristics of the Web, however, require a separate set of supplemental guidelines for several Web topics, including, word usage, error message presentation, and text, heading, and title writing. Additionally, the writing of links must be addressed. This section focuses on these topics.

Words

- Minimize the use of words that call attention to the Web.

Generally, avoid using words that are specific to the Web. A few Web-specific terms are "This Web site," "Click here," and "Follow this link." A good test of this guideline is to print out a page, read it, and see if it makes as much sense on paper as it does on the screen.

Page Text

Web page text must be legible and properly written for the medium.

Presentation

- Provide text that contrasts highly with the background.

Text legibility can be a severe problem if insufficient contrast exists between the text and its background. Patterned backgrounds can severely impact legibility, as do many colors. A common characteristic of the best Web sites is they contain text highly contrasting with its background. Overall, the best combination is black text on a white background.

Writing

- Style:
  - — Use a style reflecting the needs of the site users.
  - — Write objectively.
  - — Use the inverted pyramid organization.
  - — Be concise, using only about half the number of words of conventional text.
  - — Each paragraph should
    - Be short.
    - Contain only one main idea.
- Links:
  - — Minimize within-text links.
  - — Place them at the beginning or end of paragraphs or sections of text.
- Scanning:
  - — Make text scannable by using
    - Bulleted listings.
    - Tables.
    - Headings and subheadings.
    - Highlighted and emphasized important issues.
    - Short paragraphs.
- International audience:
  - — Consider internationalization needs.
- Testing:
  - — Test for legibility and readability.

Style. Web users can be characterized as being multicultural with multi-interests, multi-needs, and multi just about everything else. Writing styles will vary, depending on the needs of the target audience. Establishing the proper style depends on who the viewers are, what they know, where they normally get

similar information, and the nature of the material. A business application will be written differently than an entertainment site; a product sales site differently than that of a business application or entertainment site. Writing style depends less on medium differences than on answers to the above questions. Writing style, then, should reflect the tone of similar copy published for the target audience in other media. Generally speaking, writing that strays too far from what is conventional for the target audience draws attention to itself at the expense of content.

If Web writing does have one quality that sets it apart from print writing, however, it is its informality. Users seem to prefer a more informal writing style. Users also prefer writing, says research, that is objective rather than filled with overly hyped or boastful promotional claims or sprinkled with "marketeseisms." Subjective adjectives, such as outstanding, experienced, reliable, and dynamic, have been shown to inspire mistrust on the part of the user, and also to increase the user's cognitive load because the "irrelevant stuff" must first be comprehended and then discarded. So, always be objective in writing style.

The *inverted pyramid* organization starts with a conclusion or summary of key points and follows with the supporting details or background information. This organization scheme, also commonly found in newspaper articles, lets the user quickly identify an article's content and assess whether continued reading is warranted.

Be *concise*, succinct, and to the point, using only about half the number of words of conventional text. Pack the maximum meaning into minimum text, so users will get the message in the shortest possible time. Keep the writing tight and nonverbose. Use short sentences and the shortest form of a word or an idea. Minimize "fluff," useless, and inessential information, or words that do not add meaning to what is being said. Avoid words with three syllables. Research shows that concise and short writing reduces the user's cognitive load, resulting in faster and more efficient information processing.

Each *paragraph* should contain only one main thought. Make the paragraph's intentions plain in the first sentence. For additional ideas or points use additional paragraphs. Users tend to skip over more than one point or ideas in a paragraph as they scan. Keep paragraphs short, no longer than five sentences encompassing no more than 75 words. Provide clear paragraph breaks.

Links. Too many links embedded within text can disrupt reading continuity and content understanding. Minimize within-text links and, where possible and appropriate, place them at the beginning or end of paragraphs or sections of text.

Scanning. Because people frequently scan Web pages, make texts more scannable by using bulleted listings, tables, headings and subheadings, short paragraphs, and highlighted important issues. Key information will be found faster.

Internationalization. If the Web site is used by an international audience, or translated into another language, adhering to internationalization requirements will be necessary. This topic is discussed in Step 10.

Testing. Test for readability. Print out text to carefully proofread it; errors will be more easily caught. Also, write and edit with international readers in mind.

Writing Link Labels

- Create meaningful labels that use the following:
  — Descriptive, differentiable, predictive, and active wording.
  — Keywords positioned at the beginning.
  — Content that is concise but long enough to be understood.
  — Wording that clearly indicates link destination or resulting action.
  — Link names that match with their destination page.
- Integrate embedded links smoothly into the text.
- Ensure that embedded links are descriptive.
  — Make only a few words the active link.
  — Do not spread links over two lines.
- Standalone links should not exceed one sentence in length.
- Provide glosses or link labels to assist link understanding.

Meaningful labels. The success of a link is determined by how well the user can predict where the link leads. Link differentiability and descriptiveness aids prediction. Understanding of a link's purpose reduces disorientation, because irrelevant links are less likely to be followed. Link text should clearly communicate the link's nature and purpose, and contain enough information to let users decide whether or not to follow it. The links of the best-rated Web sites are textual and descriptive, letting the user know what to expect.

People should be able to quickly scan a link label and comprehend what will be found on the link's destination page. Locating a link's keyword, or most relevant word, at the beginning aids scanning. LeDoux et. al (2005) studied the "cautious clicking" behavior of older adults and found that adding action words such as "Go to" and "View" to link labels helped understanding and performance. Similar improvements were found for users of all ages.

Create links that are concise and to the point, avoiding wordiness. Generally, a link has to strike a proper balance between enough words to make it descriptive and differentiable, and few enough words to make it most easily readable and legible. Underlining causes slow reading of text. So, the length of a link will involve trade-offs. A one-word link may not provide enough information about the destination; a link of several or more words may be difficult to read quickly. One study, as reported by Koyani et al. (2004), found that links of nine or ten words elicited better performance than shorter or longer links. In general it is best that text links do not wrap, extending to two lines. Remember to create link labels that are consistent with the destination page title or heading. Poorly titled pages make using the Back Button/Browser History harder (Cockburn et al., 2002).

Avoid repeating the same exact label on successive pages if the links lead to different destinations. Also avoid similar labels to avoid confusion. As previously mentioned, the success of the link will be dependent on how well the user can predict where the link will lead. Descriptiveness aids prediction. People with a broad range of needs and interests will use Web sites.

Embedded links. Write text containing embedded links as if there were no links in it. The links must integrate smoothly and continuously into the text. Choose the

most relevant words or phrase as the active link. Embedded links should also exactly describe the link's destination. People often ignore the text surrounding an embedded link (Koyani et al., 2004), so the link must stand by itself. Clues to the destination content should not be placed within the embedded link's surrounding text. Embedded links must not be continued over two lines. They may be mistaken for two links.

Standalone links. Standalone links should not exceed one sentence in length.

Glosses or link labels. Glosses or tooltips are short phrases of information that pop up when a pointer is placed close to a link. It provides a more thorough preview of the information on the destination page. Baker et al., (2002) found that presenting short summaries with text links helps users understand and predict the content associated with the link. LeDoux et al., (2005), in his study of older users, found that an option to turn on a one- or two-sentence summary also improved usability. People actually spent less time reading the summary than they did pondering what a link was for if no pop-up existed. Summaries need not, of course, be presented in glosses but can appear on the Web page itself. Glosses should not be relied on to compensate for poor label design. Glosses/tooltips are discussed in more detail in Step 7. Link label writing guidelines are provided in the following section.

Examples of proper link writing are shown in Figure 8.4. Placing links in headings always make them easier to find.

Link Titles

- Provide link titles that describe
  - — The name of site the link will lead to (if different from current site).
  - — The name of subsection the link will lead to (if staying within current site).
  - — The kind of information to be found at the destination.
  - — How the linked information relates to the anchor link and the current page content.
  - — How large the linked information is.
  - — Warnings about possible problems to be encountered at the other end.
- Restrict titles to no more than 60 characters.

POOR> Paragraphs with embedded links are sometimes useful for a variety of reasons.

BETTER> Paragraphs with embedded links are sometimes useful for a variety or reasons.

BEST> Embedded Links

Paragraphs with embedded links are sometimes useful for a variety of reasons.

Figure 8.4: Writing links.

Some Web browsers have added the ability to pop up a short explanation of a link before the user selects the link. This explanation, called a *link title*, gives a more thorough preview of where the link goes, greatly enhancing predictiveness. Types of information that may be included in a link title are summarized above. Link titles should be reserved for supplementary information to help clarify the link's purpose. They do not eliminate need for a link and its surrounding text to be understandable. Generally, a link title should not exceed 60 characters in length.

Page Title

- Provide a page title
  - — That possesses meaningful keywords.
  - — Whose first word is its most important descriptor.
  - — That makes sense when viewed completely out of context.
  - — That is different from other page titles.
  - — That is written in mixed case using the headline style.
- Do not highlight keywords.

Page titles must be carefully designed to provide useful information. They should contain as many keywords as possible. While a title may contain 60 characters, ensure that the first 40 characters adequately describe the page topic. Titles are often truncated in navigation menus and by search facilities. The title's first word should be its most important descriptor. This word is most easily noticed in the scanning of long lists. Never begin a title with a generic term such as "Welcome" or "Page," or with an article such as "The." Give different titles to different pages. If page titles addressing the same topic must begin with same word, end the title with words that explain the differences between them.

A title must also make sense when viewed completely out of context, with no supporting content or when arrayed in a listing with other titles. Write titles in mixed case using the headline style. Do not use highlighting for keywords. A single keyword might be emphasized through putting it in uppercase, but be conservative in this regard. Never use uppercase for the first word in a title; its position is sufficient emphasis.

Headings and Headlines

- Create meaningful headings and headlines that quickly communicate the content of what follows.
  - — Make the first word an important information-carrying one.
  - — Skip leading articles (the and a).
- Create meaningful subheadings to break up large blocks of text.

Headings and headlines are often scanned to find screen content of interest. Their wording must provide a strong clue about the content they relate to. Headings should be descriptive and straightforward. Headlines must often be made sense of out of

context. Clever, cute or funny headlines or headings, or teasers to entice, should be avoided. A study has found that users prefer straightforward headlines to funny or cute ones. The first word in a heading or headline is the most important information-carrying one. Make it as distinctive as possible, especially if the heading or headline will be contained in an alphabetized listing. Skip leading articles (the and a) to also achieve distinctiveness. Distinctive first words will be easier to find in scanning. Use subheads to break up large blocks of text for visual appeal and ease of scanning.

Instructions

- Do not use phrasing that indicates a certain page order or flow.
- Explain where "Up" leads too.
- Phrase them in a browser-independent manner.
- Minimize "Click here" instructions.
- Say "Select this link."

Do not use phrasing that indicates a certain page order or flow. How the visitor arrived at the site is unknown. Do not use "Return to" instructions; it cannot be assumed that the term is meaningful in the new context. Describe where an "Up" button leads, where the user will go, and what will be found there. Make sure instructions are detailed enough to be understood without being specific to one browser version or brand. Don't use the phrase "click here." Some users will not use a mouse and may feel alienated. A more proper instruction for all users is "Select this link."

Error Messages

- Provide helpful and precise error messages for
  — Incomplete or incorrectly keyed, entered, or selected data.
  — Requests for documents that do not exist or cannot be found.
- Redisplay a message on the page to which it relates.
- Present them in a visually distinctive and noticeable manner.

Provide helpful and precise error messages for data that has been incompletely or incorrectly entered. An all too frequently occurring problem exists with login screens. An incorrect user ID or password entry often results in a message similar to the following: *User ID and/or password is invalid.* Because the system is intelligent enough to determine which of these two fields is in error, it should tell the user which of these fields is in error. The system should also say that the entry was *not recognized*, accepting some of the blame and not imposing it on the user.

Also provide messages for requested documents that do not exist or cannot be found. In a graphical interface, an error message is displayed in a message box overlaying the error-causing screen. The underlying screen is visible and can be viewed in conjunction with the error-correction instructions. The message box remains displayed

until the user acknowledges its presence. In Web page design, displaying the error message on a separate page is accomplished at the expense of the error-causing page disappearing from view. Human memory being what it is, a possible solution now exists to a problem whose details are now vague. Problem resolution typically involves paging back and forth between the error message and the related Web page, an inefficient operation.

The alternate solution is to present the error message on the page where the error exists. This is the recommended choice. Context is maintained, and both elements can be viewed in fairly close proximity to each other. The error message must be displayed in a visually distinctive manner as close to the problem as possible. Visual distinctiveness can be achieved through displaying the message in a larger, bolder, and distinctive font. The user's attention will probably be directed to the part of the page on which actions can be performed, so the message should be made as obvious as possible. A message in the same font style as the page will be less likely to be noticed.

Keep in mind, however, that it is much better to prevent errors than handle them. This topic is discussed next in Step 9.

Step 8 Exercise

An exercise for Step 8 can be found on this book's companion Web site, www.wiley.com/college/galitz.

STEP

9

Provide Effective Feedback and Guidance and Assistance

All user actions must be reacted to in some way. Feedback, as has been noted, shapes human performance. Without it, people cannot learn. To aid user learning and avoid frustration, it is also important to provide thorough and timely guidance and assistance. In this step, the following feedback topics are discussed:

- Acceptable response times.
- Dealing with time delays.
- Blinking for attention.
- The use of sound.

This will be followed by a review of guidance and assistance, including

- Preventing errors and problem management.
- The types of guidance and assistance to provide
  - Instructions or prompting.
  - A Help facility.
  - Contextual Help.
  - Task-oriented Help.
  - Reference Help.
  - Wizards.
  - Hints or tips.

Providing the Proper Feedback

To be effective, feedback to the user for an action must occur within certain time limits. It is known that excessive delays can be annoying, interrupt concentration, cause the user concern, and impair productivity as one's memory limitations begin to be tested. What the ideal system response time is has been the subject of numerous studies for decades. The following general guidelines were derived through research using text-based and graphical systems. After this research is surveyed, the expanding body of knowledge regarding response time delays in Web-based systems will be reviewed.

Response Time

- System responsiveness should match the speed and flow of human thought processes.
  - — If continuity of thinking is required and information must be remembered throughout several responses, response time should be less than 1 or 2 seconds.
  - — If human task closures exist, high levels of concentration are not necessary, and moderate short-term memory requirements are imposed; response times of 2 to 4 seconds are acceptable.
  - — If major task closures exist, minimal short-term memory requirements are imposed; responses within 4 to 15 seconds are acceptable.
  - — When the user is free to do other things and return when convenient, response time can be greater than 15 seconds.
- Constant delays are preferable to variable delays.

Unfortunately, this earlier research could not provide definitive times that are acceptable under all conditions. What was clear, however, was that dissatisfaction with a response time is very dependent on user expectations. It was also clear that expectations could vary, depending on the task as well as the situation. The ideal condition is one in which a person *perceived* no delays. Generally, a response time is too long for a person when one notices that something is taking too long. The following paragraphs summarize some study conclusions and the tentative findings.

The optimum response time is dependent upon the task. There is an optimum work pace that depends on the task being performed. Longer or shorter response times than the optimum lead to more errors. In general, response times should be geared to the user's short-term memory load and to the way he or she has grouped the activities being performed. Intense short-term memory loads necessitate short response times. While completing chunks of work at task closures, users can withstand longer response delays.

The human now, or psychological present, is under 2 to 3 seconds. This is why continuity of thinking requires a response time within this limit. Research indicates that for many creative tasks, response times under 1 second, in the range of four-tenths to nine-tenths of a second, can yield dramatic increases in productivity, even greater in proportion to the decrease in response time. The probable reason is the elimination of restrictions caused by short-term memory limitations.

For data entry tasks, research has found no advantages for having response times less than 1 second.

If human task closures exist, high levels of concentration are not necessary, and moderate short-term memory requirements are imposed; response times of 2 to 4 seconds are acceptable. If major task closures exist, minimal short-term memory requirements are imposed, and responses within 4 to 15 seconds are acceptable. As the response-time interval increases beyond 10 to 15 seconds, however, continuity of thought becomes increasingly difficult to maintain. Research in applied attention and cognition suggests that after 10 seconds or more of wait time, the boundaries of the current "unit task" are broken (Card et al., 1983). It has been postulated that with long delays the sequence of actions stored in short-term memory become badly disrupted and must be reloaded.

The aforementioned response time guidelines, then, relate to the general tasks being performed. Their applicability to every situation can never be guaranteed.

Satisfaction with response time is a function of expectations. Expectations are based, in part, on past experiences. These experiences may be derived from working with a computer, from the world in general, or from the perceived complexity of the task the computer is performing. These expectations vary enormously across individuals and tasks.

MAXIM **Service = Perception – Expectation (D. Meister, 1985).**

Dissatisfaction with response time is a function of one's uncertainty about delay. The degree of frustration with delay may depend on such psychological factors as a person's uncertainty concerning how long the delay will be, the extent to which the actual delay contradicts those expectations, and what the person thinks is causing the delay. Such uncertainty concerning how long a wait there will be for a computer's response may in some cases be a greater source of annoyance and frustration than the delay itself.

People will change work habits to conform to response time. As response time increases, so does think time. People also work more carefully with longer response times because the time penalty for each error made increases. In some cases, more errors have been found with very short response times. This may not necessarily be bad if the errors are the result of trial-and-error learning that is enhanced by very fast response times.

Constant delays are preferable to variable delays. It is the variability of delays, not their length, that most frequently distresses people. From a consistency standpoint, a good rule of thumb is that response-time deviations should never exceed half the mean response time. For example, if the mean response time is 4 seconds, a 2-second deviation is permissible. Variations should range between 3 to 5 seconds. Variation should never exceed 20 percent, however, because lower response time variability has been found to yield better performance, but small variations may be tolerated.

More experienced people prefer shorter response times. People work faster as they gain experience, a fact that leads Shneiderman (1987) to conclude that it may

be useful to let people set their own pace of interaction. He also suggests that in the absence of cost or technical feasibility constraints, people will eventually force response time to well under 1 second. In general, the longer people interact with a system, the less delay they will tolerate.

Very fast or slow response times can lead to symptoms of stress. There is a point at which a person can be overwhelmed by information presented more quickly than it can be comprehended. There is also some evidence indicating that when a system responds too quickly, there is subconscious pressure on people to respond quickly also, possibly threatening their overall comfort, increasing their blood pressure, or causing them to exhibit other signs of anxious behavior. Symptoms of job burnout have been reported after substantial reductions in response time.

Slow and variable response times have also been shown to lead to a significant build-up of mood disturbances and somatic discomfort over time, culminating in symptoms of work stress, including frustration, impatience, and irritation.

Web Page Download Times

Web research concerning acceptable page download delays is summarized in the following paragraphs. Weinberg (2002) estimates that download delays cost e-commerce $4 billion in lost revenue a year. This discussion is partially based upon Straub (2003b) and Koyani et al. (2004).

Ramsay et al. (1998) looked at the effect of fixed download delays (2 seconds to 2 minutes), site type, and page style on perceived interest of content and ease-of-scanning. Sites with long delays, over 41 seconds, were reported as significantly less interesting and more difficult to scan independent of content. Additionally, page style did not influence perceptions. Graphics-heavy sites were expected to respond as quickly as text-only sights.

Bouch et al. (2000) performed three related studies. Web pages were presented at preestablished delays ranging from 2 to 73 seconds. Delay was defined as the time between a page's request and its complete display on the screen. Test participants rated the response times with the following results:

- High (Good): Up to 5 seconds
- Average: From 6 to 10 seconds
- Low (Poor): Over 10 seconds

In the second study, test participants were presented a button labeled "Increase Quality" and asked to press it when response time became unacceptable. The average button-pressing time was 8.6 seconds. In the third study, the Web pages were loaded incrementally, the banner first, the text second, and the graphics last. The test participants were much more tolerant of delays under these conditions. Response times up to 39 seconds were rated as "good," and response times over 56 seconds were rated as "poor."

Selvidge et al. (2000) studied the effect of downloading delays on user performance. For delays of 1, 30, and 60 seconds they examined task success, task efficiency, and participant frustration. They found that participants were less frustrated with the 1-second delay, but task success and efficiency were not affected by any of the response times.

Other studies have found the following:

- Longer delay times are tolerated by
  - Novice users (Shneiderman, 1998; Ryan and Valverde, 2003).
  - Older users (Selvidge, 2003).
  - People not experienced with high bandwidth connections (Selvidge, 2003).
  - New visitors to a site (Bouch et al., 2000).
  - People performing important tasks (Ceaparu et al., 2004).
  - People performing successful tasks (Watts-Perotti and Woods, 1999).
  - Better content (Ryan and Valverde, 2003).
- Perceived delays in presentation cause sites to be evaluated as
  - Less interesting (Ramsay et al., 1998).
  - Possessing lower quality content (Sears and Jacko, 2000).
  - Interfering with task continuity and use flow (Shubin and Meehan, 1997).
  - Less rememberable (Shubin and Meehan, 1997).
  - Less secure (Bouch et al., 2000).
- Exceedingly slow sites can lead people to believe that they made an error (Lazar and Norico, 2000).

In general, these studies seem to indicate that the same factors affecting optimum computer response times also operate in the world of the Web, although slightly longer downloading times may be more readily accepted because of the graphical nature of the Web's content. Because of the greatly expanded population of Web users (as compared to graphical system users), other factors such as user age, Web page content quality, and success in performing a task have become important as well. The studies also point out the different expectancies that different types of users bring to their Web experience. This research has led to the development of Web-based guidelines to reduce page download times.

Page Downloading

- Maximum downloading time should be about 10 seconds.
  — Use incremental or progressive image presentation.
- Images should be
  — Small.
  — Lean (Low bit depth, resolution, use of fewer colors, and so forth).
  — Reusable.
  — Contain pixel height and width dimensions in a tag.
- Use thumbnail images to preview larger images.
- Use simple background images.

Downloading times. Downloading times above about 10 seconds per page, from a practical standpoint, appear to substantially reduce the amount of work that can be performed, and lead to increased user frustration and dissatisfaction. Other factors such as user age, task importance, and so forth do, however, influence what is acceptable and what is not to the user. In some cases, longer times will be tolerated. Display the page progressively to assure users that their requests are being responded to.

Images. To speed up downloading, use several small images rather than one large image on a page and reuse images whenever possible. Images should also be as simply constructed as possible. To achieve faster response time for people with dial-up modems, restrict page size to less than 30,000 bytes. Also, provide height and width pixel dimensions in a tag.

Thumbnails. If viewing a full-size image is not critical, a thumbnail image of the larger image can be presented. People who do not want to look at the large image will not be slowed down by a large image download. The thumbnail image should be linked to a full-size copy.

Background Images. Use background images sparingly. In addition to slowing down download times, background images can make text much harder to read. If background images are used, provide simple, small images with "tiling" and/or keep the image resolution low.

Future years will probably see a person's expectancies regarding an acceptable delay become lower as technology improves and a person's experience using the Web broadens.

Dealing with Time Delays

- Button click acknowledgement:
  - — Acknowledge all button clicks by visual or aural feedback within one-tenth of a second.
- Waits of up to 10 seconds:
  - — If an operation takes 10 seconds or less to complete, present a "busy" signal until the operation is complete.
    - Display, for example, an animated hourglass pointer.
- Waits of 10 seconds to 1 minute:
  - — If an operation takes longer than 10 seconds to complete, display
    - A rolling barber's pole or other large animated object.
    - Additionally, a progress indicator, percent complete message, or elapsed time message.
- Waits over 1 minute:
  - — Present an estimate of the length of the wait.
  - — Display a progress indicator, percent complete message, or elapsed time message.

— When a long operation is completed, present an acknowledgment that it is completed.
  - A significantly changed screen appearance.
  - An auditory tone.

— If an operation is very time-consuming
  - Consider breaking the operation into subtasks and providing progress indicators for each subtask.
  - Allow users to start a new activity while waiting.

- Long, invisible operations:
  — When an operation not visible to the user is completed, present an acknowledgment that it is completed.
    - A message.
    - An auditory tone.
- Progress indicator:
  — A long rectangular bar that is initially empty but filled as the operation proceeds.
    - Dynamically fill the bar.
    - Fill it with a color or shade of gray.
    - Fill it from left to right or bottom to top.
- Percent complete message:
  — A message that indicates the percent of the operation that is complete.
  — Useful if a progress indicator takes too long to update.
- Elapsed time message:
  — A message that shows the amount of elapsed time that the operation is consuming.
  — Useful if
    - The length of the operation is not known in advance.
    - A particular part of the operation will take an unusually long time to complete.
- Web page downloads:
  — For pages requiring download times greater that 5 seconds, give the user something to do while waiting.
    - Quickly present, at the top of the downloading page, an image, text or links.
  — Advise of long download times.
  — Warn of "Time Outs."

Elapsing time is in the eye of the beholder. What is important is perceived passing time, not actual time as measured by a clock. Dealing with time delays involves providing feedback that the system is truly working, and that the system's processing will be completed at some foreseeable and predictable time. Dealing with time delays also involves diverting people's attention away from a delay by engaging them in some meaningful interim activities.

Button clicks. Acknowledge all button clicks by visual or aural feedback within one-tenth of a second. This assures the user that a requested action has been received by the system.

Waits of up to 10 seconds. If an operation takes 10 seconds or less to complete, present a "busy" signal until the operation is finished. An hourglass pointer is the customary signal. A "Please wait..." message can be presented to indicate that more complex processing is occurring or has been delayed. When the process is finished, provide an indication that the user may proceed.

Waits of 10 seconds to 1 minute. If an operation takes longer than 10 seconds to complete, display a rolling barber's pole or other large animated object. Additionally, present a progress indicator, percent complete message, or elapsed time message. When the process is finished, provide an indication that the user may proceed.

Waits over 1 minute. For waits exceeding 1 minute, present an estimate of the length of the wait. If the length is unknown, an educated guess is better than a "Don't Know" or no estimate at all. A time estimate allows the user to decide what to do next — wait, go to lunch, or start some other task. For these waits, display a progress indicator, percent complete message, or elapsed time message. If an operation is very time-consuming, consider breaking the operation into subtasks and providing progress indicators for each subtask. Also, allow users to start a new activity while waiting so a delay will not be unproductive. Also, consider offering engaging text messages to keep users informed and entertained while they are waiting for process completion. Provide a clear indication of when the process is finished, significantly changing the screen's appearance so the change may be recognized from some distance away. Also, include an auditory tone to attract the user's attention back to the screen.

Long, invisible operations. When a long operation not visible to the user is completed, present an acknowledgment message that it is completed. For example, upon completion of a search with no positive results, "Search complete, Jones not found" might be displayed. Also provide an auditory signal, because the user's attention may be directed to another part of the screen, or entirely away from the screen.

Progress indicator. A *progress indicator* is a long rectangular bar that is initially empty but filled as the operation proceeds. Dynamically fill the bar with a color or shade of gray. Fill all bars from left to right or bottom to top. A progress indicator is shown in Figure 9.1.

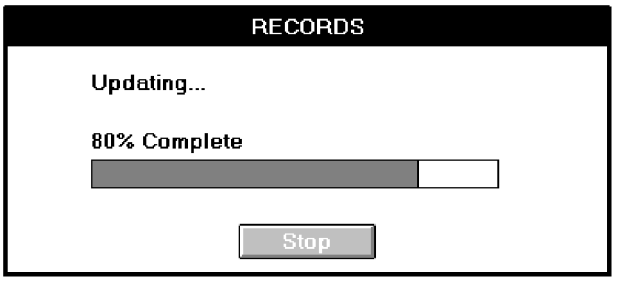

Figure 9.1: Processing progress indicator.

Percent complete message. A *percent complete* message provides an indication of the percent of an operation that is complete. It is useful if a progress indicator takes too long to update. An indication of the percentage of processing that has been accomplished can also be given through a message such as "22 of 27 transactions have been processed."

Elapsed time message. An elapsed time message shows the amount of elapsed time the operation has consumed. It is useful if the length of the operation is not known in advance, or if a particular part of the operation will take an unusually long time to complete.

Web page downloads. For pages requiring download times greater than 5 seconds, give the user something to do while waiting. Quickly provide at the downloading page top some text or image to hold one's interest, or some links to act upon. These diversions will reduce impatience while images load. Advise people if a page is programmed to "time out." Provide the opportunity for additional time to be requested. This is especially important for people who read or type slowly. For long downloads, provide the size and download time of large images or documents. This allows users to decide whether or not they are willing to wait for the file to download.

Blinking for Attention

- Attract attention by flashing an indicator when an application is inactive but must display a message to the user.
  - — If a window, flash the title bar.
  - — If minimized, flash its icon.
- To provide an additional message indication, also provide an auditory signal (one or two beeps).
  - — Very useful if
    - The window or icon is hidden.
    - The user's attention is frequently directed away from the screen.
- Display the message
  - — When the application is activated.
  - — When requested by the user.

Attention. Flashing an element on the screen will usually capture a person's attention. If a window is displayed on the screen, flash its title bar. If the window is minimized, flash its icon.

Auditory signal. To provide an additional indication that a message is waiting, also provide an auditory signal (one or two beeps). This will be useful if the window or icon is hidden or the user's attention is frequently directed away from the screen.

Message display. Display the message when an application is activated or when the user requests it. Displaying it when the user requests it preserves the user's control over the work environment and ensures that the message is not accidentally closed through an inadvertent key press. Finally, blinking is annoying to many people, so it should not be overused on a screen.

Use of Sound

- Always use in conjunction with a visual indication.
- Use no more than six different tones.
  — Ensure that people can discriminate among them.
- Do not use
  — Jingles or tunes.
  — Loud signals.
- Use tones consistently.
  — Provide unique but similar tones for similar situations.
- Provide signal frequencies between 500 and 1,000 Hz.
- Allow the user to adjust the volume or turn the sound off altogether.
- Test the sounds with users over extended trial periods.
- Use sounds sparingly because they
  — Are annoying to many people, including other users and nonusers in the vicinity.
  — Can be easily overused, increasing the possibility that they will be ignored.
  — Are not reliable because
    - Some people are hard of hearing.
    - If they are not heard, they leave no permanent record of having occurred.
    - The user can turn them off.

Sounds, sometimes called *earcons*, are useful for alerting the user

- To minor and obvious mistakes.
- When something unexpected happens.
- Where visual attention is directed away from the screen and immediate attention is required.
- When a long process is finished.

Tones used must be discriminable, nonannoying, and consistently used. Therefore, they must be thoroughly tested for discrimination and effectiveness. Brewster et al. (1993) found that high levels of recognition can be achieved by careful use of earcon pitch, rhythm, and timbre. They recommend

- Timbre: Use synthesized musical instrument timbres, where possible with multiple harmonics.
- Pitch: Do not use on its own unless there are very big differences between the pitches used.
- Register: Acceptable to use alone to differentiate earcons; otherwise large differences of three or more octaves should be used.
- Rhythm: Make rhythms as different as possible. Including a different number of notes in each rhythm is very effective.

- Intensity: 10dB to 20dB above threshold. Because sound level will be under control of the user, it should be kept in a close range.
- Combinations: Leave a delay of 0.01 second between successively played earcons.

Because sounds can be annoying to some people, they should be capable of being turned down or off by the user. Playing jingles or tunes, or loud sounds, focuses attention on the sound itself, which is distracting. Loud sounds can also be irritating, especially to those with sensitive hearing.

Never consider sounds reliable because they can be turned off, they leave no permanent record of their existence, and not all users will be able to hear all tones because of hearing defects. Sounds should always be used in conjunction with a visual indication of some kind.

Guidance and Assistance

This section first addresses how to prevent errors from occurring. Then, it covers how to gracefully handle them when they do occur. Finally, this section reviews guidance and assistance and its components, including the various forms of Help typically available in a system.

Preventing Errors

In spite of our lofty design goals, people will make errors using even the most well-designed system. When errors occur, they must be properly managed. The magnitude of errors in computer systems is astounding. Studies have found error rates in commands, tasks, or transactions as high as 46 percent. In addition to stranding the user and wasting time, errors interrupt planning and cause deep frustration.

Errors can be classified as slips or mistakes. A *slip* is automatic behavior gone awry. One's hands navigate the keyboard improperly and the wrong key is accidentally pressed. The wrong menu bar item is chosen because of inattentiveness. An inference error is made because of carelessness. A person often detects a slip because it is usually noticeable. The wrong letter appears within a word or the expected action is not performed. Slips are usually, but not always, corrected fairly easily. Slips can be reduced through proper application of human factors in design (for example, by providing adequate separation between elements to be selected).

A *mistake* results from forming a wrong model or goal and then acting on it. A mistake may not be easily detected because the action may be proper for the perceived goal — it is the goal that is wrong. Anticipating a mistake in design is also more difficult. Mistakes can be reduced, however, by eliminating ambiguity from design. Doing usability testing and watching for nonsensical (to the designer) requests and actions can also detect mistake-conducive situations.

Some experts have argued that there is no such thing as an "error" in using a system; they are simply iterations toward a goal. There is much truth to that statement. It is also said "to err is human." The corollary to that statement, at least in computer

systems, might be "to forgive is good design." Whatever they are called, errors will occur. People should be able to correct them as soon as they are detected, as simply and easily as they were made.

MAXIM **Everyone makes mistakes, so every mistake should be fixable.**

Problem Management

- Prevention:
  - — Disable inapplicable choices.
  - — Use selection instead of entry controls.
  - — Use aided entry.
  - — Accept common misspellings, whenever possible.
  - — Before an action is performed,
    - Permit it to be reviewed.
    - Permit it to be changed or undone.
  - — Provide a common action mechanism.
  - — Force confirmation of destructive actions.
    - Let expert users disable less critical confirmations.
  - — Provide an automatic and continuous Save function.
- Detection:
  - — For conversational dialogs, validate entries as close to point of entry as possible
    - At character level.
    - At control level.
    - When the transaction is completed or the window closed.
  - — For high speed, head-down data entry
    - When the transaction is completed or the window closed.
  - — Leave window open.
  - — Maintain the item in error on the screen.
  - — Visually highlight the item in error.
  - — Display an error message in a window.
    - Do not obscure item in error.
  - — Handle errors as gracefully as possible.
    - The greater the error, the more dramatic should be the warning.
  - — Use auditory signals conservatively.
- Correction:
  - — Preserve as much of the user's work as possible.
  - — At window-level validation, use a modeless dialog box to display an error list.
    - Highlight first error in the list.
    - Place cursor at first control with error.
    - Permit fixing one error and continuing to next error.
  - — Always give a person something to do when an error occurs.
    - Something to enter/save/reverse.
    - A Help button.
    - Someone to call.

— Provide a constructive correction message saying
- What problem was detected.
- Which items are in error.
- What corrective action is necessary.

— Initiate a clarification dialog if necessary.

Preventing, detecting, and correcting errors involve doing the following:

Prevention. It is always better to prevent errors than handle them. Errors can be reduced in several ways. First, disable all choices that are not applicable at any one moment. Make improper alternatives impossible to select or activate. Next, after considering the task and user, if practical, design screens using selection instead of entry controls. Selection error rates tend to be lower than entry error rates. Use aided entry if at all possible. The computer has been found to be a better speller than most people. When entry is performed, human misspellings of commands and requests should be accepted by the system. Person-to-person communication does not require perfection. Person-to-computer communication should impose no more rigor than that imposed between people. Use of the Shift key should also be discouraged, because it is such a large cause of keying errors. Actions about to be performed should also be reviewable and changeable. Keying or selection slips will occasionally occur.

A common send mechanism should be provided to transmit an action to the system. The existence of two or more keys to accomplish the same purpose, especially if their use is mandated by different conditions, can be confusing and more prone to error.

If an action causes a critical or irreversible change, the user should be requested to confirm the change. Primarily used to prevent slips, confirmations should be used sparingly because they slow task performance. Frequent use may also cause people to ignore them. If keys are used for confirmation, a separate key should be used for this purpose, not the "Send" key. More typically, a dialog box is used to ask the user if the action about to be performed was intended, and if the user wishes to proceed. Messages to the user should be detailed but concise. The message should be structured to require a Yes or No answer, or with an action verb that conveys the action to be performed. The use of OK and Cancel together should be avoided. When an action's consequences are not serious, or can be easily reversed, confirmations are not needed. Let expert users disable the confirmation request, if the action is recoverable.

Finally, provide an automatic and continuous Save function so that users never lose their work because of a system (or user) malfunction.

Detection. The computer should detect errors quickly, but without disrupting a person's thought patterns and actions if this can be avoided. Generally, the longer the wait before editing is performed, the longer the time to accomplish the editing. So, validate according to how important accuracy is to the user, and the characteristics of the task being performed. It is also preferable to wait for a closure point in the dialog. For conversational dialogs, accuracy is usually more important than speed, actions are slower paced, and more closure points usually exist.

In these situations, validate as close to the point of input as possible: at the character level or at the control level, and when the transaction is completed or the window closed. High-speed, head-down data entry is generally fast paced. Constant interruptions for errors can be a great speed detriment. In this situation, validate when the transaction is completed or the window closed. This is usually the only task closure point.

All errors should be maintained on the screen and identified to the user through a highlighting display technique (for example, high intensity or contrasting color). Display an error message in a dialog box and position it on the screen so it does not obscure the item in error. Handle all errors as gracefully as possible, avoiding discouraging, embarrassing, or alarming words. Words with such intent can compound the frustration a person already feels in having made an error. For minor problems, provide less intrusive warnings. The greater the error, the more dramatic may be the warning. Be cautious in using auditory signals to notify of an error. Many people, especially those with status or position, do not want their inefficiencies advertised, especially to peers and subordinates.

Correction. Preserve as much of the user's work as possible. It can be irritating to have to reenter an entire screen when only one field is in error. At the window level of validation, use a modeless dialog box to display a list of errors. Highlight the first error in the list and place the cursor at the first control with error. Permit fixing one error, and then continuing on to the next error. If multiple errors occur, and it is impossible to display messages about all of them at one time, provide an indication that there are additional messages. Say, for example, "+ 2 other problems." Also, provide a distinct visual difference if the same error message is displayed more than once because the first attempt to correct the problem failed. A person may not notice a repeated message that looks identical to the previous one. Always give a person something to do when an error occurs: something to enter, save, or reverse, or someone to call. Also provide a Help button. The Help button must be helpful, though.

Explicit and constructive error messages should be provided. These messages should describe what error occurred, and how it should be corrected. Corrective actions will be clearer if phrased with words like "must be" or "must have." A study addressing restructuring messages following guidelines such as these, and others previously described, found improved success rates in fixing errors, lower overall error rates, and improved user satisfaction. Any error ambiguities should be resolved by having the system query the user. Errors should be corrected with minimal typing. Another important error control measure is to have the system identify and store errors. This will allow tracking of common errors so that appropriate prevention programs can be implemented.

Providing Guidance and Assistance

New users must go through a learning process that involves developing a conceptual or mental model to explain the system's behavior and the task being performed. Guidance in the form of the system's hard copy, online documentation, computer-based training, instructional or prompting messages, and system messages serves as a cognitive devel-

opment tool to aid this process. So does assistance provided by another form of online documentation, the Help function. Broadly speaking, online documentation is every communication provided online to help people to do their work effectively.

Although it is desirable that the human-computer interface be so self-evident and intelligent that people never experience difficulties, this goal will not be achieved in the foreseeable future. So a great deal of emphasis should be placed on creating good guidance and assistance, and managing the trouble that does occur. Indeed, one survey found that documentation was the second most important factor influencing the decision to purchase something (quality was first).

Useful guidance and assistance answers the following questions:

- What is this?
- What does it do?
- How do I make it do it?
- What is its role in the overall scheme of things?

Technical information, unlike works of fiction, is seldom read for pleasure. People turn to it only when a question has to be answered. Failure to provide the guidance and assistance needed in learning, answering questions, and problem solving makes it very difficult for the user to recover from trouble on his or her own and to avoid future trouble by learning from his or her mistakes. The result is most often more errors and great frustration.

Problems with Documentation

Wright (1991) feels that poor documentation is usually not the result of stupid and careless writing. Most writers, professional or not, she says, try to communicate their ideas as well as they can. Poor products, however, suggest that being a native speaker of the language is not a sufficient qualification to ensure communicative success. Rather, four other factors contribute to bad design.

Organizational factors. First are organizational factors including management decisions concerning who does the writing: product developers or specialist technical authors. Product developers, by their nature, are more interested in the technical aspects and seldom have time to focus on writing. Another organizational factor is the frequency and nature of the contact between writers and developers. Successful writing requires that frequent contact be maintained between writers and developers. If not, modifications may go undocumented, and functionality may occur that is difficult to explain.

Time scale. Second is the time scale allocated for the writing process. Successful writing also involves detailed planning, drafting, testing, and considerable revising. Without adequate time being made available for the writing process, the planning, testing, and revising processes are limited, thereby increasing the potential for a mismatch between the final product and its documentation.

Theoretical rationale. Third, there is not yet a clear theoretical rationale about what content should be included in documentation and how this information should be presented. Until this is developed, one cannot be sure that the documentation being developed is the most effective that it can be.

Resources. Finally, Wright concludes, there are the resources. Adequate resources are needed to include people with different skills in the documentation development process. Required are people good at visual layout, writing, and test and evaluation. Rarely does the same person possess more than one of these skills. Without the proper expertise, documentation will also suffer.

Another problem with documentation is created by the need for translation in our globalized world. The following is found in a current user guide: "The color deviation from the original is thus resulted." (KYE Systems, 1995) The product manufacturer is guilty of Wright's sins number two and four above. International considerations will be presented in detail in Step 10.

How Users Interact with Documentation

There are three broad stages through which a reader interacts with documentation: finding information that is relevant; understanding what the documentation says; and applying that understanding to the current task to solve the problem that prompted turning to the documentation in the first place.

Finding information is enhanced through use of contents pages and index lists. It is also enhanced if browsing is made easy through clearly visible page headings and subheadings. Pictures and symbols can also be used to draw the reader's attention to particular kinds of information. Understanding information is achieved through a variety of factors. Included are following good writing principles. Understanding can also be maximized through testing and revision of materials as necessary.

Instructions or Prompting

Instructional or prompting information is placed within the body of a screen. It may take the form of messages or other advice, such as the values to be keyed into a field. Prompting is provided to assist a person in providing what is necessary to complete a screen.

Inexperienced users find prompting a valuable aid in learning a system. Experienced users, however, often find prompting undesirable. It slows them down, adds noise to the screen, and may reduce the amount of working information that can be displayed at one time.

Because instructions or prompting can easily create screen noise, be cautious in placing it on a screen. Use it only if all screen usage will be casual or infrequent. If people with a wide range of experience will be using a screen, it should be selectable, capable of being turned on or off as needed. As an alternative, two separate sets of screens could be made available, one with prompts and the other without. Guidelines for writing instructions and prompts are covered in Step 8.

Help Facility

The most common form of online documentation is the Help system. The overall objective of a Help facility is to assist people in remembering what to do. Its benefits

include improving the usability of a system, providing insurance against design flaws that may develop, and accommodating user differences that may exist (novice versus expert). Typical methods of invoking Help include through a typed command, by pressing a Help key or button, or by selecting a Help option from a multiple-item menu. Help may also automatically appear on the screen.

Some studies have found a Help system can aid performance; others have concluded that a Help function can impair performance if it is not task-oriented, and if it makes the interface more complex. One potential danger of the Help facility, as one study found, is that a person's recall of command operations is related to frequency of Help facility access; fewer Help requests were associated with better command recall. The researchers speculate that the availability of Help may become a crutch and lead to less effective retention. People may implement a passive cognitive strategy. A Help facility, then, may influence performance in systematic and subtle ways.

The specific design characteristics that enhance online Help are still being identified. Three broad areas of Help that must be addressed in creating Help are: its content, its presentation, and its access mechanisms. Of these, presentation and access are best understood.

Elkerton and Palmiter (1991) propose that the content (and structure) of effective online Help can be specified using the GOMS (goals, operators, methods, selection rules) model (Card et al., 1983). Using GOMS, information is provided to the user on *goals* for meaningful tasks, on *operators* for actions required to be performed, on *methods* for accomplishing the goals, and where multiple interface methods exist, and on *selection rules* for choosing a specific method. Gugerty et al. (1991) found that this structure was useful in remembering medical procedures. Elkerton (1988) presents a set of suggested principles for online assistance (which he calls online aiding). These principles are reproduced in Table 9.1.

Next are some general Help guidelines. Then, some specific considerations for contextual Help, task-oriented Help, reference Help, and wizards will be addressed.

Help Facility Guidelines

- Kind:
  — Collect data to determine what types of Help are needed.
- Training:
  — Inform users of availability and purpose of Help.
- Availability:
  — Provide availability throughout the dialog.
  — If no Help is available for a specific situation, inform the user of this and provide directions to where relevant Help may exist.
- Structure:
  — Make them as specific as possible.
  — Provide a hierarchical framework.
    - Brief operational definitions and input rules.
    - Summary explanations in text.
    - Typical task-oriented examples.

- Interaction:
  - — Provide easy accessibility.
  - — Leave the Help displayed until
    - The user exits.
    - The action eliminating the need for Help is performed.
  - — Provide instructions for exiting.
  - — Return to original position in dialog when Help is completed.
- Location:
  - — Minimize the obscuring of screen content.
  - — If in a window, position priorities are right, left, above, and below.
- Content:
  - — Define unfamiliar terms.
  - — Minimize Help's length.
  - — Develop modular dialogs that can be used to describe similar and dissimilar procedural elements of the interface.
  - — Provide step-by-step interface procedures to assist the user with specific problems.
  - — Provide procedural demonstrations of interface procedures to aid quick learning of simple operations.
  - — Provide information to help users select between multiple interface methods.
  - — Provide users with an understanding of representative tasks to increase their knowledge of when to apply specific skills.
- Style:
  - — Provide easy browsing and a distinctive format.
    - Contents screens and indexes.
    - Screen headings and subheadings.
    - Location indicators.
    - Descriptive words in the margin.
    - Visual differentiation of screen components.
    - Emphasized critical information.
  - — Use concise, familiar, action-oriented wording.
  - — Refer to other materials, when necessary.
  - — Never use Help to compensate for poor interface design.
- Consistency:
  - — Provide a design philosophy consistent with other parts of the system.
- Title:
  - — Place the word "Help" in all Help screen titles.

Table 9.1: Suggested Design Principles for Providing Online Advice Based on the GOMS Model

USE *GOALS* IN ONLINE AIDING TO DO THE FOLLOWING:
1. Describe what can be done in task-oriented terms (interface actions and objects) for improved initial skill learning.
2. Provide an adjustable level of detail on interface procedures for accommodating the information needs of a wide range of users.
3. Provide procedurally incomplete advice so that users can actively learn for improved long-term performance with and understanding of the interface.
4. Provide feedback to users that may help remind them of appropriate procedures to use, particularly when recovering from errors.
5. Develop modular assistance and instructional dialogs that can be used to describe similar and dissimilar procedural elements of the interface.
USE *OPERATORS* IN ONLINE AIDING TO DO THE FOLLOWING:
1. Describe simple actions, such as pressing specific keys or finding specific objects on the display, that are common to many interface procedures, to assist the user in current task performance.
2. Provide detailed information on interface procedures that inexperienced users can actively learn and that more skilled users can combine with other procedural knowledge to improve long-term performance and understanding of the interface.
3. Monitor users' actions to provide context-sensitive Help or to diagnose user problems actively.
USE *METHODS* IN ONLINE AIDING TO DO THE FOLLOWING:
1. Present step-by-step interface procedures to assist the user with specific problems.
2. Improve user understanding and acceptance of online advice.
3. Decrease the cognitive load of users who are learning a new interface task by providing an explicit procedure for users to follow.
4. Provide procedural demonstrations of interface procedures so that users can quickly learn simple operations.
5. Map sequences of users' actions to a reduced set of interface goals to help provide context-sensitive advice to users.
USE *SELECTION RULES* IN ONLINE AIDING TO DO THE FOLLOWING:
1. Help users choose between multiple interface methods.
2. Provide users with an understanding of representative tasks to increase their knowledge of when to apply specific interface skills.

From Elkerton (1988).

Kind. The two most common reasons people use Help are: (1) Confusion exists about something located on the screen, and (2) information about a specific function is needed. All system usability problems should be systematically identified through testing and evaluation. Monitoring users' actions can also be a useful tool in identifying user problems. Online Help can then be developed to address these problems.

Training. Inform users of the availability and purpose of various types of Help. Never assume that this will be obvious.

Availability. Make Help available at all points in the dialog. It is especially critical that Help be available consistently in all similar situations. For example, if one particular system menu has Help, ensure that all menus provide Help. If no Help is available for a specific situation, inform the user of this and provide directions to where relevant Help may exist, including hard-copy materials.

Structure. The Help response should be as specific as possible, tailored to the task and the user's current position. When accessed, the Help facility should be aware of the kind of difficulties a person is having and respond with relevant information. Only the information necessary to solve the immediate problem or to answer the immediate question should be presented. If the Help facility is unsure of the request, it should work with the user through prompts and questions to resolve the problem.

A Help facility should be multilevel, proceeding from very general to successively more detailed and specific explanations to accommodate a wide range of users. The first level should provide brief definitions and rules, simple reminders, and memory joggers sufficient for skilled users. The second level should incorporate more detailed explanations in a textual format. The final, and deepest, level should provide guidance in the form of task-oriented examples.

Interaction. A Help facility should be retrievable simply, quickly, and consistently by a key action, selection, or command. Leave Help displayed until the user explicitly exits Help, or performs the action eliminating the need for Help. Instructions for exiting Help process should always be provided. These may take the form of displayed pushbuttons, function keys, or something similar.

Help should not disrupt processing. Easy return to the point of the problem should be permitted. Ideally, the problem or work should be retained on the screen when Help is accessed, but this will not always be possible unless the system provides a windowing capability.

Location. When Help is displayed, minimize the obscuring of relevant screen content. If Help is displayed within a window, position priorities are right, left, above, and below.

Content. The Web has introduced many new terms into both the designer and user's vocabulary. Users may not understand or be familiar with many terms . User terms may also differ from the designer's terms. In providing Help, always explain what is being referred to. Even if a person knows how to use a screen element, the term a person uses to describe it may not be the same term that a designer would use. Minimize Help's length, whenever possible. Carroll et al. (1986) recommends the development of Help text in the form of "minimal manuals." These manuals are explicit and focus on real tasks and activities, and they

have been found to be significantly better than traditional Help texts (Black et al., 1987; Carroll et al., 1986).

Elkerton (1988) suggests that few Help users want detailed, fact-oriented knowledge such as a hierarchical list showing the syntax of a command. Instead, they want to know the methods to complete a task. Without knowledge of how to do things, users are left to browse through a wealth of information with little understanding of what may be useful. Hence, he recommends, among other things, providing the following:

- Step-by-step interface procedures to assist the user with specific problems.
- Procedural demonstrations of interface procedures to aid quick learning of simple operations.
- Information to help users choose between multiple interface methods.
- Help users with an understanding of representative tasks to increase their knowledge of when to apply specific skills.

When procedural steps are presented, consecutive numbering will make them easy to follow.

Style. Provide easy browsing and a distinctive format. Often the exact location of information needed to answer a question cannot be definitely established. Providing information in a format that can be easily skimmed aids the search process and also helps the user become familiar with the information being presented. The following techniques enhance the skimming process:

- Contents screens and indexes.
- Screen headings and subheadings.
- Location indicators.
- Descriptive words in the margin.
- Visual differentiation of screen components.
- Emphasized critical information.

An index has been found to be one of the first place users turn to when they have a problem. Help wording should also be concise, familiar, and action oriented. Reference to outside material may be included in the Help text, especially if the Help information cannot be provided in a concise way. Never use Help to compensate for poor interface design.

Consistency. The Help design philosophy should be consistent with the philosophy used in other parts of the system. This includes presentation techniques, style, procedures, and all other aspects.

Title. For easy identification, place the word "Help" in all Help screen titles.

Contextual Help

Contextual Help provides information within the context of a task being performed, or about a specific object being operated upon. Common kinds of contextual Help include Help command buttons, status bar messages, and ToolTips. Microsoft Windows has also introduced what is called the *What's This?* Command.

Help Command Button

- Description:
  — A command button.
- Purpose:
  — To provide an overview of, summary assistance for, or explanatory information about the purpose or contents of a window being displayed.
- Design guidelines:
  — Present Help in a secondary window or dialog box.

Description and purpose. The proper usage of a command button labeled Help, as shown in Figure 9.2, is to provide supplemental Help for a secondary window, dialog box, or message box. It should provide an overview of, summary assistance for, or explanatory information about, the purpose or contents of a window.

Design guideline. Present this form of Help in a secondary window or dialog box. Microsoft Windows considers this Help an optional, secondary form of contextual assistance, and not a substitute for the What's This? command to be described shortly. The guidance and assistance provided by a Help command button differs from the What's This? in that more general assistance is provided rather than information specific to the control that has the current input focus.

Status Bar Message

- Description:
  — An abbreviated, context-sensitive message related to the screen item with the focus.
  — Appears in window's status bar when the primary mouse button is pressed over an item (or keyboard focus is achieved).
- Purpose:
  — To provide explanatory information about the object with the focus.
  — Use to
    - Describe the use of a control, menu item, button, or toolbar.
    - Provide the context of activity within a window.
    - Present a progress indicator or other forms of feedback when the view of a window must not be obscured.
  — Do not use for information or access to functions essential to basic system operations unless another form of Help is provided elsewhere in the Help system.
  — If extended Help is available and must be presented, place "Press F1 for Help" in bar.

- Writing guidelines:
  — Be constructive, not simply descriptive.
  — Be brief, but not cryptic.
  — Begin with a verb in the present tense.
  — If a command has multiple functions, summarize them.
  — If a command is disabled, explain why.

Description. An abbreviated, context-sensitive message related to the screen item with focus. The message appears in the screen's status bar, as shown in Figure 9.3 when the primary mouse button is pressed over an item (or keyboard focus achieved).

Purpose. A status bar message's purpose is to provide explanatory information about the screen object with focus. Because the user may not always notice a message displayed in the bar, or the bar may be turned off and not displayed, it must be considered a form of secondary or supplemental assistance. Use a status bar message to provide context for the activity being performed in window, or to describe the use of toolbars, menu items, or buttons being displayed. When the primary mouse button is clicked over one of these items (or keyboard focus achieved) display a short message describing the use of the associated command. The bar may also be used for presentation of a progress indicator, or other forms of feedback, when the view of a window must not be obscured. Never use the bar for information or access to functions essential to basic system operations, unless another form of Help for this operation is provided elsewhere in the interface. If extended Help must be provided, and displaying it in the bar is not possible, place "Press F1 for Help" in the bar.

Writing. Do not simply describe something but explain it in a constructive manner Be as brief as possible so the text can be read easily, but do not make the text so short that it is cryptic. Begin all messages with a verb in the present tense. If a command with multiple functions has focus, summarize its multiple uses. If a command is disabled, explain why.

Figure 9.2: Help command button.

Figure 9.3: Status bar message.

ToolTip

- Description:
  — A small pop-up window that appears adjacent to control.
  — Presented when the pointer remains over a control a short period of time.
- Purpose:
  — Use to display the name of a control when the control has no text label.
- Design guidelines:
  — Make application-specific ToolTips consistent with system-supplied ToolTips.
  — Use system color setting for ToolTips above to distinguish them.

Description. A *ToolTip* is a small pop-up window with a label that appears adjacent to a control without a label (such as a toolbar) when the pointer is positioned over the control. It is displayed after the pointer remains over the control for a short period of time. This avoids the distracting effect of a ToolTip appearing when a pointer is simply being moved past a control.

Purpose. To display the name of a control when the control has no text label.

Design guidelines. Make application-specific ToolTips consistent in size and structure with system-supplied ToolTips, including using the system's color setting to distinguish them. ToolTips are also discussed in Step 7.

What's This? Command

- Description:
  — A command located on the Help drop-down menu on a primary window.
  — A button on the title bar of a secondary window.
  — A command on a pop-up menu for a specific object.
  — A button on a toolbar.
- Purpose:
  — Use to provide contextual information about any screen object.
- Design guidelines:
  — Phrase to answer the question "What is this?"
  — Indicate the action associated with the item.
  — Begin the description with a verb.
  — Include "why," if helpful.
  — Include "how to," if task requires multiple steps.
  — For command buttons, use an imperative form: "Click this to...."

Description and purpose. A *What's This?* command may take the form of a command in a menu or a button, as summarized previously. It's purpose is to provide contextual information about any screen object, including controls, dialog boxes, and property sheets.

Design guidelines. Phrase the label or caption to answer the question "What is this?" Indicate the action associated with the item and begin description with a verb. If helpful, include an answer to "why?" as well. Include a "how to" if the task requires multiple steps. For command buttons, use an imperative form, such as "Click this to. . . ."

The guidance and assistance provided by What's This? differs from that of a command button. With command button Help, more general assistance is provided rather than information specific to the control that has the current input focus.

Task-Oriented Help

- Description:
  - — A primary window typically accessed through the Help Topics browser.
  - — Includes a set of command buttons at the top; at minimum
    - A button to display the Help Topics browser dialog box.
    - A Back button to return to the previous topic.
    - Buttons that provide access to other functions such as Copy or Print.
- Purpose:
  - — To describe the procedural steps for carrying out a task.
  - — Focuses on how to do something.
- Design guidelines:
  - — Provide one procedure to complete a task, the simplest and most common.
  - — Provide an explanation of the task's goals and organizational structure at the start.
  - — Divide procedural instructions into small steps.
  - — Present each step in the order to be executed.
  - — Label each step.
  - — Explicitly state information necessary to complete each step.
  - — Provide visuals that accurately depict the procedural steps.
  - — Accompany visuals with some form of written or spoken instructions.
  - — Begin any spoken instructions simultaneously with or slightly after a visual is presented.
  - — Segment any animation to focus attention on specific parts.
  - — Segment instructions.
  - — Delay the opportunity to perform the procedure until all the procedure's steps have been illustrated.
- Presentation guidelines:
  - — The window should consume a minimum amount of screen space, but be large enough to present the information without scrolling.
  - — Normally, do not exceed four steps per window.
  - — Use a different window color to distinguish task-oriented Help windows from other windows.
- Writing guidelines:
  - — Write simply and clearly, following all previously presented guidelines.
  - — Focus on how information, rather than what or why.

— Do not include introductory, conceptual, or reference material.
— Limit steps to four or fewer to avoid scrolling or multiple windows.
— If a control is referred to by its label, bold the label to set it off.
— Include the topic title as part of the body.

Description. *Task-oriented Help*, sometimes called procedural Help, is presented on a primary window accessed through the Help Topics browser dialog box in Microsoft Windows. It includes a set of command buttons at the top: minimally, a button to display the Help Topics browser dialog box, a Back button to return to the previous topic, and buttons that provide access to other functions such as Copy or Print.

Purpose. Task-oriented Help details the procedural steps for carrying out a task. People prefer task-oriented Help to product-oriented Help, and research evidence shows a productivity gain using it. It is not surprising that task-oriented Help has such a preference and benefits, because people think in terms of tasks, not functions. This form of Help focuses on how to do something, rather than what or why. Its purpose is not to document everything there is to know about a subject.

Design guidelines. The following guidelines are mostly derived from Harrison (1995). First, present only one procedure to complete a task, the simplest and most common. (If information about alternate methods is included, place it in a Notes or Related Topic section.)

At the beginning, provide an explanation of the task's goals and organizational structure. Divide procedural instructions into small steps and present them in the order they are to be executed. Clearly label each step. Explicitly state what information is necessary to complete each step, presenting the most important information first.

Provide visuals that accurately depict the procedural steps. People prefer to follow visual examples rather than instructions, and visuals minimize orientation errors. Accompany the visuals with some form of written or, if possible, spoken instructions. Instructions provide cues as to most important aspects of the procedure. Begin any spoken instructions simultaneously with or slightly after a visual is presented. If animation is included, segment it to focus attention on specific parts. Segment the instructions to reinforce the concept of chunks or steps. Finally, delay the opportunity to perform the procedure until all the procedure's steps have been illustrated.

Presentation guidelines. A task-oriented Help window should consume a minimum amount of screen space, but be large enough to cover all the necessary information without requiring cumbersome scrolling. Normally, this means do not exceed four steps per window. To distinguish task-oriented Help windows from other windows, use a different window color to present them.

Writing guidelines. Write simply and clearly, following all previously presented text guidelines. Focus on how information, rather than what or why. Do not include introductory, conceptual, or reference material. If a control is referred to by its label, bold the label to set it off. Include the topic title as part of the body.

Reference Help

- Description:
  - — An online reference book.
  - — Typically accessed through a
    - Command in a Help drop-down menu.
    - Toolbar button.
- Purpose:
  - — To present reference Help information, either
    - Reference oriented, or
    - User guide oriented.
- Design guidelines:
  - — Provide a consistent presentation style, following all previously presented guidelines.
  - — Include a combination of contextual Help, and task-oriented Help, as necessary.
  - — Include text, graphics, animation, video, and audio effects, as necessary.
  - — Make displayed toolbar buttons contextual to the topic being viewed.
  - — Provide a jump, a button or interactive area that triggers an event when it is selected, such as
    - Moving from one topic to another.
    - Displaying a pop-up window.
    - Carrying out a command.
  - — Visually distinguish a jump by
    - Displaying it as a button.
    - Using a distinguishing color or font to identify it.
    - Changing the pointer image when it is over it.
- Presentation guidelines:
  - — Provide a nonscrolling region for long topics to keep the topic title and other key information visible.
- Writing guidelines:
  - — Write simply and clearly, following all previously presented guidelines.
  - — Provide meaningful topic titles.

Description and purpose. *Reference Help* is another form of online documentation. Its purpose is to present Help information that may be reference-oriented, documenting the features of a product, or it may serve as a user's guide to a product. It is typically accessed through a command in a Help drop-down menu, or a toolbar button. Reference-oriented Help is usually organized by functions and features and includes more text than other types of Help. User-guide-oriented Help is usually organized by tasks and may include more illustrations than other types of Help.

Design guidelines. Provide a consistent presentation style, following all previously presented guidelines. Include a combination of contextual Help and task-oriented Help, as necessary. Include text, graphics, animation, video, and audio

effects, as necessary and as available. Make toolbar buttons contextual to the topic being viewed in the Help window. Provide a jump, a button or interactive area that triggers an event when it is selected. The action may be to move from one topic to another, to display a pop-up window, or to carry out a command. Jumps, when in button form, are called shortcut buttons in Microsoft Windows. They automatically perform a task, thereby providing efficiency by reducing the amount of information necessary to present for reading by the viewer. Do not use a jump, however, if the goal is to enable the user to perform the task. Consider a balance for common tasks. Provide information that explains how to perform a task and also provide a shortcut button to accomplish the task, making stepping through the task easier. Visually distinguish a jump by displaying it as a unique style button or using a distinguishing color or font to identify it. The system default for a textual jump in Microsoft Windows is green underlined text. Also, change the pointer image when the pointer is positioned over the jump.

Presentation guidelines. If scrolling is necessary, provide a nonscrolling region for long topics to keep the topic title and other key information visible.

Writing guidelines. Write simply and clearly, following all previously presented guidelines. Also, provide meaningful topic titles.

Wizards

- Description:
  - — A series of presentation pages displayed in a secondary window.
  - — Include
    - Controls to collect input.
    - Navigation command buttons.
  - — Typically accessed through
    - Toolbar buttons.
    - Icons.
- Purpose:
  - — To perform a complex series of steps.
  - — To perform a task that requires making several critical decisions.
  - — To enter critical data and for use when the cost of errors is high.
  - — To perform an infrequently accomplished task.
  - — The necessary knowledge or experience to perform a task is lacking.
  - — Not suited to teaching how to do something.
- Design guidelines:
  - — Provide a greater number of simple screens with fewer choices, rather than a smaller number of more complex screens with too many options or too much text.
  - — Provide screens of the exact same size.
  - — Include on the first page
    - A graphic on the left side to establish a reference point or theme.
    - A welcoming paragraph on the right side to explain what the wizard does.

— Include on subsequent pages
  - A graphic for consistency.
  - Instructional text.
  - Controls for user input.
— Maintain consistent the locations for all elements.
— Make it visually clear that the graphic is not interactive.
  - Vary from normal size or render it as an abstract representation.
— Include default values or settings for all controls when possible.
— For frequently used wizards, place a check box with the text "Do not show this Welcome page again" at the bottom of the Welcome page.
— Include a Finish button at the point where the task can be completed.
— Do not require the user to leave a wizard to complete a task.
— Make sure the design alternatives offered yield positive results.
— Make certain it is obvious how to proceed when the wizard has completed its process.

- Presentation guidelines:
  — Display the wizard window so it is immediately recognized as the primary point of input.
  — Present a single window at one time.
  — Do not advance pages automatically.
- Writing guidelines:
  — Clearly identify the wizard's purpose in title bar.
  — At the top right of the wizard window, title the Welcome page "Welcome to the Wizard Name Wizard."
    - Use mixed case in headline style and no ending punctuation.
  — Write simply, concisely, and clearly, following all previously presented guidelines.
  — Use a conversational rather than instructional style.
  — Use words like "you" and "your."
  — Start most questions with phrases like "Which option do you want . . ." or "Would you like. . . ."

Description. A *wizard* is a structured set of screens that guides the user through a decision-making or data entry process. Wizards are displayed in a secondary window. The screens include controls to collect input, and navigation command buttons located at the page bottom (Back, Next, Finish, and Cancel). A wizard is typically accessed through toolbar buttons or icons.

Purpose. A wizard's purpose is to assist a user by automating a task and walking the user through the process. It may not appear as an explicit part of the Help interface. Wizards are useful for complex or infrequently occurring tasks that people may have difficulty learning or doing. Wizards are designed to hide many of the steps and much of the complexity in doing something. They are not suited to teaching how to do something, and should be considered a supplement to the actual performance of the task. An experienced user who knows a process will usually find a wizard inefficient or lacking access to all necessary functionality. A

wizard can be accessed through toolbar buttons or icons. Microsoft (2001) suggests the following guidelines.

Design guidelines. Provide a greater number of simple pages with fewer choices, rather than a smaller number of more complex pages with too many options or too much text. Fewer pages will make it easier to understand the wizard and the process. Create screens of the exact same size. Include on the first page a graphic on the left side to establish a reference point or theme and a welcoming paragraph on the right side to explain what the wizard does. The graphic's purpose is to establish a reference point, or theme, or present a preview of the wizard's result. Include on subsequent pages a graphic for consistency, instructional text, and the necessary controls for user input. (If screen space is critical, graphics on subsequent pages may be omitted.)

Make it visually clear that the graphic is not interactive by varying it from normal size or rendering it as an abstract representation. Do not require the user to leave a wizard to complete a task. The user, often a novice, may lose context if asked to leave. Everything must be done from within the wizard. Make sure the design alternatives offered to the user yield positive results.

For frequently used wizards, place a check box with the text "Do not show this Welcome page again" at the bottom of the Welcome page. Include a Finish button at the point where the task can be completed. Make certain it is obvious how to proceed when the wizard has completed its process by including proper closing text on the last page.

Presentation guidelines. Display the wizard window so it is immediately recognized as the primary point of input. Present a single window at one time, overlaying underlying windows so they are not visible. Do not advance pages automatically. The viewer may be unable to read all the information, and control of the dialog is removed from the user and placed in the hands of the computer.

Writing guidelines. Clearly identify the wizard's purpose in the title bar. At the top right of the wizard window, title the Welcome page "Welcome to the Wizard Name Wizard." Use mixed case in the headline style of presentation, and no ending punctuation. Write simply, concisely, and clearly, following all previously presented guidelines. Use a conversational rather than instructional style, and words like "you" and "your." Start most questions with phrases like "Which option do you want?" or "Would you like . . .?" People react better to phrasing that implies they are in control, rather than phrasing telling them what to do.

Hints or Tips

- Description:
  — A command button labeled Hints or Tips.
- Purpose:
  — To provide a few important contextual, but specific, items of information related to a displayed screen.

- Design guidelines:
  — Provide guidance on only two or three important points.
  — Locate the button near where its guidance applies.
  — Write concisely and to the point.

Description. A *Hint* or *Tip* is a command button placed on a screen and labeled as such.

Purpose. To provide a few important contextual, but specific, items of information related to a displayed screen. It is a supplement to the standard Help facility, but more easily accessible and relevant to the current situation. The objective is to quickly get the user back on track when disorientation or confusion occurs.

Design guidelines. Provide guidance on only two or three important points. Locate the button near the location where its guidance applies and write concisely and to the point.

For more information on Hints and Tips, see *User Interface Engineering* (2001).

Step 9 Exercise

An exercise for Step 9 can be found on this book's companion Web site, www.wiley.com/college/galitz.

STEP

10

Provide Effective Internationalization and Accessibility

Today the Internet and the market for software are global. They cross endless cultural and language boundaries, each with its own requirements, conventions, customs, and definitions of acceptability. To be accepted, and used, a screen or page's text and images must reflect the needs and sensibility of each partner in the worldwide community where it is used. Comprehension and recall can be enhanced when presented information is culturally appropriate (Spyridakis and Fukuoka, 2002). To make a product acceptable worldwide, it must be internationalized. A system must also be designed to be usable by an almost unlimited range of people, being accessible to anyone who desires to use it. The design concepts used to achieve these goals are called internationalization and accessibility. This step addresses these design issues and includes the following:

- International considerations
  - Localization
  - Cultural considerations
  - Writing text
  - Using images and symbols
- Accessibility considerations
  - Types of disabilities
  - Designing for accessibility

International Considerations

To create a product for use internationally may involve two steps, *internationalization* and *localization* (Russo and Boor, 1993). Internationalization is the process of isolating culturally specific elements from a product. The German text of a program developed in Germany, for example, is isolated from the program itself. This occurs in the country where the product is developed. Localization is the process of infusing a specific cultural context into a previously internationalized product. Translating a screen written in German into English is an example of localization.

Creating a product that has been properly localized and speaks fluently to another culture requires addressing several factors. These include text; formats for elements such as number, date, and time; images; symbols; colors; flow; and functionality.

Localization

- When to do it:
  - — When the market includes few or no English speakers.
  - — When translation is required by law or by custom.
  - — When the widest possible market is desired.
- When not to do it:
  - — When the audience already reads English.
- When the cost of retrofitting or rewriting the software is prohibitive.

This discussion of when and when not to internationalize and localize a product is mostly based on Fowler and Stanwick (1995). Considerations include the prospective users and their English capabilities, local laws, culture, customs, and costs associated with translation.

English is the most widely used language in the world. An estimate for its speakers ranges from 700 million to 2 billion (Tripathi, 1992). Although many speakers of English have been taught it as a second language and may not all be facile readers and writers, they can communicate using it. About 35 percent of Web users speak English as their first language. The second most common first language is Chinese, about 14 percent (see Table 1.3 in Step 1). The first consideration, then, is the English capabilities of the prospective user. This must be ascertained. Toward this end, both IBM (National Language Technical Center, 1991) and Apple (1992a) have documents listing the official language requirements of countries, and regions or political divisions. In addition, within some international business and scientific communities, English is the accepted language of communication. For example, the air transportation industry uses English as the language of communication between airline pilots and flight controllers worldwide. Scientists and engineers in Japan also prefer to communicate their research findings in English because of its greater precision (Kohl et al., 1993). If English is accepted in the using body, then concerns are only cultural.

Legal requirements may also mandate translation. For example, Canada, being composed of both English and French speakers, requires bilingual materials. The European Economic Community (ECC) will, at some point, mandate that all documentation

shipped with imported products be written in all of the ECC languages. Whether the product will actually be used in all the countries will be immaterial.

Cost will also, of course, dictate whether a translation can, or will, be performed. Software translation rates can range from $40 to $80 dollars an hour or more, documentation translation $50 to $150 or more per page. These rates are presented for illustrative purposes only. Actual costs will be driven by many factors, including the local cost of living. For readers in need of a translation, one will be best served by getting a quote reflecting the time and locale of the translation. A translation performed in the target country often results in better quality than a translation by those who are native speakers of the producing country.

Cultural Considerations

Cultural differences across the globe are immense. Effective localization requires adapting to local sensibilities and cultures. Straub (2004) has written an excellent review of the potential issues. This discussion is based upon her writing.

Hofstede (1980, 1997, 2001) has derived and validated five independent dimensions along which cultures vary: power distance, individualism (vs. collectivism), masculinity (vs. femininity), uncertainty avoidance, and long-term orientation (vs. short term). *Power distance* is the degree of acceptance of inequality of power and authority. The greater the existing distance between the powerful and pedestrian, the greater the power distance. In high power distance countries spokesmen tend to be venerable, older, and of high status. In low power distance countries anyone can be a spokesperson. Marcus (2001) suggests that Web site navigation in high power distance countries should be more directive, and information more highly structured.

Individualism (vs. collectivism) reflects how well integrated a person is into the larger group. Collectivists, well integrated into the group cultures, it is suggested, tend to prefer national or global brands or objects over private labels or objects. This behavior, de Mooij (2003) suggests, reflects the collectivist's desire to maintain harmony and willingness to assume one's "rightful place" in society.

Masculinity (vs. femininity) is the balance between assertiveness or toughness and supportiveness or caring. Highly masculine audiences should respond more favorably to competitive interactions and imagery with clear, distinct gender roles. More feminine cultures, on the other hand, may prefer less gender-specific imagery and collaborative interactions.

Uncertainty avoidance is the level of discomfort with unstructured and potentially unpredictable conditions. High uncertainty-avoidance cultures might deal better with simple and self-evident Web sites, and are more likely to seek guidance or directive information. Low uncertainty-avoidance cultures possibly have a greater tendency to ignore guidance and instructions. It is predicted that people in high uncertainty-avoidance countries will lag behind in Internet adoption. These countries lag behind in e-commerce adoption (de Mooij and Hofstede, 2002).

Long-term orientation (vs. short term) is the trade-off between long-term reward and immediate recognition. Long-term orientation indicates greater perseverance and thrift. A possible difference in Web site navigation may exist. Long-term-oriented people might show more persistence in delving deep into Web sites, in spite of any navigation obstacles they encounter. Short-term-oriented people, in the same situation, may more quickly reject the site and leave.

It is also known that cultural differences can influence the results of usability testing. Testing often requires that participants offer critical commentary about a dialog or interface. In the Western culture, critical comments and design advice are often freely and comfortably offered. So are admissions that a task can't be completed or something being looked for cannot be found. When this happens there are few feelings of regret or personal failure. In the Asian culture, critical comments are hard to elicit because it is not polite to tell someone that they have a lousy design (Chavan, 2004). In this culture, it is also embarrassing and not comfortable to admit that a task cannot be completed.

Hofstede's dimensions have interesting implications for structural variations in effective designs across cultures. Future research may provide more answers. In the meantime, a body of guidelines is available to assist in addressing cultural differences.

Words and Text

- Use very simple English.
  - — Develop a restricted vocabulary.
  - — Restrict the sentence structure using noun-verb-object.
- Avoid
  - — Acronyms and abbreviations.
  - — Slang or obscure phrasing.
  - — Stringing three nouns together.
  - — Local or computer jargon.
  - — A telegraphic writing style.
  - — An over-friendly writing style.
  - — Culturally specific examples.
  - — References to national, racial, religious, and sexist stereotypes.
- Adhere to local user language idioms and cultural contexts.
- Keep the original term for words that cannot be translated.
- Allow additional screen space for the translation.
  - — Horizontally, using Table 10.1.
  - — Vertically.
- When translating to other languages, first do
  - — European: German.
  - — Middle East: Arabic.
  - — Far East: Japanese.
- Position icon captions outside of the graphic.
- Modify mnemonics for keyboard access.
- Adhere to local formats for date, time, money, measurements, addresses, and telephone numbers.

The effects of bad Web writing will most likely be amplified for non-native speakers of the English language (Ozok and Salvendy, 2003). Text translation is simplified and user-interpretation errors reduced if these guidelines, many of which are derived from del Galdo (1990), Russo and Boor (1993), and Fowler and Stanwick (1995), are followed.

Simple English. Simple English text will be easier and less expensive to translate. Simple English is achieved by using a restricted vocabulary. Create a dictionary of approved terms and prohibit all synonyms and different meanings for the same word. A restricted sentence structure is also necessary. Sentences meaning the same thing can be written in many ways in English. This makes text more interesting to look at and read. In other languages, however, word order affects the meaning. Multiple structures cause translation problems and foster errors. Follow a *noun-verb-object* structure. Another benefit of simple English: translation may not always be necessary. The number of non-native English-speaking people capable of understanding the language will increase as screen English is simplified.

Avoid. Do not use acronyms and abbreviations. They are difficult, and often confusing, to translate. A translated acronym may not be as concise, or may possess negative associations. Abbreviations may also not be as concise, and they may not be understandable. Avoid stringing three nouns together. Relationships between nouns become very explicit in many other languages, and it is difficult to determine what terms are modifying one another when three are strung together. The use of prepositions, such as *at, in, by,* and *on,* can help to clarify nouns' relationships. Avoid local or computer jargon. Jargon is not universal and probably will not be understood. Do not use telegraphic writing. This means a terse style where words such as "and," "the," and "is," are left out. Again, translation problems can easily occur. An overly friendly style, in which the reader is addressed in the first person or in a childish manner, should also be avoided. It can be considered condescending and irritating to readers in non-English-speaking countries. Finally, avoid references to national, racial, religious, and sexist stereotypes and do not use culturally specific examples. The latter must be recreated by the translator so they are suitable for the language and culture.

Local language's idioms. Adhere to local language's idioms and cultural contexts. Some words have different meanings in other languages. This is of special concern for product names. Automakers have been particular victims of this problem. Italy's Fiat had an auto named "Uno." They could not sell it by that name in Finland because uno in Finnish means "garbage." England's Rolls Royce planned to name a new car "Silver Mist." Then, someone discovered that mist in German means "manure" (Taylor, 1992). Proper attention to localization can avoid some embarrassing, and costly, problems. Some languages are not read from left to right, as English is. Arabic, for example, is read from right to left. Chinese is read from top to bottom, right to left.

Original terms. Keep the original terms for words that cannot be translated. Some words do not exist in other languages. "Disk drive" and "zooming" do not exist in Thai, for example. It has been found that people often prefer the original term to a created word. Never invent words; keep the original term for nontranslatable words (Sukaviriya and Moran, 1990).

Additional screen space. Allow additional screen space for the translation. English is very concise. It usually takes less space to communicate the same word, phrase, or text than most other languages. Following is a list of words with the same meaning from four languages. Can you translate them?

- Besturingselement (Dutch)
- Olvadaci prvek (Czech)
- Ohjausobjekti (Finnish)
- Steuerelement (German)

Here is a clue. This word in English is seven characters long and has already been mentioned many, many times in this book. The Dutch version is 17 characters in length, or 143 percent longer than the English version. The others are composed of 13 characters and are 85 percent longer. The answer will follow shortly. Objects whose sizes are affected by translation include captions, entry areas, menu options, prompting message boxes, areas of text, and icon labels. Expansion room must be allowed for translation. Generally, the shorter the text, the more additional room is needed. Table 10.1 (National Language Technical Center, 1991) provides some additional horizontal space guidelines. Extra vertical spacing may also have to be allowed. In many languages, accents and descenders fall above and below the usual ascender and descender lines. What is the English version of the above words? *Control*. Were you able to translate one or more of them?

Translating. When translating, start from a translator's point of view. The language world is divided into three parts: Europe, the Middle East, and the Far East. Fowler and Stanwick (1995) report that Microsoft addresses translation in the following manner. In Europe, where problems involve changes in words caused by gender, accented letters, and text expansion, translation begins with German. This is done because German solves for accent, gender, and expansion issues. In the Middle East, difficulties in translation include bidirectional and cursive letters. To address these, Microsoft recommends starting with Arabic. When this is done, localization is accomplished for Hebrew, Farsi, Dari Persian, Pashto, and the Indian languages Sindhi and Urdu. In the Far East, the main difficulty is double-byte character sets. One of the most difficult Asian languages, with ten thousand ideograms divided into four character sets, is Japanese. So Microsoft starts with it.

Icon captions. Place icon captions outside of the graphic. Text placed within an icon may cause the icon to have to be redrawn when translation occurs. Text positioned outside the icon will negate the need for redrawing.

Mnemonics. Modify mnemonics used for keyboard access. Because mnemonics are established for ease of memorization, and because they are based upon a letter in a text object, when the text changes, so must the mnemonic. Attempting to create unique mnemonics may constrain the translation, but this must be addressed. Maintaining the old mnemonics will severely affect users' ability to learn them. They will no longer be mnemonics.

Local formats. Adhere to local formats for date, time, money, measurements, addresses, and telephone numbers. A nearly infinite variety of these various units exist worldwide. They must also be localized to the exact needs of the user.

Table 10.1: Translation Expansion Requirements

NUMBER OF CHARACTERS IN TEXT	ADDITIONAL SPACE
Field labels and menu options	
Up to 10	100–200%
11–20	80–100%
Messages and on-screen instructions	
21–30	60–80%
31–50	40–60%
Online help and documentation	
51–70	31–40%
Over 70	30%

From National Language Technical Center, IBM (1991).

Images and Symbols

- Adhere to local cultural and social norms.
- Use internationally accepted symbols.
- Develop generic images.
- Be particularly careful with
  - — Religious symbols (crosses and stars).
  - — The human body.
  - — Women.
  - — Hand gestures.
  - — Flags.
  - — Controversial geographic maps.
  - — The cross and check for check boxes.
- Review proposed graphical images early in the design cycle.

Images are the visible language of a culture and must be recognizable, meaningful, and acceptable. Like text, improper use of images, symbols, and icons can create problems internationally. Social norms vary, so great variations exist in what is recognizable and acceptable throughout the world. What one culture recognizes may have no meaning in another. What is acceptable in one country may not be in another. The images created for graphical interfaces are particularly susceptible to these problems. To be successful internationally, images must be carefully selected and designed. The following guidelines are also derived from del Galdo (1990), Russo and Boor (1993), and Fowler and Stanwick (1995):

Local norms. Adhere to local cultural and social norms. Few world travelers have not suffered embarrassment caused by failure to understand, and adhere to, local customs and more. On an early trip to Australia, I pulled in to a service station to replenish my auto's "petrol." I communicated my need to the attendant through a "thumbs-up" sign, an American convention (when there were still attendants) meaning "fill-it-up." The Australian attendant's response was a stunned look and a frown. Sensing something was wrong, I hastily lowered the window and communicated my need verbally. He smiled, replying, "Ah, you're American, eh, OK." It wasn't until much later I discovered I had made a gesture considered obscene in Australia.

Examples abound in the computer literature of images that have created problems internationally. The mailbox and trash can are two examples of objects whose shape, and resulting recognizability, vary substantially around the world. A cocktail glass used to signify an after-work appointment is a poor image to use in countries where alcohol is not associated with social activities. In the United States, a black cat is usually associated with bad luck; in the United Kingdom it means good luck. In the United States, the number 13 is considered unlucky; in Japan the number 4 is. Images that are culturally specific must be isolated during the internationalization process. Then, proper images must be developed for use in the culture where the product will be used.

Internationally accepted symbols. Use internationally accepted symbols. Before developing an image, first determine if any international images have already been created by trade or standards organizations. The ISO (International Standards Organization), for example, has developed standard shapes for a variety of purposes. Always consult all relevant reference books before inventing new images or modifying existing ones.

Generic images. Whenever possible, create generic images that are usable in multiple cultures. Having different images can confuse people who may use more than one language version of a product.

Where caution is necessary. Some topics are more susceptible to acceptability problems than others. Inappropriate presentation can result in the viewer's being offended or insulted. Be particularly careful when using religious symbols such as crosses or stars. Also be wary of images depicting a human body, particularly the female. In some cultures simply revealing a woman's arms and legs is unacceptable. During the World Cup soccer tournament in the United States in 1994, one Middle East country televised the soccer games using a several-second tape delay. This was done so that stadium crowd pictures potentially containing pictures of women dressed to accommodate the USA's summer heat would not be shown on local television. What crowd scenes were substituted instead? Pictures of people attending an American football game in December in a northern city (like Green Bay, Wisconsin) when the temperature hovered around zero degrees Fahrenheit. Needless to say, *all* the fans were well covered from toes to top of head. While television viewers in this middle-eastern country saw spectators with skin barely visible, the soccer players cavorted in shorts and jerseys.

Also, be wary of hand gestures, as my Australian experience illustrates. Actually, I'm in pretty good company in committing this kind of faux pas. A former American president departed Air Force One on a visit to Germany exhibiting

his customary hand wave to the welcoming people. Unfortunately, his Protocol Officer neglected to inform him that his wave had a vulgar connotation in Germany. We can only hope that German viewers of this action interpreted what he felt in is heart, not what he indicated with his hands.

Also exercise caution in using a country's flag for a language icon. Many countries are multilingual: Canada, South Africa, and Switzerland, for example. Their flags may not be associated with any one language. Be more generic in nature; a word (such as in French, Spanish, Italian, English) encompasses many countries and cultures. Avoid, if possible, presenting maps that include controversial regional or national boundaries so as not to offend viewers.

Finally, the X and check mark used for check boxes do not have meaning universally. It has also been found that they do not have universal meaning in the United States. In recent years, various graphical systems have moved away from X to the check mark as the symbol to indicate an active or set check box control. Why? In an engineering environment an X in a check box means the choice is not applicable or not set; a check means it is applicable, or it is set. Thus, an "X" was found to be confusing to some people when it meant active or set. Research has also indicated that when people complete a form with check boxes, the symbol most often used is the check mark.

MAXIM **Perception = Reality!**

Review images early. Review proposed graphical images early in the design cycle. Creating acceptable images can be a time-consuming process. Start developing them early so ample time exists for extensive testing and modification.

Color, Sequence, and Functionality

- Adhere to local color connotations and conventions.
- Provide the proper information sequence.
- Provide the proper functionality.
- Remove all references to features not supported.

Other international considerations include the following.

Local color connotations. Color associations also differ among cultures. In the United States, mailboxes are blue; in England, they are red; in Greece, they are yellow. In the United States red is associated with danger or stop, green with OK or go. This red-green association does not exist everywhere in the world. Table 10.2, derived from Russo and Boor (1993), lists some common cultural color associations. Colors used on screens must also reflect the color expectancies of its viewers.

Information sequence. Information within a screen will be arranged to reflect the logical flow of information. In many cultures, including those we are most familiar with, it will be from left to right for text, and from top to bottom, left to right

for ease of scanning. Some cultures, however, read from right to left. For these, information sequence must be reorganized to reflect this right-to-left sequence. Similarly, cascaded windows for left-to-right readers are usually presented in an upper-left to lower-right structure. These will have to be reorganized to reflect different reading patterns.

Proper functionality. Product features developed for one culture may not be appropriate for all cultures. Nielsen (1990), for example, describes a school hypertext product developed in France. During requirements determination it was established that only the schoolteacher should be able to add comments and viewpoints to the screens, not the students. This was a socially acceptable practice in France. Later, when the product was marketed in Sweden, this aspect created problems. In Sweden, independent discovery is greatly valued, and the inability of the students to add comments and viewpoints was unacceptable. All international products have to be reviewed for functionality as well and may require multiple versions to reflect the individual needs of cultures.

Features not supported. All aspects of a product not supported internationally should be removed from the system. Any references to features not supported should also be eliminated from all documentation. To leave this information in creates visual noise and will be confusing.

Table 10.2: Some Cultural Color Associations

	RED	YELLOW	GREEN	BLUE	WHITE
China	Happiness	Birth Wealth Power	Ming Dynasty Heavens Clouds	Heavens Clouds	Death Purity
Egypt	Death	Happiness Prosperity	Fertility Strength	Virtue Faith	Joy
France	Aristocracy	Temporary	Criminality	Truth Freedom Peace	Neutrality
India	Life Creativity	Success	Prosperity Fertility		Death Purity
Japan	Anger Danger	Grace Nobility	Future Youth Energy	Villainy	Death
United States	Danger Stop	Cowardice Caution	Safety Go	Masculinity	Purity

Requirements Determination and Testing

- Establish international requirements at the beginning of product development.
- Establish a relationship within the target culture.
- Test the product as if it were new.

When a product is translated for a new culture, it becomes a new product. Russo and Boor (1993) suggest the following should be accomplished:

Establish requirements at beginning. Developers must establish in what cultures the product will be used at the start of the development cycle. Then, differing product requirements must be established, reflecting the differing needs of the various users. This permits localization issues to be addressed throughout the development process.

Relationship with target culture. A close working relationship with natives from all using cultures during requirements and development will permit local, culturally specific feedback to be obtained in a timely manner. A close working relationship will also educate the designers about the culture where their product will be used.

Testing. When a product is translated for a new culture, it is a new product and it should be subjected to a normal testing during the development cycle. If international testing is delayed until after the product is released to the domestic market, problems may be difficult, if not impossible, to address.

Accessibility

Accessibility, in a general sense, means a system must be designed to be usable by an almost unlimited range of people, essentially anyone who desires to use it. In a narrower sense, accessibility can be defined as providing easy access to a system for people with disabilities. The focus will be on this aspect of accessibility in the following paragraphs. Design objectives in creating accessibility for users with disabilities are

- Minimize all barriers that make a system difficult, or impossible, to use.
- Provide compatibility with installed accessibility utilities.

Many governments have passed laws requiring that most employers provide reasonable accommodation for workers with disabilities. In the United States, one piece of legislation with this intent is the Americans with Disabilities Act. Accessible system design, then, seeks to ensure that no one with a disability is denied access to computer technology.

Types of Disabilities

Worldwide, a significant number of people have disabilities of one form or another. Disabilities may be temporary or permanent, or simply the result of aging. Disabilities can be grouped into several broad categories: visual, hearing, physical movement, speech or language impairments, cognitive disorders, and seizure disorders. It is reported that about 8 percent of Web users have a disability that may make traditional use of a Web site very difficult or impossible (Koyani et al., 2004). Disabilities include vision (4 percent), physical movement (2 percent), hearing (1 percent), and learning or cognitive problems (less than 1 percent).

Visual disabilities can range from slightly reduced visual acuity to total blindness. *Hearing* disabilities range from an inability to detect certain sounds to total deafness. *Physical movement* disabilities include difficulties in, or an inability to, perform certain physical tasks such as moving a mouse, pressing two keyboard keys simultaneously, or accurately striking a single keyboard key. People with *speech or language* disabilities may find it difficult to read and write (as with dyslexia). *Cognitive* disabilities include memory impairments and perceptual problems. People with *seizure* disorders are sensitive to visual flash rates, certain rates triggering seizures.

Accessibility Design

- Consider accessibility issues during system planning, design, and testing.
- Provide compatibility with installed accessibility utilities.
- Provide a customizable interface.
- Follow standard Windows conventions.
- Use standard Windows controls.
- Assure online forms can be easily completed.

Accessibility issues should be considered throughout the entire system development cycle. Costs of retrofitting after the design is completed are always much higher than costs associated with proper design itself. Unlike internationalization, where design costs are weighed against potential benefits, designing for accessibility may be required because of federal laws. All accessibility issues and requirements must be understood in system planning so that they may be incorporated within the design and testing processes.

Provide compatibility with accessibility utilities installed by users (screen review and voice input, for example). Also provide a customizable interface to accommodate the widest variety of user needs and preferences. Users are then free to choose an array of properties most satisfying to their viewing and usage needs. Whenever possible, follow standard Windows conventions and use standard Windows controls in design. Most accessibility aids work best with applications that follow standard system conventions. Custom controls may not be usable by screen-review utilities.

People using assistive technologies must be able to complete and submit online forms. Online forms are the primary way information is provided by people using the Web. All users should be able to use standard screen controls such as text boxes, radio buttons, and check boxes.

Visual Disabilities

- Utilities:
  - — Ensure compatibility with screen-review utilities.
  - — Ensure compatibility with screen-enlargement utilities.
- Screen components:
  - — Include meaningful screen and window titles.
  - — Provide associated captions or labels for all controls, objects, icons, and graphics.
    - Include graphical menu choices.
  - — Provide a textual summary for each statistical graphic.
  - — Allow for screen element scalability.
  - — Support system settings for high contrast for all user interface controls and client area content.
    - When a high contrast setting is established, hide any images drawn behind the text to maintain screen information legibility.
  - — Avoid displaying or hiding information based on the movement of the pointer.
    - Exception: Unless it's part of the standard interface (example: ToolTips).
- Keyboard:
  - — Provide a complete keyboard interface.
  - — Provide a logical order of screen navigation.
- Color:
  - — Use color as an enhancing design characteristic.
  - — If used
    - Select color combinations that can be discriminated.
    - Ensure that the lightness contrast between foreground and background color is high.
    - Increase the lightness contrast between colors in the color spectrum (blues and reds).
    - Avoid combining dark colors from the middle of the spectrum with light colors from either end of the spectrum.
    - Create the color combinations based on the system colors for window components.
    - Do not define specific colors.
  - — Use tools to verify what colors will look like when seen by color-deficient people.

Visual disabilities range from impaired visual acuity, often resulting from aging; decreased sensitivity to a specific color or colors; partial blindness; or total blindness. Moderately impaired vision may simply require the availability of larger fonts or restrictions in the use of colors. Severe impairments, such as blindness, may require compatibility with speech or Braille utilities.

Utilities. For people who cannot use a screen's visual content, a *screen-review* utility will be necessary. These utilities, also called *screen-reader* programs or *speech access* utilities, take the displayed information being focused on and direct it through another medium. Alternate media include synthesized speech and refreshable Braille displays. *Screen enlargement* utilities enable the user to enlarge a portion of

the screen, the monitor becoming a viewport that displays only a section of an enlarged display. These programs, also referred to as *screen magnification* utilities or *large-print* programs, track the user's use of a keyboard or mouse, moving the viewport to different areas of the screen as the user navigates within it.

Screen components. Meaningful, specific, and unique screen and window *titles* will assist the user in differentiating between these, especially when using a screen-review review utility. When using a reader, content must be addressed separately, so it will not be available with the title to aid in comprehension of what is presented. Provide associated *labels or captions* for all controls, objects, icons, and graphics, because all screen information must be presented as text by a screen reviewer. These labels must also be located in close proximity to the screen elements they refer to. A screen reviewer will relate the label to its associated screen element by its physical proximity, if it is not related programmatically. In rare situations, where the caption may be visually distracting (display-only data on inquiry screens, for example), provide a label but do not make it visible. Follow all the conventions presented in Step 3 for caption and label placement. *Graphical menu* choices, such as illustrated colors, shades, and patterns, must also possess textual labels.

Also provide a textual summary for each *statistical graphic*. Statistical graphics are images containing detailed information and, because of their graphic nature, their contents cannot be conveyed by a screen reader. The textual summary should include all information available to a sighted user.

Support screen element *scalability*, the presentation of larger text and graphics for people with only slight or moderate vision impairment. Also consider providing a "Zoom" command that scales the information displayed within a window. Support system settings for *high contrast* for all user interface controls and client area content. Users with visual impairments require a high contrast between foreground and background elements for best text legibility. Poor contrasts may result in severely degraded legibility because the background may "bleed" into the foreground. When a high-contrast setting is established, hide any images drawn behind text (watermarks, logos, patterns, and so on) to maintain screen information legibility. Monochrome versions of graphics and icons can also be presented using an appropriate foreground color for the displayed background color. In general, use black text on a white background to achieve the best foreground-background contrast. While some softer colors may be more attractive to look at, black on white always yields the best legibility.

Finally, avoid displaying or hiding information based on the movement of the pointer, unless it is part of the standard interface (a ToolTip, for example). These techniques may not be available to screen-review utilities. If these techniques are used, however, allow them to be turned on or off if a screen-review utility is used.

Keyboard. Provide a thorough and complete *keyboard interface*. Blind users cannot use a mouse to navigate because the pointer's location is unknown. All mouse actions, therefore, must be available through the keyboard using keyboard equivalents and keyboard accelerators. A logical order of screen *element navigation* is also a requirement for blind users. While this principle is standard for all screen users, a failure to adhere to it can be especially confusing for the

blind because, when using a screen-review utility, they must navigate a screen sequentially in the predetermined navigation order. Their ability to scan the entire contents of a control or screen to establish context is simply not possible.

Color. Color must always be used as a supplemental or *enhancing* design characteristic. It should never be used alone as the only indicator for critical activities. Users with a color-viewing deficiency may not be able to discriminate certain colors and, consequently, they may be unable to understand that an action is required if the action is based upon an element's color alone. If color is used, select colors that can be easily discriminated by people with color-viewing deficiencies, including the right contrasts and combinations. Provide a *variety* of color selections capable of producing a range of contrast levels. Create these combinations based on the system colors for window components. Never define and use specific colors. With a selection variety, the user may then customize the interface, choosing the best combination for his or her visual needs. Use of color is discussed in more detail in Step 12.

Hearing Disabilities

- Provide captions or transcripts of important audio content.
- Provide an option to display a visual cue for all audio alerts.
- Provide an option to adjust the volume.
- Use audio as an enhancing design characteristic.
- Provide a spell-check or grammar-check utility.

Hearing disabilities range from an inability to detect or interpret auditory output at normal or maximum levels of certain sounds, to total deafness. A noisy work environment may also disrupt hearing, or sound may be turned off to avoid annoying neighboring workers.

Because audio may be missed or not understood, provide *captions or transcripts* of all important audio content. Also provide an option to display a *visual cue* for all audio alerts. Methods include displaying the alert in a message box or within the status bar. Provide an option to *adjust the volume* so that auditory content may be turned louder or off as necessary. A volume control may also benefit the vision-impaired user, who relies on a speech access utility to understand the screen. Like color, always use audio as an *enhancing* design characteristic; never rely on it as the sole means of communicating with the user.

Many people who are deaf, and whose language is American Sign Language, can be helped by a *spell-check* or *grammar-check* utility. Uses of and problems with sound are discussed in more detail in Step 9.

Physical Movement Disabilities

- Provide voice-input systems.
- Provide a complete and simple keyboard interface.

- Provide a simple mouse interface.
- Provide on-screen keyboards.
- Provide keyboard filters.

Voice input. People who have difficulty typing should have the option of using a voice-input system. Voice-input systems, also called *speech recognition* systems, permit the user to control software by voice instead of by mouse or keyboard. In a voice-input system, captions or labels are used to identify manipulable screen objects. Speaking the object's label then activates the object.

Keyboard interface. People with limited use of their hands may not be able to effectively use a mouse because of the fine motor movements necessary to control it. All mouse actions, therefore, must also be available through the keyboard using keyboard equivalents and keyboard accelerators for people with this physical movement disability. Accessibility Options in the Windows Control Panel also provide a setting to allow the mouse pointer to be controlled through the numeric keypad. Some people may have difficulty pressing two keys at the same time. This can be remedied by ensuring that the keyboard interface is simple.

Mouse interface. Pointing devices may actually be more efficient for some users with physical movement disabilities. Therefore, a simple mouse interface is also important. As is done for the entire range of system users, do not require basic system functions to be performed through double-clicks, drag-and-drop manipulation, and keyboard-modified mouse actions. These are shortcut techniques for advanced users.

On-screen keyboards. Some people cannot even use a standard keyboard. Keyboards can be presented on the screen and activated through special switches, a special mouse, or a headpointer, a device used to manipulate a pointer through head motion.

Keyboard filters. People with erratic motion, tremors, or slow responses often make incorrect keystrokes. Keyboard filters can be used to ignore brief or repeated keystrokes. Accessibility Options in the Windows Control Panel provide a range of keyboard filtering options.

Speech or Language Disabilities

- Provide a spell-check or grammar-check utility.
- Limit the use of time-based interfaces.
  - — Never briefly display critical feedback or messages and then automatically remove them.
  - — Provide an option to permit the user to adjust the length of the time-out.

Spell-checker. People with language disabilities, such as dyslexia, find it difficult to read and write. A spell-checker or grammar-checker can help these users, as well as people with writing impairments, and people whose first language is not English.

Time-based interfaces. Limit the use of interface techniques that time-out and are removed after a prescribed period of time. People with some speech and language disabilities may not be able to react, either by reading text or pressing keys, within the allotted time period. Again, it is helpful to provide an option to permit the user to adjust and extend the time-out period.

Cognitive Disabilities

- Permit modification and simplification of the interface.
- Limit the use of time-based interfaces.
  - — Do not briefly display critical feedback or messages and then automatically remove them.
  - — Provide an option to permit the user to adjust the length of the time-out.

Interface modification and simplification. People with memory or perceptual problems can often be aided by a simplified interface. Allowing modification of the interface, customization of menus, customization of dialog boxes, or hiding graphics, for example, should be permitted. Conversely, some people with cognitive difficulties can be assisted by more extensive use of icons and graphics to illustrate objects and choices. Permitting modifications of this sort is also beneficial.

Time-based interfaces. People with cognitive impairments may also not be able to react to some situations in a timely manner. Again, for these people limit use of interface techniques that time-out and are removed after a prescribed period of time. It is also helpful to provide an option to permit the user to adjust and extend the time-out period.

Seizure Disorders

- Use elements that do not blink or flicker at rates between frequency ranges of 2 Hz and 55 Hz.
- Minimize the area of the screen that is flashing.
- Avoid flashing that has a high level of contrast between states.
- Provide an option to enable users to slow down or disable screen flashing.

People with seizure disorders (5 percent of people with epilepsy) may experience photosensitive epileptic seizures when exposed to certain visual flicker or flash rates of screen elements. In general, the higher the intensity of the flash, the larger area of the flash, or the faster the frequency of the flash, the greater the problem may be.

Screen elements particularly susceptible to this phenomenon are flashing text, graphics that repeatedly turn on and off, and screen images that repeatedly change. Seizures, however, are unlikely to be provoked with current monitors.

2 Hz to 55 Hz flicker. Use screen elements that do not blink or flicker at rates between 2 Hz and 55 Hz.

Flashing area. Smaller areas of flicker are less likely to cause seizures than larger areas. Minimize the area of the screen that is flashing.

High contrast. Avoid flashing that has a high level of contrast between states. Some people are more susceptible to high-intensity flashing.

Slow down or disable. Provide an option to enable users to slow down or disable screen flashing. In Windows, the Keyboard option in the Control Panel permits adjustment of the cursor blink rate. When set to slow, the cursor will flash 1.2 times per second. The rate increases 100 milliseconds for each notch up to a maximum of 5 times per second.

Web Page Accessibility Design

- Pages:
  - — Provide a simple and consistent layout.
  - — Place important information at the page top.
  - — Provide simple backgrounds contrasting well with the text.
  - — Provide a "Skip to Main Content" link at the top of each page.
  - — Structure articles with two or three levels of headings.
  - — End sentences, headings, and list items with punctuation.
  - — Provide frame titles.
  - — Provide user adjustable font sizes and styles, colors, graphical attributes, and volume.
  - — Avoid blinking or constantly changing elements.
- Controls:
  - — Provide large buttons.
- Links:
  - — Provide fully descriptive headings.
  - — Separate consecutive links with a dividing character.
- Tables, frames, and columns:
  - — Use sparingly.
  - — Provide alternate ways to access items contained within tables.
- Images:
  - — Provide associated text.
  - — Provide a link to a separate page for lengthy descriptions.
- Audio — include one or more of the following:
  - — A caption or pop-up text window.
  - — A textual transcript.
  - — A textual description.
    - For lengthy transcripts or descriptions, provide a link to a separate page.

- Video — include one or more of the following in both a textual and audio format:
  — A transcript.
  — A description.
    - For lengthy transcripts or descriptions, provide a link to a separate page.
- Image maps:
  — Provide equivalent text menus.
- Animation:
  — Provide an option to display in a nonanimated presentation mode.
- Synchronize multimedia elements.
- Plug-ins and applets:
  — Use sparingly.
- Test for accessibility.
- For online forms that cannot be read by screen utilities, provide alternate methods of communication.
- If accessibility cannot be accomplished in any other way, provide a text-only page with equivalent information and functionality.
  — Follow the guidelines set by the World Wide Web Consortium for accessibility of Web content.
  — If being designed for the United States Government, ensure that the requirements of Section 508 of the Rehabilitation Act are met.

In addition to the previously described guidelines, Web page design requires additional accessibility considerations. A few of these guidelines mirror good Web page design in general. A portion of these guidelines are derived from Head (1999). In general, text equivalents should be provided for all non-text elements.

Pages. A *simple and consistent layout* is important for people with visual impairments. When using screen readers, a page can be more quickly navigated. Important information at the *top of a page* also aids screen readers because the reader reads left-to-right and top-to-bottom. Simple, contrasting *backgrounds* allow the information to be more easily read.

When a navigation bar is located at the top or left side of a page, a user using speech synthesis must listen to all navigation links before arriving at the main page content. This can become especially cumbersome if the links are consistently repeated on successive pages. (A sighted user can easily ignore the links.) To bypass these links, and other elements such as tables of contents, provide a "Skip to Main Content" link attached to an unimportant image at the beginning of each page. The user can activate this link when it is presented, and the focus will move directly to the start of the page's content. (The user always has the choice to pass over this link and continue through the navigation links.)

Structure articles with two or three levels of *headings*. Nested headings facilitate access using screen-review utilities. All *sentences, headings, and list items* should end with punctuation so the screen reader can signal a break to the user. Screen readers do not recognize physical separation or bullets. Provide *frame titles* that help to easily identify the frame. This aids navigation, and proper orientation within the Web site will be facilitated. Provide *user adjustable* font sizes

and styles, colors, graphical attributes, and volume so the user can make adjustments to satisfy his or her needs. When a font size adjustment is made, the page should automatically resize to match the adjustment. *Blinking* or constantly changing elements should not be used so that people with visual or seizure impairments are not disturbed.

Controls. Buttons should be large, making them easy targets. People with physical movement disabilities will find them much easier to select.

Links. Provide fully descriptive link headings so people using screen readers will fully understand the link's meaning. The link title should aid decision-making. Separate consecutive links with a dividing character so that a clear break in content can be ascertained by the screen reader.

Tables, frames, and columns. These elements should be used sparingly because the majority of screen readers in their left-to-right movement will not distinguish separate cells of information in their translation. If *tables* are used, provide alternate ways to access their content because of the difficulty sight-impaired users have in navigating within a table using screen-review utilities. If *frames* are used, provide frame titles to facilitate frame identification, orientation, and navigation.

Images. Screen-review utilities cannot reveal images to visually impaired users. Therefore it is important to associate text with active images, particularly links or command buttons. When an image is not active, whether to provide associated text must be determined based upon the situation. The visually impaired user will not be able to ignore this audio text as a sighted user can if text is included. Include, then, short textual description for all important images. To include a lengthy text description, provide a link to a separate page that contains a complete description.

Audio. For hearing-impaired users, include one of the following textual alternatives. For short audio pieces, provide a *caption or small pop-up* window describing the audio. For longer audio, consider providing a *textual transcript*, an exact word-for-word version of the audio. Give the user the choice of reading the transcript, listening to the audio, or both reading and listening. Also consider a *textual description*, a longer and more extensive audio presentation than a transcript. This kind of description can be both subjective and artistic, depending on the needs of the user. Governmental legislation in some countries requires that these textual alternatives be synchronized with the audio presentation. For a very lengthy transcript or description, consider providing a link to a separate page containing a complete transcript or description.

Video. For all video content include a transcript or description in both a textual and audio format. As previously mentioned, a *transcript* is an exact word-for-word version of the video. A *description*, also both subjective and artistic, is a longer and more extensive summarization of the video. It generally includes actions, settings, body language, and scene changes necessary to fully understand the video. Again, governmental legislation in some countries requires that these alternatives be synchronized with the video presentation.

Image maps. For content embedded in image maps provide equivalent textual menus because their content may not be accessible to screen-review utilities.

Animation. Screen reviewers cannot read information that is animated. Provide an option that enables users to stop animation. Also, ensure that the information conveyed by the animation is available in an alternate format.

Multimedia elements. Captions or auditory descriptions of a visual track must be synchronized with the presentation.

Plug-ins and applets. Use sparingly because they, and other software, may create problems for people using assistive technologies. If used, they should always be tested for accessibility.

Online forms. For online forms that cannot be read by screen utilities, provide alternate methods of communication. For example, provide instructions for supplying needed information by telephone, regular mail, or e-mail.

Text-only pages. If accessibility cannot be accomplished in any other way, provide a text-only page with equivalent information and functionality. These pages must be maintained and updated in conjunction with the primary Web page. Tell users that the text-only pages are equivalent and as up to date as their graphic counterparts.

World Wide Web Consortium. The World Wide Web Consortium (W3C) has established guidelines for Web content accessibility. The guidelines cover a wide range of issues and recommendations for making Web content more accessible. This document contains principles, guidelines, and success criteria that define and explain the requirements for making Web-based information and applications accessible. The first series of guidelines entitled, "Web Content Accessibility Guidelines (WCAG) 1.0" were published in 1999. They are summarized in Table 10.3 and can be found in their entirety at `http://www.w3.org/TR/WAI-WEBCONTENT/`.

The first public version of a follow-up draft, WCAG 2.0 was published in January 2001. Since then, nine working drafts have been published addressing more than 1,000 issues. In April 2006, a Last Call Working Draft was issued. Publication as a Last Call Working Draft indicates that the WCAG working group believes it has addressed all substantive issues and that the document is stable. Final release will occur after this final draft is approved. The WCAG 2.0 final draft contains the following principles and guidelines:

- Principle 1: Content must be perceivable.
  - Guideline 1.1: Provide text alternatives for all non-text content.
  - Guideline 1.2: Provide synchronized alternatives for multimedia.
  - Guideline 1.3: Ensure that information and structure can be separated from presentation.
  - Guideline 1.4: Make it easy to distinguish foreground information from its background.
- Principle 2: Interface components in the content must be operable.
  - Guideline 2.1: Make all functionality operable via a keyboard interface.
  - Guideline 2.2: Allow users to control time limits on their reading or interaction.

- Guideline 2.3: Allow users to avoid content that causes seizures because of photosensitivity.
- Guideline 2.4: Provide mechanisms to help users find content, orient themselves within it, and navigate through it.
- Guideline 2.5: Help users to avoid mistakes and make it easy to correct mistakes that do occur.

- Principle 3: Content and controls must be understandable.
  - Guideline 3.1: Make text content readable and understandable.
  - Guideline 3.2: Make the placement and functionality of content predictable.
- Principle 4: Content must be robust enough to work with current and future agents (including assistive technologies).
  - Guideline 4.1: Support compatibility with current and future agents (including assistive technologies).
  - Guideline 4.2: Ensure that the content is accessible or provide an accessible alternative.

The complete guidelines are available at `http://www.w3.org/TR/WCAG20/`.

Section 508. If a Web site is designed for the United States Government, ensure that the requirements of this section of the Rehabilitation Act are met. Section 508 requires Federal agencies to ensure that their procurement of information technology takes into account the needs of all users — including people with disabilities. For additional information on Section 508 see `http://www.section508.gov`.

Table 10.3: World Wide Web Consortium (W3C) Accessibility Guidelines

1. Provide equivalent alternatives to auditory or visual content. Provide content that, when presented to the user, conveys essentially the same function or purpose as to auditory and visual content.
2. Don't rely on color alone. Ensure that text and graphics are understandable when viewed without color.
3. Use markup and style sheets and do so properly. Mark up documents with the proper structural elements. Control presentation with style sheets rather than with presentation elements and attributes.
4. Clarify natural language usage. Use markup that facilitates pronunciation or interpretation of abbreviated or foreign text.
5. Create tables that transform gracefully. Ensure that tables have necessary markup to be transformed by accessible browsers and other agents.

Table 10.3 *(continued)*

6. Ensure that pages featuring new technologies transform gracefully. Ensure that pages are accessible even when newer technologies are not supported or turned off.
7. Ensure user control of time-sensitive content changes. Ensure that moving, blinking, scrolling, or auto-updating objects or pages may be paused or stopped.
8. Ensure direct accessibility of principles of embedded interfaces. Ensure that the user interface follows accessible design: device-independent access to functionality, keyboard operability, self-voicing, and so on.
9. Design for device-independence. Use features that enable activation of page elements via a variety of input devices.
10. Use interim solutions. Use interim accessibility solutions so that assistive technologies and older browsers will operate correctly.
11. Use W3C technologies and follow accessibility guidelines. Use W3C technologies (according to specification). Where it is not possible to use a W3C technology, or doing so results in material that does not transform gracefully, provide an alternate version of the content that is accessible.
12 Provide context and orientation information. Provide context and orientation information to help users understand complex pages or elements.
13. Provide clear navigation mechanisms. Provide clear and consistent navigation mechanisms — orientation information, navigation bars, a site map, and so on — to increase the likelihood that a person will find what they are looking for at a site.
14. Ensure that documents are clear and simple. Ensure that documents are clear and simple so they may be more easily understood.

Usability for Lower-Literacy People

- To aid lower-literacy Web users,
  - — Prioritize information.
  - — Avoid moving or changing text.
  - — Streamline the page design.
  - — Simplify navigation.
  - — Optimize search.

Nielsen (2005) provides the following guidelines for improving usability for lower-literacy users:

Prioritize information. Place the main point at the top of the page where it will be quickly seen. Place other important information above the fold to minimize the risk of users losing their place after scrolling. This, of course, is good design for any user.

Avoid moving or changing text. Static text is easier to read than animations or pop-up menus. This guideline also aids international users who may have to look up a word in a dictionary, and people with motor skill impairments who may have difficulty catching elements that move.

Streamline page design. Place all important information in a single main column. Scanning the page is easier and picking out design elements in a two-dimensional layout is not required. This guideline also helps vision-impaired users, and also users of hand-held devices with small screens.

Simplify navigation. Place the main navigation choices in a single column menu. They will be easier to read and understand.

Optimize search. Be very tolerant of misspellings and provide short, easy-to-read summaries. Spelling tolerance will also help all users.

Nielsen applied these simplified guidelines to an existing pharmaceutical Web site and, using lower-literacy and higher-literacy users, measured and compared success rate in performing tasks, the time needed to complete a task, and the users' subjective satisfaction. The success rate for the revised design with lower-literacy users increased from 46 to 82 percent, the total task time decreased from 22.3 minutes to 9.5 minutes, and the satisfaction level increased also. Higher-literacy user performance measures improved on all measures as well (68 to 93 percent and 14.3 to 5.1 minutes). For both groups of users, all the differences between the two sites were statistically significant. In conclusion, revising the text for a very broad audience benefited all users.

Usability for Senior Citizens

Seniors are one of the fastest growing user groups of the Internet. AARP says that more than 40 million adults over age 50 are now online in the United States. The worldwide number of senior users would be substantially larger. The degenerative effects of aging on a person are well known, however. Common effects are diminished vision, motor impairments, reduced attention, and reduced memory. Senior users, in spite of a loss in capabilities, do desire, and are entitled to, a usable and productive Web experience.

Unfortunately, studies have shown that many Web sites have not been designed with older users in mind. Nielsen (2002) performed a study comparing performance in four Internet tasks using three Web sites. Participants were a group of seniors (over age 65) and a group of younger users (ages 21 to 55). He found that seniors had a lower success rate (52.9% to 78.2%), took more time (12 minutes and 33 seconds to 7:14), took more erroneous actions per task (4.6 to 0.6), and gave the sites a lower rating (3.7 to 4.6 on a scale of 1 to 7). He concluded that overall usability was more than twice as good for non-seniors as it was for seniors.

Nielsen attributed the lower Web site usability for seniors to two factors. First, Web site designers are typically young and possess non-diminished physical and mental capabilities. Many then, erroneously, make the assumption that all users possess the same skills as they do. Second, many seniors retired without having extensive experience using computers and the Internet. Consequently, their understanding of technology is poor. A similar erroneous designer assumption is made (consciously or unconsciously): that the users know as much as they do (a common design problem that has existed throughout the history of computer system design).

What to do? Zaphiris et al. (2005), as reported by Bailey (2005), performed an extensive literature review of over 100 research papers on aging and human interaction. From this review they created a series of guidelines for making Web sites easier to use by seniors. The most important guidelines are

- Provide large targets to make selection easier.
- To reduce the number of selections or clicks,
  - Do not require double-clicks.
  - Do not use pull-down menus.
  - Do not have a deep page hierarchy.
- Concentrate important information at the top of pages.
- Avoid the need to scroll to find information.
- Put most links in a bulleted, not tightly clustered, list.
- Provide a clear differentiation between visited and non-visited links.
- Use few colors, and avoid using blue and green tones.
- For text to be read or scanned, use
  - 12 to 14 point sans serif font (Helvetica, Arial).
  - Black text on a white background.
  - Left justification.
  - Increased spacing (leading) between lines.
  - Sentence style mixed-case letters rather than all capital letters.
  - Appropriate large headings in a 14 to 16 point sans serif font.

Applying these guidelines would also, of course, benefit all users of Web sites. As always, usability testing should be performed to ensure an effective system for seniors.

Documentation

- Provide documentation on all accessible features.
- Provide documentation in alternate formats.
- Provide online documentation for people who have difficulty reading or handling printed material.

All accessibility features must be documented for the user. Much standard documentation does not address keyboard access as thoroughly as is required by disabled people. Also, some people have difficulties in reading or handling printed material. Documentation in alternate formats, such as audio or Braille, may be required.

Testing

- Test all aspects of accessibility as part of the normal system testing process.

Testing for accessibility must be part of the normal testing process. Testing is reviewed in Step 14.

Step 10 Exercise

An exercise for Step 10 can be found on this book's companion Web site, www.wiley.com/college/galitz.

STEP

11

Create Meaningful Graphics, Icons, and Images

The graphics era in interface and screen design began with the Xerox Star computer in the 1970s and fully blossomed with the advent of Apple's Lisa and Macintosh in the mid-1980s. GUI systems rapidly began to supplement the earlier text-based systems that had been in existence for three decades. When Microsoft finally entered the picture with their Windows system, GUI systems quickly became the dominant user interface. The significant graphical feature of a GUI system is the use of icons (the symbolic representation of objects, such as applications, office tools, and storage locations) and the symbolic representation of actions that could be applied to objects. The faces of many 1990s and beyond GUI screens scarcely resembled their older text-based siblings of the mid- to late-twentieth century.

The graphical evolution in interface design was further expanded in the 1990s with the maturing of the World Wide Web. The Web permitted easy inclusion of other media on a screen, including images, photographs, video, diagrams, drawings, and spoken audio. Because these media, including icons, could be combined in various ways, the term multimedia was coined to describe these combinations. A Web interface, then, has its foundation in GUI systems, but it has added its own unique elements to screen design.

Screen graphics, if used properly, can be a powerful communication and attention-getting technique. They can hold the user's attention, add interest to a screen, support computer interaction, and help overcome language barriers. Research over the years has shown that the use of graphics can facilitate learning and recall. Pictures, for example, are more easily recognized and recalled than words. It has been found, however, that memory for pictures and words together is superior to memory for words alone or pictures alone (Lidwell et al., 2003). A recent study evaluating graphics in Web site

design has found that people prefer and recall better a picture of a product paired with text (Hong et al., 2004). Improperly used graphics, however, can confuse the user, lead to navigation inefficiencies, and be distracting. Screen graphics must always serve a useful purpose.

This step will provide design guidelines for the various graphical techniques available in GUI and Web screen design. It will review

- The kinds of icons available, their characteristics, and their usability influences.
- How icons are chosen and the icon design process.
- Design guidelines for the various other graphical media including images, photographs, pictures, diagrams, drawings, audition, and animation.

Icons

Icons are pictorial images most often used to represent objects and actions with which users can interact with or that they can manipulate. Icons may stand alone on a desktop or in a window, or be grouped together in a toolbar. A secondary use of an icon is to reinforce important information, such as a warning icon in a dialog message box.

Kinds of Icons

The use of icons to reflect objects, ideas, and actions is not new to mankind. We've been there before. Early humans (100,000 years or so ago) used pictographs and then ideographs to communicate. Some of these early communications can still be found today on rock walls and in caves around the world. Until recent times, this was also the only way to communicate in some cultures (Native Americans and Australian aborigines, for example).

Word writing is traced back to Chinese writing from about 6000 B.C. and Egyptian hieroglyphics from about 3000 B.C. This was followed by cuneiform (Babylonia and Assyria) from about 1900 B.C., and the contemporary Chinese vocabulary (numbering about 50,000) around 1500 B.C. In 1000 B.C. the Phoenicians developed a 22-sign alphabet that the Greeks adopted about 800 to 600 B.C. The Greeks passed this alphabet on to the Romans about 400 B.C., who then developed a 23-character alphabet. This alphabet has been modified and embellished but has remained essentially the same for the last 2000 years.

Pictorial representations, then, have played a prominent role in mankind's history. Word writing, however, unleashed much more flexibility and richness in communication. This has caused some skeptics to wonder why, after taking 2500 years to get rid of iconic shapes, we have now revived them on screens.

Whatever the past, today objects or actions *are* depicted on screens by icons. The term *icon*, however, is not very specific and can actually represent very different things. An attempt has been made by some to define the actual types of icons that do exist. Marcus (1984) suggests icons fall into these categories:

- **Icon**. Something that looks like what it means.
- **Index**. A sign that was caused by the thing to which it refers.
- **Symbol**. A sign that may be completely arbitrary in appearance.

He states that what are commonly referred to as icons may really be indexes or symbols. A true icon is something that looks like what it means. It is representational and easy to understand. A picture of a telephone or a clock on a screen is a true icon. An index is a sign caused by the thing to which it refers. An open door with a broken window indicates the possible presence of a burglar. The meaning of an index may or may not be clear, depending upon one's past experiences. A symbol is a sign that may be completely arbitrary in appearance and whose meaning must be learned. The menu and sizing icons on screens are examples of symbols. From this perspective, strictly speaking, so-called icons on screens are probably a mixture of true icons, signs, and indexes.

Rogers (1989) provided an expanded definition for icon kinds.

- **Resemblance** — An image that looks like what it means.
- **Symbolic** — An abstract image representing something.
- **Exemplar** — An image illustrating an example or characteristic of something.
- **Arbitrary** — An image completely arbitrary in appearance whose meaning must be learned.
- **Analogy** — An image physically or semantically associated with something.

She suggests that an icon is used in a number of different ways: for *objects* such as a document, *object attributes* such as a color or fill pattern, *actions* such as to paste, *system states* such as ready or busy, and *message types* like critical or warning.

The different ways icons are used may then be represented by different design schemes. A *resemblance* icon is an image that looks like what it means — a book, for example, to represent a dictionary. This is equivalent to Marcus's icon. A *symbolic* icon is an abstract image that represents something. A cracked glass, for example, can represent something fragile. Marcus's symbol would be similar. An *exemplar* icon represents an example or characteristic of something. A sign at a freeway exit picturing a knife and fork has come to indicate a restaurant. An *arbitrary* icon is not directly related in any way and must be learned. Marcus's symbol would be an equivalent. Finally, an *analogy* icon is an image physically or semantically associated with something — a wheelbarrow full of bricks for the move command, for example. Marcus's symbol would also be similar.

In a study looking at various kinds of icons, Rogers found that those depicting both an action and an object were quite effective. For example, a drawing of a page and an arrow pointing up means "go to the top of the page." She also found that arbitrary icons were only meaningful in very small sets, and that icons based on analogies were relatively ineffective.

Characteristics of Icons

An icon possesses the technical qualities of syntactics, semantics, and pragmatics (Marcus, 1984). *Syntactics* refers to an icon's physical structure. Is it square, round, red, green, big, small? Are the similarities and differences obvious? Similar shapes and colors can be used to classify a group of related icons, communicating a common relationship. Semantics is the icon's meaning. To what does it refer, a file, a wastebasket, or some other object? Is this clear? *Pragmatics* is how the icons are physically produced and depicted. Is the screen resolution sufficient to illustrate the icon clearly? Syntactics, semantics, and pragmatics determine an icon's effectiveness and usability.

Influences on Icon Usability

Simply providing an icon on a screen does the user no particular favor, unless it is carefully designed to present a natural and meaningful association between the icon itself and what it stands for. Unfortunately, a sampling of many current systems finds icons that do not achieve this objective. Icons are included because "this is the thing to do" in a graphical system today. Little concern is given to effectiveness. The result is too often a cluttered and confusing screen that is visually overwhelming. So, proper icon design is important from an acceptance, learning, and productivity perspective. The following factors influence an icon's usability:

- Provide icons that are
  - Familiar.
  - Clear and Legible.
  - Simple.
  - Consistent.
  - Direct.
  - Efficient.
  - Discriminable.
- Also consider the
  - Context in which the icon is used.
  - Expectancies of users.
  - Complexity of task.

Familiarity. How familiar is the object being depicted? Familiarity will reduce learning time. How familiar are the commonly seen icons in Figure 11.1? Lack of familiarity requires learning the icons' meanings. Very unfamiliar icons require a great deal of learning.

Experience often makes words and numbers more familiar to a person than symbols. Confusion matrices have been developed through extensive research for alphanumeric data (0 versus O, 1 versus I). Graphic symbols may be more visually similar to each other.

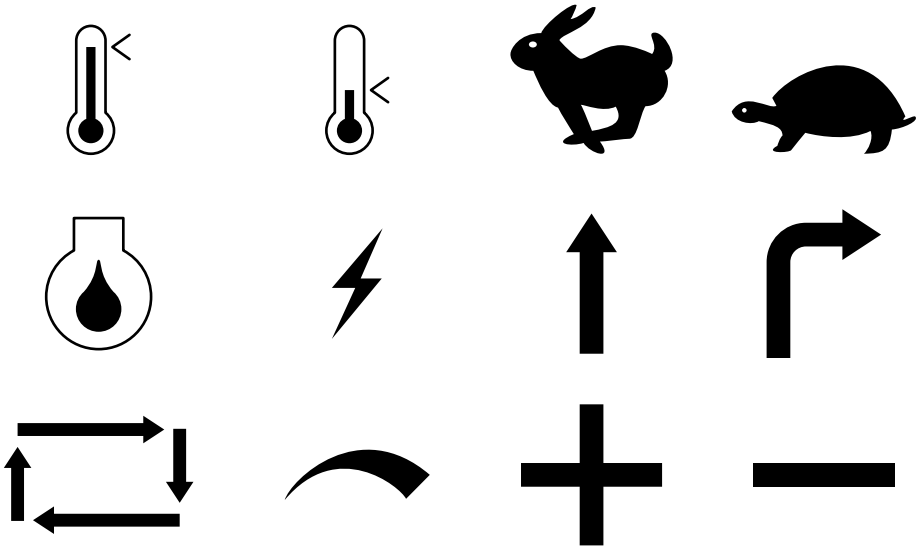

Figure 11.1: Some common icons. What do they stand for? Answers are on the next page.

Clarity. Is the icon legible? Does the shape, structure, and formation technique on the screen permit a clear and unambiguous depiction of what it is? Screen resolution should be sufficiently fine to establish clear differences of form at the normal working distance. The resolution and pixel shapes for screens differ from one another. Icons must appear correctly and consistently no matter what kind of screen is used. If color is used, it should contrast well with the background. Poor clarity will lead to identification errors and slower performance.

Simplicity. Is the icon simple? Is the shape clean and devoid of unnecessary embellishments? Too many parts will only confuse the screen viewer.

Consistency. Are families of icons consistent in structure and shape? Are the same icons displayed on different screens consistent in shape and structure? Are the same icons displayed in different sizes also consistent in structure and shape?

Directness. How "sign-like" is the icon; how well does it convey its intended meaning? For concrete objects and actions, direct links are more easily established. Adjectives, adverbs, conjunctions, and prepositions can cause problems, however. Also, how does one easily convey concepts such as bigger, smaller, wider, or narrower?

Efficiency. In some situations, a graphics screen may be less efficient, consuming more screen display space than a word or requiring more physical actions by the user than text. A telephone directory of 50 names and numbers listed on an alphanumeric screen may consume the same screen space required for, and manipulation of, 15 file cards. Raising an arm or moving a mouse may be slower than simply typing. In other situations, icons can be more effective than words in communicating concepts in a smaller area of space. Icons' strength lies in situations where this occurs.

The icons depicted in Figure 11.1 have the following meanings:

Hot	Cold	Fast	Slow
Engine Oil	Ammeter/Generator	Straight	Turn
Automatic	Variable Regulation (Increase/Decrease)	Plus/Positive	Minus/Negative

From Micro Switch (1984).

Discriminability. The symbols chosen must be visually distinguishable from other symbols. A person's powers of differentiation for shapes and other forms of codes have been experimentally determined over the years. The maximum number of codes that can be effectively differentiated by a human being, including geometric shapes, is summarized in Table 11.1. A person's ability to discriminate alphabetic or alphanumeric information is much more potent.

Context. The context of a symbol may change its meaning. Does the rabbit symbol illustrated in Figure 11.1, if seen on a road sign in a national park, mean "go faster"? From this contextual perspective, icons are similar to words.

Expectancies. The symbol may be comprehended, but a false conclusion may be reached about the desired action because of an incorrect expectancy. A study of international road signs found that 8 percent of all drivers never saw the "do not do" slash through a symbol on a road sign. Their expectancy was that they could do it, not "not do it."

Complexity of task. The more abstract or complex the symbol, the more difficult it is to extract or interpret its intended meaning. It has been found that more concrete graphic messages are easier to comprehend than the more abstract. Icons, therefore, cannot completely replace words in more complex situations.

Table 11.1: Maximum Number of Codes for Effective Human Differentiation

ENCODING METHOD	RECOMMENDED MAXIMUM	COMMENTS
Alphanumerics	Unlimited	Highly versatile. Meaning usually self-evident. Location time may be longer than for graphic coding.
Geometric Shapes	10–20	High mnemonic value. Very effective if shape relates to object or operation being represented.
Size	3–5	Fair. Considerable space required. Location time longer than for colors and shapes

Table 11.1 *(continued)*

ENCODING METHOD	RECOMMENDED MAXIMUM	COMMENTS
Line Length	3–4	Will clutter the display if many are used.
Line Width	2–3	Good.
Line Style	5–9	Good.
Line Angle	8–11	Good in special cases (such as wind direction).
Solid and Broken Lines	3–4	Good.
Number of Dots or Marks	5	Minimize number for quick assimilation.
Brightness	2–3	Creates problems on screens with poor contrast.
Flashing/Blinking	2–3	Confusing for general encoding but the best way to attract attention. Interacts poorly with other codes. Annoying if overused. Limit to small fields.
Underlining	No data	Useful but can reduce text legibility.
Reverse Polarity	No data	Effective for making data stand out. Flicker easily perceived in large areas, however.
Orientation (location on display surface)	4–8	-
Color	6–8	Attractive and efficient. Short location time. Excessive use confusing. Poor for the color blind.
Combinations of Codes	Unlimited	Can reinforce coding but complex combinations can be confusing.

Data derived from Martin (1973); Barmack and Sinaiko (1966); Mallory et al. (1980); Damodaran et al. (1980); and Maguire (1985).

Choosing Icons

Icon design is an important process. Meaningful and recognizable icons will speed learning and recall and yield a much more effective system. Poor design will lead to errors, delays, and confusion. While the art of icon design is still evolving, it is agreed that the usability of a system is aided by adhering to the following icon design guidelines.

A Successful Icon

- Looks different from all other icons.
- Is obvious what it does or represents.
- Is recognizable when no larger than 16 pixels square.
- Looks as good in black and white as in color.

Fowler and Stanwick (1995) provide these general guidelines. An icon must look different from all other product icons, making it discriminable and differentiable. What it does or represents must also be obvious so it is interpretable. It must be recognizable when no larger than 16 pixels square. Finally, it must look as good in black and white as in color. Color is always an enhancing quality of an icon.

Size

- Supply in all standard sizes.
  - — 16 × 16 pixels
    - 16- and 256-color versions.
  - — 32 × 32 pixels
    - 16- and 256-color versions.
    - Effective: 24 × 24 or 26 × 26 in 32 × 32 icon.
  - — 48 × 48 pixels
    - 16- and 256-color versions.
- Use colors from the system palette.
- Use an odd number of pixels along each side.
  - — Provides center pixel around which to focus design.
- Minimum sizes for easy selection:
  - — With stylus or pen: 15 pixels square.
  - — With mouse: 20 pixels square.
  - — With finger: 40 pixels square.
- Provide as large a hot zone as possible.

Size. Typically, icons come in three standard sizes: 16, 32 and 48 pixels square. For clarity, 16 × 16 should be an icon's minimum size. An effective combination for an image is a 24 × 24 or 26 × 26 in a 32-pixel square icon.

Colors. Microsoft suggests that while 256 colors may be used in sizes smaller than 48 × 48 pixels, to do so increases icon storage requirements, and they may not be displayable on all computer configurations. If 256 colors are used for icons, they suggest that the standard 16-color format should always be provided. Also, use colors from the system palette to ensure that the icons look correct in all color configurations.

Odd number of pixels. Horton (1994) recommends using an odd number of pixels along each side of the matrix. This provides a center pixel around which to focus, thus simplifying the design process.

Icon selection. For easy selection the following are minimum icon sizes: with a stylus or pen, 15 pixels square; with a mouse, 20 pixels square; with one's finger, 40 pixels square.

Hot zone. An icon's hot zone, the area within it that allows it to be selected, should be as large as possible, preferably the entire size of the icon. This allows easier selection.

Choosing Icon Images

- Use existing icons when available.
- Use images for nouns, not verbs.
- Use traditional images.
- Consider user cultural and social norms.

Existing icons. Many standard icons have already been developed for graphical systems. Use these standard icons where they are available. This will promote consistency across systems, yielding all the performance benefits that consistency provides. Where standard icons are not available, determine if any applicable icons have already been developed by industries and trade or standards organizations. The International Standards Organization (ISO), for example, has developed standard shapes for a variety of purposes. Always consult all relevant reference books before inventing new symbols or modifying existing ones.

Nouns. An object, or noun, is much easier to represent pictorially than an action or verb. Choose nouns for icons whenever possible.

Traditional images. Old-fashioned, traditional images often work better than newer ones. They have been around longer, and more people recognize them.

Cultural and social norms. Consider users' cultural and social norms. Improper design of icons can create problems internationally. Social norms vary, so great variations exist in what is recognizable and acceptable throughout the world. What one culture recognizes may have no meaning in another. What is acceptable in one country may not be in another. International considerations are discussed in Step 10.

Creating Icon Images

- Create familiar and concrete shapes.
- Create visually and conceptually distinct shapes.
  — Incorporate unique features of an object.
  — Do not display within a border.

- Clearly reflect objects represented.
- Simply reflect objects represented, avoiding excessive detail.
- Create as a set, communicating relationships to one another through common shapes.
- Provide consistency in icon type.
- Create shapes of the proper emotional tone.

Concrete and familiar shapes. Ideally, an icon's meaning should be self-evident. This is enhanced when concrete shapes are provided, those that look like what they are. A study found concrete icons are easier to recognize for infrequent users but frequent users perform equally well using both concrete and abstract icons. An icon should also be intuitive or obvious, based upon a person's preexisting knowledge. Familiar shapes are those images that are well learned. Figure 11.2 illustrates concrete and familiar icons for a file folder, book, and telephone as well as images for the same objects that are more abstract and unfamiliar. A study found that concrete, familiar icons were preferred to abstract, unfamiliar ones.

Keep in mind, however, that familiarity is in the eye of the viewer. The concrete images pictured may be familiar to us, readers of this book, but not to a tribal chief living in a remote area of the world where these objects do not exist. Similarly, items familiar to those working on the factory floor may not be at all familiar in the office or in the home, and vice versa. Mayhew (1992) also cautions that some abstract images should not be discounted because they have become familiar, in spite of their being abstract. On a road sign, for example, an angled red bar inscribed over an object means do not do what is pictured beneath (at least to most people, as described earlier). While abstract, it is a very familiar shape today. If an abstract image must be used, it should be capable of being learned quickly and easily recalled. Familiarity can only be determined through knowing one's user.

Visually and conceptually distinct shapes. It must be easy to tell icons apart so the chances of confusing them are minimized. Differentiation is aided when icons are visually different from one another. It is also aided when icons are conceptually different, that is, when they portray specific features of an object that are relatively unique within the entire set of objects to be displayed. Figure 11.3, based upon Mayhew (1992), illustrates how distinctiveness may be achieved for two similar items: a dictionary and a telephone book. Visual distinctiveness is achieved by incorporating unique features of each: for the dictionary, it is its content of letters and words; for the telephone book, numbers and the telephone bell. Visual distinctiveness is degraded when borders are placed around icons, as illustrated in Figure 11.4. Borders tend to obscure the shape of the object being displayed.

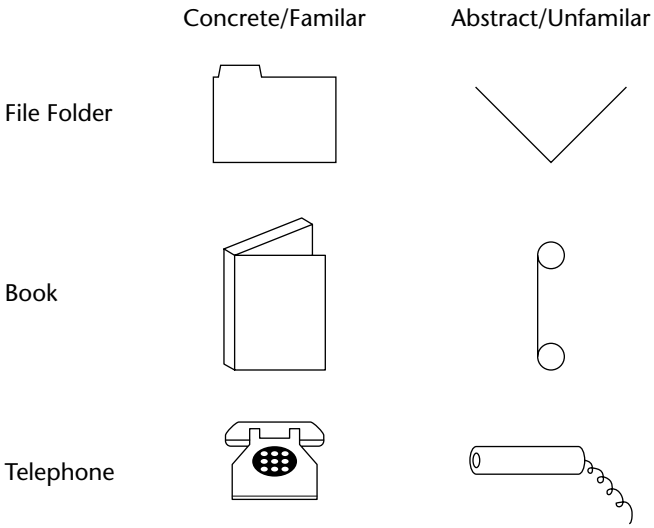

Figure 11.2: Concrete and familiar shapes.

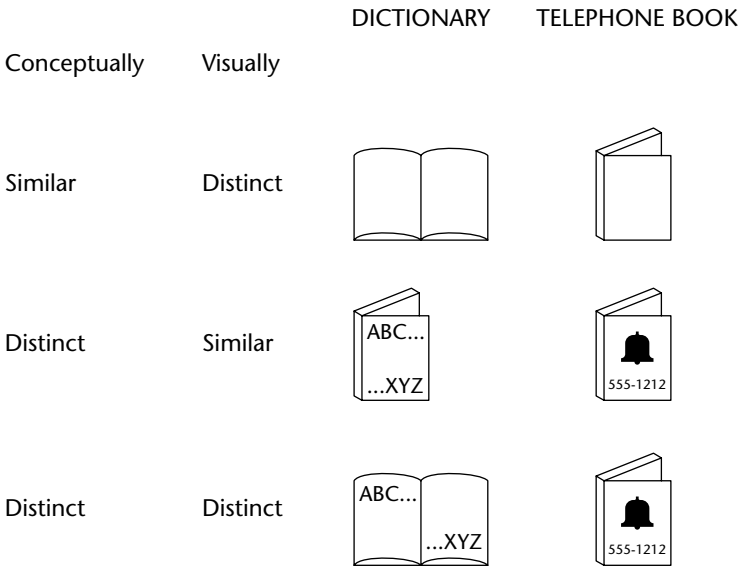

Figure 11.3: Visually and conceptually distinct shapes.

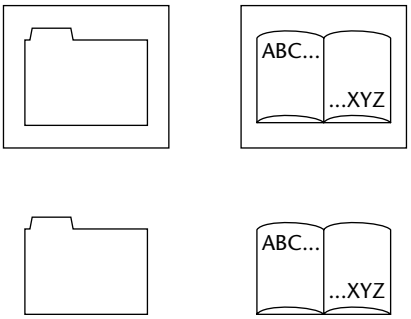

Figure 11.4: Borders degrading icon distinctiveness.

Clearly reflect objects. The characteristics of the display itself should permit drawings of adequate quality. Poorly formed or fuzzy shapes will inhibit recognition.

Simply reflect objects. Construct icons with as few graphical components as necessary, using no more than two or three, if possible. Also, use simple, clean lines, avoiding ornamentation. Byrne (1993) found that simple icons, icons containing fewer graphical elements, were located faster in a visual search task than complex icons, icons with more components. He concluded that complex icons seemed to clutter a screen with information that people were unable to employ to their advantage. Too much detail inhibits rather than facilitates perception, as illustrated in Figure 11.5. For real-world objects, use only enough detail to permit recognition and recall.

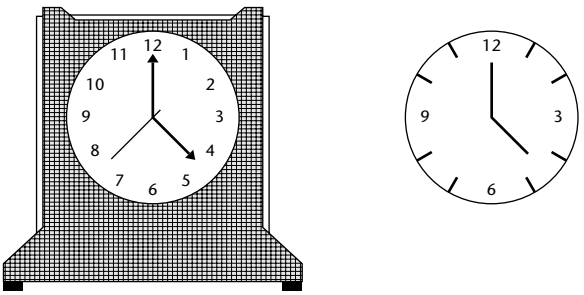

Figure 11.5: Avoid excessive detail in icon design.

Design as a set. Do not design icons in isolation, but as a family considering their relationships to each other and the user's tasks. Provide a common style. When icons are part of an overall related set, create shapes that visually communicate these relationships. Objects within a class, for example, may possess the same overall shape but vary in their other design details, as illustrated in Figure 11.6. Color may also be used to achieve this design goal. In creating sets, always avoid repeating unrelated elements.

Consistency in icon type. As previously noted, there are many different kinds of design schemes for icons (resemblance, symbolic, arbitrary, and so on). All these schemes might be used to create a meaningful family of icons for an application. Learning the meaning of icons and searching for the right icon, however, will be aided if the same design scheme is used for all icons within a family. In presenting a series of icons for actions such as paint, cut, and so on, one could, for example, (1) depict a before-after representation of the action, (2) depict the action itself being performed, or (3) picture the tool to perform the action. While a series of meaningful icons could be developed using each scheme, the best approach would be to use only one of these schemes to develop the entire family of icons.

Proper emotional tone. The icon should appropriately reflect the environment in which it is used. A sewage disposal system would be an inappropriate metaphor for an electronic mail system wastebasket.

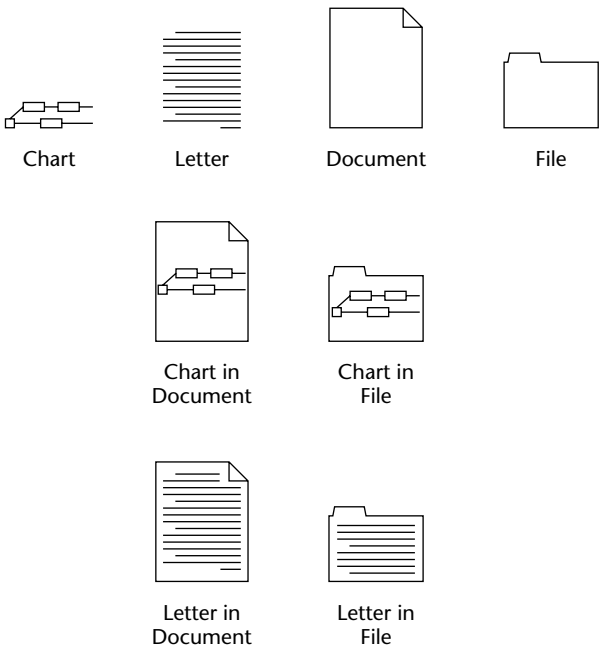

Figure 11.6: Communication relationships in icons.

Drawing Icon Images

- Provide consistency in shape over varying sizes.
- Do not use triangular arrows in design to avoid confusion with other system symbols.
- When icons are used to reflect varying attributes, express these attributes as meaningfully as possible.
- Provide proper scale and orientation.
- Use perspective and dimension whenever possible.
- Accompany icon with a label to assure intended meaning.

Consistency. When drawing images, create consistency in shapes for identical icons of differing sizing. Preserve the general shape and any distinctive detail. Consistency is achieved through limiting the variations of angles, line thicknesses, shapes, and amount of empty space.

Triangular arrows. Avoid using a triangular graphic similar to that used as a cascade symbol for menus, a drop-down button for controls, and scroll arrows. The similarity may cause confusion.

Meaningful attributes. When an icon is also used to express an attribute of an object, do this as meaningfully as possible. The status of a document, for example, might be represented by displaying it in a different shade, but would be more effectively illustrated by filling it in, as illustrated in Figure 11.7. Shading requires remembering what each specific type of shading stands for; the filled-in proportion is more intuitively obvious.

Scale and orientation. Ensure that the size and orientation are consistent with other related objects. Also ensure that they fit well on the screen.

Perspective and dimension. Use lighting and shadow to more accurately reflect the real-world experiences of people. When a light source is used, it must be located upper left, as is done with other screen elements.

Caption or label. Because icons may not be used often, the ability to comprehend, learn, and recall an icon's meaning can be greatly improved by attaching textual captions or labels to them. This is especially important for new or infrequent users. Wiedenbeck (1999), comparing textual and iconic links, found inexperienced people performed best with text-only links. Frequent users used either equally effectively but icons were not faster, relative to text links alone. The preferred label location is directly beneath the icon, not within it, because of the international considerations discussed in Step 10. Labels beneath the icon also provide a larger target, speeding selection. Labels should always be related to icons in a consistent positional way. "Mystery icons," icons with no caption or label to explain them, lead to a user guessing game and many errors. While ToolTips can be used to present labels, they are time-consuming to present, taking about two-thirds of a second to appear and be comprehended. Scanning an entire row of 15 icons with ToolTips, therefore, will consume about 10 extra seconds.

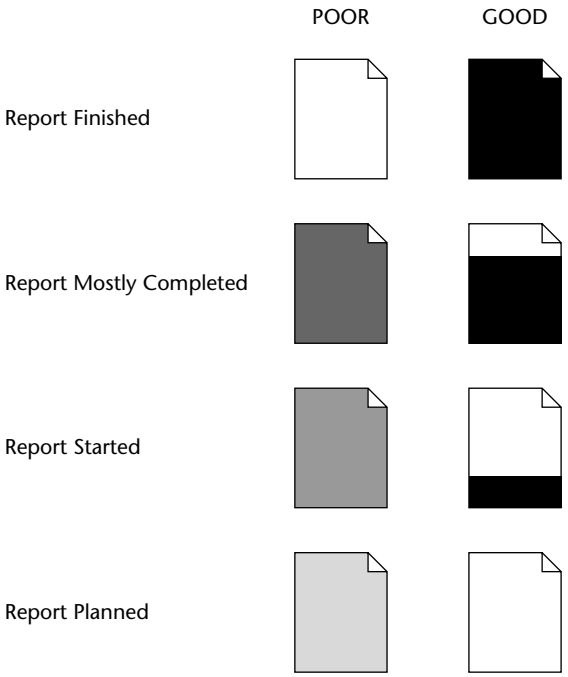

Figure 11.7: Expressing attributes in icon design.

MAXIM **If people must remember hieroglyphics, they won't stick around long.**

Icon Animation and Audition

- Animation:
  - — Use:
    - To provide feedback.
    - For visual interest.
  - — Make it interruptible or independent of user's primary interaction.
  - — Do not use it for decoration.
  - — Permit it to be turned off by the user.
  - — For fluid animation, present images at 16 or more frames per second.
- Audition:
  - — Consider auditory icons.

Animation. Recent research has explored the use of bringing to life on screens the icons representing objects and actions. An animated icon appears to move instead of maintaining a static position on the screen. Animation can take two forms, best described as static and dynamic. A *static* icon's appearance is unchanged over a period of time and changes only at the moment that a system

event occurs. An example would be the open door of a mailbox shutting when an electronic message is received. A *dynamic* icon's movement is independent of a system event, changing appearance to represent functions, processes, states, and state transitions. An example is an icon that begins movement to illustrate an action when a pointer is moved close to it.

Animation can be used to provide feedback and to create visual interest. Researchers caution, however, that there are many outstanding issues. Among them are that few animation creation rules exist, prototyping is difficult, a scheme for how they fit into a larger system is lacking, and whether they can be made useful for more complex and abstract concepts is not known. Morimoto et al. (1993) found that dynamic animation of the type in the preceding example did not increase the comprehensibility of icons. Its only advantage was its entertainment value. Faraday and Sutcliffe (1997) did find animation was useful in calling attention to an item to which users should first attend.

Some general guidelines, however, seem appropriate. First, do not prevent the user from interacting with the system while the animation is performed. Unless the animation is part of a process, it should be independent of what the user is doing. It should also be interruptible. Be conservative in its use; do not use animation simply for decoration. It can be very distracting or annoying. Finally, provide the user with the option of turning it on or off, as desired. Microsoft recommends that to achieve fluidity in movement, images should be presented at a speed of at least 16 frames per second. The reader interested in more information on animation is referred to Baecker and Small (1990).

Audition. Objects make sounds as they are touched, dragged, bumped against one another, opened, activated, and thrown away. Auditory icons are computer sounds replicating everyday sound-producing events. When a printer near one's desk begins printing, the sound of the printing mechanism is heard. This provides auditory feedback that a print operation one has just asked for has successfully started. An auditory icon would be the same sound, generated by the computer. Another example would be to convey information about an object's dimensions. If a file is large, it can sound large. If an object is dragged over a new surface, the new surface is heard. If an ongoing process starts running more quickly, it sounds quicker. Sounds can convey information about many events in computer systems, permitting people to listen to computers as we do in the everyday world. It may be well suited to providing information

- About previous and possible interactions.
- Indicating ongoing processes and modes.
- Useful for navigation.
- To support collaboration.

Auditory icons are distinct from earcons, abstract synthetic tones used in structured combinations to create sound messages. Auditory icons may also be susceptible to the distracting influences that sounds can cause to listeners, especially others. The use of sound is discussed in more detail in Step 9. The reader in need of more information on auditory icons is referred to Garver (1993).

The Icon Design Process

- Define the icon's purpose and use.
- Collect, evaluate, and sketch ideas.
- Draw in black and white.
- Draw using an icon-editing utility or drawing package.
- Test for user
  — Expectations.
  — Recognition.
  — Learning.
- Test for legibility.
- Register new icons in the system's registry.

Define purpose. To begin the design process, first define the icon's purpose and use. Have the design team brainstorm about possible ideas, considering real-world metaphors. Simple metaphors, analogies, or models with a minimal set of concepts are the best places to start in developing icons.

Collect, evaluate, and sketch ideas. Start by designing on paper, not on the computer (Fowler and Stanwick, 1995). Ask everyone to sketch his or her ideas. Do not worry about too much detail; exact pixel requirements are not necessary at this time.

Draw in black and white. Many icons will be displayed in monochrome. Color is an enhancing property; consider it as such.

Test for expectation, recognition, and learning. Choosing the objects and actions, and the icons to represent them, is not a precise process, and will not be easy. So, as in any screen design activity, adequate testing and possible refinement of developed images must be built into the design process. Icon recognition and learning should both be measured as part of the normal testing process.

Test for legibility. Verify the legibility and clarity of the icons in general. Also, verify the legibility of the icons on the screen backgrounds chosen. White or gray backgrounds may create difficulties. An icon mapped in color, then displayed on a monochrome screen, may not present itself satisfactorily. Be prepared to redraw it in black and white, if necessary.

Register new icons in the system's registry. Create and maintain a registry of all system icons. Provide a detailed and distinctive description of all new icons.

Screen Presentation

- Follow all relevant general guidelines for screen design.
- Limit the number of symbols to 12, if possible, and at most 20.

- Arrange icons
  — In a meaningful way, reflecting the organization of the real world.
  — To facilitate visual scanning.
  — Consistently.
- Place object and action icons in different groups.
- Present an interactive icon as a raised screen element.
- Ensure that a selected icon is differentiable from unselected icons.
- Permit arrangement of icons by the user.
- Permit the user to choose between iconic and text display of objects and actions.

In designing, or establishing, screen layout rules, adhere to the following presentation rules.

General guidelines. Follow all relevant general guidelines for screen design. Icons are but one part of a larger picture.

Number of icons. A person's ability to identify shapes is limited (see Figure 11.1). A literature review suggests using no more than eight to twelve or so functions that require icons at one time. At most, present no more than 20. If labels are attached to icons, however, the meaning of the icon is greatly clarified. Too many icons on a screen, though, will greatly increase screen clutter and create confusion. In general, fewer are better.

Arranging icons. Organize icons in a way that reflects the *real-world* organization of the user. Place object icons and action icons within different groupings. *Visual scanning* studies, in a non-iconic world, universally find that a top-to-bottom scan of columnar-oriented information is fastest. Generalization of these findings to an icon screen may not necessarily be warranted if icons have attached labels. Columnar orientation icons (with labels below the icons) will separate the labels from one another by the icons themselves. The labels will be farther apart and fewer icons will fit in a column than in a horizontal or row orientation. A row orientation would seem to be more efficient in many cases, as adjacent icons will be in closer physical proximity. Until research evidence is established to the contrary, organizing icons either in a column or a row seems appropriate. In either case, a *consistent* straight eye movement must be maintained through the icons.

Object and action icons. Conceptually similar items should always be arrayed together. Locating them will be easier.

Interactive icons. To provide a visual indication that an icon is interactive or clickable, present it in a three-dimensional state raised from the screen background.

Selected icon. Ensure a selected icon is visually differentiable from unselected icons. One common method to achieve this is to present the selected icon in a three-dimensional pressed state.

User arrangement. Allow the user to arrange the icons in a manner that is meaningful for the task. A default arrangement should be provided, however.

Iconic or text display. In some situations, and for some users, pure text labels may be more meaningful than icons. The option to display text only should always be provided.

Multimedia

The graphical flexibility of the Web permits inclusion of other media on a screen, including images, photographs, video, diagrams, drawings, and spoken audio. The availability of these additional interface elements has, however, been a double-edged sword. On the one hand, the various media can be powerful communication and attention-getting techniques. Multimedia can hold the user's attention, add interest to a screen, entertain, and quickly convey information that is more difficult to present textually. It can also make the Web much more accessible to people with disabilities. On the other hand, effective use of multimedia in design has been hindered by a lack of knowledge concerning how the various media may best be used, and a scarcity of applied design guidelines. (GUI guidelines relevant to Web page design have been available for years, but their existence was either unknown or ignored.) Effective multimedia use has also been hindered by the "let's use it because we have it" attitude exhibited by many designers. (To be fair, early GUI design has suffered from the same problem.) The resulting usability problems, user confusion and frustration, poor screen legibility, and slow downloads, and so on have created situations where the user was too often denied an efficient and meaningful Web experience.

As a result, recent studies (Spool et al., 1997, for example) have found that the most difficult-to-use Web sites were those that were graphically intense, and the top Web sites were characterized by little, if any, multimedia. Studies have also found that for users, text is currently a much more important Web site component than graphics (at least at this stage in Web evolution). Today, consequently, good interface design employs multimedia in a conservative and appropriate manner. The objective is good interaction design, not "sparkle." In the future, experts say, multimedia elements will be much better integrated with browsers, alleviating many of today's usability problems.

Graphics

- Use graphics to
  - — Supplement the textual content, not as a substitute for it.
  - — Convey information that can't be effectively accomplished using text.
  - — Enhance navigation through
    - Presenting a site overview.
    - Identifying site pages.
    - Identifying content areas.
- Limit the use of graphics that take a long time to load.
- Coordinate the graphics with all other page elements.
- Graphics should not look like gratuitous decorations or banner ads.

Graphics contained in Web pages serve several distinct purposes, which can be classified as follows:

- **Navigational.** To identify links that may be followed.
- **Representational.** To illustrate items mentioned in the text.
- **Organizational.** To depict relationships among items mentioned in text.
- **Explanative.** To show how things or processes work.
- **Decorative.** To provide visual appeal and emphasis.

Graphics must always be used for a specific purpose. This purpose must be determined before designing or choosing the graphic itself. Graphics should only be used when they add to a Web site's message. Graphics that do not relate to a Web site's purpose, and do not strengthen the Web site's message, should never be used.

Supplement textual content. Use graphics to supplement text, not as a substitute for it. Graphics are not easily accessible to search facilities and screen reviewers, and are slower to download than text. As studies have shown, people prefer textual page content to graphical content. So, never use graphics when text will do the job. If a graphic will help people understand the text they are reading, then certainly use it.

Convey information not possible using text. Use graphics to convey information that can't be effectively conveyed using text. In some cases the old adage "a picture is worth a thousand words" is indeed true. Photographs, for example, can be used to communicate the exact appearance of objects. Video is useful for showing objects or things that move. Diagrams can be used to present an object's structure. Drawings are useful when selected parts of an object need to be emphasized or represented. If a graphic does a better job of communicating an idea or concept than text, then use it. (Remember, however, text descriptions or transcripts of the graphic will always be necessary for accessibility reasons.)

Enhance navigation. Graphics can be used to enhance navigation. A graphical *overview* of a site's organizational scheme will enable the user to conceptualize and learn the site's structure faster than can be done through textual overviews. *Site pages* can be related through a consistent graphical theme carried from page to page. This will reinforce the browsing user's sense of place. Graphics can also be used to identify and represent major site *content areas*. The experienced user will locate and identify the content areas faster using meaningful graphical identifiers rather than text.

Limit long-loading graphics. Limit the use of graphics that take a long time to load In general, all graphics must be smaller on the Web than on the printed page. Large graphics take longer to download testing the user's patience. If a large graphic is needed, present a small version and link it to a page containing the large version. Richly colored graphics and pages containing numerous graphics are also slower to load.

Coordinate graphics. Graphics are only one component of a Web page. The graphics must fit in with the style of typography used, the colors used, and the page layout itself. Plain and simple fonts are best coordinated with simple graphics.

Realistic graphics work best with elements like three-dimensional effects and more complex typography.

Gratuitous decorations or banner ads. Important and functional graphics should not look like decoration or an ad. A study found that an informational graphic to access live help was not selected because it looked too much like a decoration or advertisement (Koyani et al., 2004).

Images

- Ensure all images convey their intended messages.
- General:
  - — Use standard images.
  - — Emulate real-world objects.
  - — Use images consistently.
  - — Produce legible images.
  - — Provide descriptive text or labels with all images.
  - — Distinguish navigational images from decorative images.
  - — Minimize
    - The number of presented images.
    - The size of presented images.
      - Restrict single images to 5KB.
      - Restrict page images to 20KB.
      - Provide thumbnail size images.
    - Image animation.
  - — Avoid extraneous or gratuitous images.
- Color:
  - — Minimize the number of colors in an image.
- Format:
  - — Produce images in the most appropriate format.
    - GIF.
    - JPEG.
- Internationalization:
  - — Provide for image internationalization.
- Design:
  - — Limit large images above the page fold.
  - — Use simple background images.
  - — Reuse images on multiple pages.

Convey intended messages. Users and designers frequently differ when asked to select the best image to reflect an intended message. Users tend to select the most familiar images while designers favor more artistic images (Koyani et al., 2004).

Standard images. Whenever possible, use standard images that have already been developed and tested. This will promote consistency across systems, yielding all

the performance benefits that consistency provides. These standard images may be found in guideline books, company or organizational documentation, or in industry, trade, or standards organizations' documentation. The International Standards Organization (ISO), for example, has developed standard image shapes for a variety of purposes. Always consult all relevant reference books before inventing new images or modifying existing ones.

Real-world objects. The meaning and use of images that look like real-world objects will be easily understood. Buttons, for example, that look like the buttons commonly found on common electronic devices or machines will be more readily identified as navigation elements.

Consistency. Use an image consistently throughout an application or Web site. Multiple images with the same meaning will be difficult to learn.

Legibility. Create legible images that are easy to identify from a variety of viewing distances and angles. Legibility is affected by many factors, including contrast with the background, image complexity, and image size. Images with a minimum amount of detail are usually easier to comprehend and faster to load. If an image with more detail is needed, provide a link to a page containing the detailed version. An image that is perfectly legible when it is drawn or rendered large may, when shrunk for placing on a page, become incomprehensible.

Descriptive text or labels. Many images are not immediately clear, even if well designed. The ability to comprehend, learn, and recall an image's meaning, especially if it is used for navigation, can be greatly improved by providing images with descriptive text or labels. Also, many people browse the Web with their graphics turned off. Without alternate text, an image's purpose and function will not be known. Alternate text for an image also provides the following benefits:

- It provides vision-impaired users with access to content through a screen-review utility.
- It helps sighted users determine whether they want to wait for the image to fully load.
- It enables users to read a description of a linked image and activate the link before the image fully loads.

Navigational and decorative images. Clearly indicate which graphical images on the screen are used for navigation by providing a visual indication that an image is interactive or clickable. Possibilities include giving the image a raised or three-dimensional appearance (like a navigational icon) or underlining any descriptive text contained within or near it (like a textual link). Also, alternate text should accompany every interactive image. Navigational images that cannot be distinguished from decorative images force users to mouse over each image to determine which are interactive (once they are over their initial state of confusion). This is time-consuming, and important navigation links may be missed.

Also clearly indicate if the entire image is clickable, or that the clickable sections are obvious. Again, mouse-over should not have to be performed to locate clickable areas on an image.

Minimize number of images. The more images presented on a Web page, the slower the download time. Use text whenever possible. Only present images

when they add value and increase the clarity of the Web site's information. To wait several seconds for an image to load, only to find it adds no value to the information presented can be frustrating for users. Some decorative graphics may be used as long as they are not visually distracting, focusing the user's attention away from the site's important information.

Minimize size of images. Oversized images also take a long time to load. Slow-loading graphics rarely add value to text, and people often don't bother to stick around for them. The design goal is to produce images that load quickly. Make the graphic as small as possible while still retaining sufficient image quality. In general, restrict *single images* to 5KB, *page images* to no more than 20KB. A 200KB file can take several minutes to load. Never put borders around an image with a drawing program because this also adds to the file size.

Thumbnail size. A thumbnail is a small version of an image, usually fairly low in quality. This small image will load quickly because of its small file size. Link this thumbnail image to a large high-quality version of the image. Users can then decide whether or not they want to retrieve and view the full-size version. Always let the user know the size of the full-size image. Thumbnails are especially useful when several images, or a collection of images, must be displayed on a Web page.

Minimize animation. Animated images take a long time to load and are distracting to many people. Only use animation when it serves a useful purpose.

Extraneous or gratuitous images. Similarly, do not present extraneous or gratuitous images. Images take longer to load than text, and Web users prefer text. Images must always serve a useful purpose.

Minimize the number of colors. To reduce the size of image files, reduce the size of the color palette and the number of colors in the image. Color-rich images tend to be large. If the image color palette is too small, however, the image will be degraded. The objective is to retain sufficient image quality while making the file as small as possible. To create images of sufficient color quality while at the same time reducing file size, begin with a high-quality image and create versions using successively smaller color palettes. Stop when the image degradation becomes apparent. (Guidelines for the use of color in screen design are discussed in Step 12 .)

Appropriate format. Produce images in the most appropriate format, GIF or JPEG. CompuServe developed the GIF format (Graphics Interchange Format) in 1987. The JPEG (Joint Photographic Experts Group) was developed for the transfer of photographic images over the Internet.

GIF. Most Web color images and backgrounds are GIF files. They are usually smaller and load faster than JPEGs. They are particularly useful for images that contain flat areas of color. Because GIFs are limited to 256 colors, they are ideal for graphics that use only a few colors. GIFs exist in either a *dithered* or *nondithered* format. Dithering is the color-mixing process a computer goes through when it encounters a color not in its palette. In this process, palette colors are mixed to approximate the appearance of the desired color. The resulting color may be grainy or unacceptable. The dithering will be most apparent in gradations, shadows, and feathered edges. A nondithered GIF attempts to match the closest colors

from the palette to the image. This is referred to as *banding*. This banding may also create an unacceptable image.

One way to control the dithering process is to create images that only use non-dithering colors. The 216 colors that are shared by PCs and Macintoshes are called the Web palette or browser-safe colors. These colors display properly across all platforms without dithering.

GIFs may also be *interlaced*. Interlacing is the gradual display of an image in a series of passes on the screen. The first pass displays a low-resolution out-of-focus image and each succeeding pass creates a clearer view until finally a complete image is displayed. With interlacing, users see a complete, although not clear, image much more quickly. An impression that the image is loading much faster is achieved, and users can quickly determine if they are interested in the image. With a *noninterlaced* GIF, the graphic unfolds more slowly one row at a time. Use interlaced GIFs to give users a preview of graphics while they unfold.

Most Web servers call up to four GIFs at a time for display. Limiting GIF images on a page to four will allow pages to load much faster.

JPEG. JPEG formats are superior for images such as photographs that contain numerous changes in color tonality. They look best on monitors capable of displaying 16 million colors. A JEPG's range of colors cannot be produced in monitors displaying 256 or fewer colors. Images that contain flat areas of color may also find that JEPGs introduce unwanted artifacts. JPEGs usually take longer to download than GIFs.

JPEGs may be displayed as progressive or standard. Progressive images gradually fade into view like interlaced GIFs, each pass an increasingly higher quality scan. *Standard* images are drawn from top to bottom like noninterlaced GIFs. Use progressive JPEGs to give users a preview of the graphics while they are unloaded.

Internationalization. When designing for international or multilingual users, using images may eliminate the need for translating words. All images, however, must comply with the internationalization design guidelines covered in Step 10.

Limit above the page fold. Do not fill an entire screen with an image when a page is first presented. A study found that when presented only with a large image, some users did not scroll down to look for more content, or even suspect that more non-visible content existed (Koyani et al., 2004).

Background Images. Use background images sparingly. In addition to slowing down download times, background images can make text much harder to read. If background images are used, provide simple, small, images with tiling, and/or keep the image resolution low.

Reuse images. Repeat the same images on multiple pages. Repeated images will be stored in a *cache*, the browser's temporary storage area. Loading an image from cache significantly reduces an image's downloading time.

Image Maps

- Use:
  — To provide navigation links to other content.
- Advantages:
  — Can be arrayed in a meaningful and obvious structure.
  — Faster to load than separate images.
- Disadvantages:
  — Consume a significant amount of screen space.
  — Hot spots not always obvious.
  — One's location within image map is not always obvious.
- Guidelines:
  — Use with caution.
  — Provide effective visual cues and emphasis to make it easy to identify link boundaries.
  — Ensure image maps are accessible to the vision-impaired.

Use. An *image map* is a complete image containing individual segments with navigation links to other content. Its primary use is to present a meaningfully structured image within which the links are contained.

Advantages/disadvantages. An *advantage* of an image map is its meaningful and obvious structure. It can reflect the user's mental model of an object, minimizing organizational learning requirements. An image map may be a map of a country, for example, with areas reflecting regions that can be selected as links to more detailed content. An image map can also be an image reflecting a site's organization. Image maps, because of their graphical nature, can aid conceptualization of a Web site and how it is organized. Another image map advantage is that they are faster to load than individual images, at least for users accessing the Web through a modem.

There are several *disadvantages* of image maps. First, they are quite wasteful of screen space. Providing large enough hot spots or clickable areas for each element often necessitates creating very large maps. Within the maps, clickable regions are also not always obvious because they cannot be seen. Whether to click on the map, or where to click, is not always known. This can be confusing for the new user. Unclear or poorly designed image maps can cost users a great deal of time when they make erroneous navigation selections. Selected image map links are also not obvious to the user. A link just selected may be again selected, directing the user right back to the page displayed with no indication that anything has changed. User confusion can again exist. Another disadvantage is that search facilities may not be able to index an image map.

MYTH **Cool = Usable**

Guidelines. Because of these disadvantages, be cautious in the use of image maps. Some experts recommend not using them at all. If used, provide effective visual cues and emphasis to make it easy to identify individual selectable segments and where link boundaries exist. Consider supplementing the image map graphic with text to inform users what they will see when they select a particular area. Finally, ensure that image maps are accessible to vision-impaired users.

Photographs/Pictures

- Use:
  — When every aspect of the image is relevant.
- Guidelines:
  — Use JPEG format.
  — On the initial page, display a small version.
    - Display a thumbnail size image.
    - Zoom in on most relevant detail.
    - Link to larger photos showing as much detail as needed.
  — Include fewer people and objects in less complicated settings than in photos for print.
  — Emphasize close-up shots with clean backgrounds.

Use. When every aspect of an image or object is relevant, present a picture or photograph of it. A photo or picture will capture all visible aspects, providing information that is difficult to describe with words.

Will photographs of people increase trust in a Web site? The research was reviewed by Bailey (2003b) and Straub (2003d). Studies by Fogg et al. (2001), Steinbruck et al. (2002), and Zheng et al. (2002) reported that exposure to photographs prior to an interaction did seem to increase trusting behavior. Riegelsberger and Sasse (2002), however, found mixed results ranging from enthusiasm to suspicion. Riegelsberger et al. (2003) reported that photographs do not increase the trustworthiness of already credible sites. They do, however, improve the credibility of sites that are not generally perceived as trustworthy. The conclusion — use photographs of people with care and perform all the necessary usability testing to make a final decision.

If photographs are used, Straub suggests the following regarding people photographs:

- Pictures of people make virtual transactions more familiar and, as such, sites seem more trustworthy, but
  — If a Web site is already credible, photographs will not enhance its trustworthiness.
  — Photographs do not enhance the trustworthiness of sites for users who are not confident about the trustworthiness of the Web in general.
- Photographs without functional value can undermine overall perception of sites for very experienced users by interfering with task completion.

Guidelines. The *JPEG* format was developed for presenting photographs that contain numerous changes in color tonality. Pictures or photos look best on monitors capable of displaying 16 million colors.

A large photo will have an excessively long downloading time. To minimize this time, on the initial page display a small version of the photo and provide a link to a larger, high-quality, complete photo on another page. The small version may be a *thumbnail* image, a complete miniature photograph, usually fairly low in quality. Because of the complexity of a photographic image, a thumbnail may not always be legible. When legibility is a problem, instead of resizing the image to a miniature photo, provide a zoom-in on the most relevant photo detail, cropping and resizing as necessary to provide a meaningful and legible image.

For linked, full-size photographs, provide as much detail as the users need and always inform the users of the image's size. Also, if necessary, provide a zoom or rotation capability for the photograph on the linked page.

Photographs often suffer from background clutter. Therefore, include fewer people and objects in less complicated settings than in photos for print, and emphasize close-up shots with clean backgrounds.

Video

- Uses:
  - — To show things that move or change over time.
  - — To show the proper way to perform a task.
- To show events that cannot be seen directly.
- To convey human behavior and emotions.
  - — To provide a personal message.
  - — To grab attention.
- Disadvantages:
  - — Expensive to produce.
  - — Slow to download.
  - — Small and difficult to discern detail.
- Guidelines:
  - — Never automatically download a video into a page.
  - — Create short segments.
  - — Provide controls, including those for playing, pausing, and stopping.
  - — Consider using
    - Existing video.
    - Audio only.
    - A slide show with audio.

Uses. Video is especially suited to showing things that move or change over time. Examples include product demonstrations, how to repair a piece of equipment, how to perform a dance step, or how to perform a task. Other uses include showing events that cannot easily be seen directly, such as something on the other side

of the world or an historical event. Or it can be used to convey human behavior and emotions — an irate customer interacting with a company employee, for example. Videos can also be used to present personal messages, although the speaker's "presence" may not always have the desired emotional effect. Because of their animation, videos can also be used to grab attention.

Video, however, because of its high attention-capturing capability, should only be used to help convey, or be supportive of, a Web site's message or content. It is important to have clear and useful reasons for its use. Otherwise, it will be an unnecessary distraction.

Disadvantages. Videos are expensive to produce and slow to download and play. They are also small and limited in the detail they can present. Always inform the user of a video's size so a choice of whether or not to download it can be made. Depending on a video's purpose, its animation may also be distracting to the user.

Guidelines. Do not *automatically download* a video into a loading Web page. Create *short segments*. There are many distractions people may encounter while using a video (the telephone or interruptions by people, and so on), so long segments should be avoided. A 60- to 90-second video is considered long, so keep a video's length well within these limits. For all playable files provide the following controls: Play, Pause/Resume, Stop, Rewind, Fast Forward, and Volume.

Because of a video's disadvantages, consider using existing videos, audio alone, or a slide show with audio. Reusing an *existing video* will save production time and money. A new voice-over may be all that is necessary. *Audio alone* may be as powerful a tool as a video, because the human voice is an important aspect of all videos. Determine whether audio alone will accomplish the video's objectives. An *audio slide show* may also be a good substitute for a video. The impression of movement is still achieved as the slides change, but they are quicker and easier to create and download.

Diagrams

- Uses:
  - — To show the structure of objects.
  - — To show the relationship of objects.
  - — To show the flow of a process or task.
  - — To reveal a temporal or spatial order.
- Kinds:
  - — Flow charts.
  - — Cause and effect charts.
  - — Gantt charts.
  - — Entity relationship diagrams.
  - — Organization charts.
  - — Network diagrams.

- Parts:
  — Shapes.
  — Lines.
  — Labels.
- Guidelines:
  — Provide simple diagrams.
  — Provide cutaway diagrams or exploded views to illustrate key points.

This discussion is partially based upon Fowler and Stanwick (2004).

Uses. Diagrams are useful for illustrating the structure of an object, its key parts and how they are related to each other. Diagrams are also useful for illustrating the relationships of objects, the structure of an organization, or the structure of a Web site. Other uses are to illustrate the flow of a process or task, a software program, or an airline passenger check-in sequence, for example. (Guidelines for displaying flow charts are discussed in Step 3.) Diagrams can also be used to reveal temporal or spatial order, including activities such as the sequence in which an object's parts should be assembled.

Kinds. Kinds of diagrams include flow charts, cause and effect charts, Gantt charts, entity relationship diagrams, organization charts, network diagrams, and so forth.

Parts. All diagrams have three elements or components: shapes, lines, and labels. *Shapes* are the entities connected by a diagram's lines. Shapes represent two levels of information. The kind and structure of the shape will have meaning to the viewer, and the shape's label will indicate what particular information this component contains.

A diagram's *lines* (also called *edges*) show the relationships between the shapes and may also contain multiple levels of information. (1) A line connecting two shapes indicates that the shapes are related. (2) The weight or style of the line may indicate a particular type of relationship. (3) Arrows or other symbols at the end of a line may indicate directionality. (4) Labels may describe the purpose of a specific line. Lines do not necessarily indicate physical distances in diagrams.

Labels are any text that states or adds to the meaning of a shape or line. Depending on the type of diagram, labels do not always have to be attached to a shape or line. They can be located in a list or tree to the left of the diagram. To reduce a diagram's clutter, labels may be hidden until the user asks for them. They may be presented in ToolTips or turned on and off through a toggle switch. Other types of information may be included in a diagram's border, if needed. Elements of a diagram are illustrated in Figure 11.8.

Guidelines. Provide simple diagrams showing only as much detail as necessary to clearly illustrate the diagram's objective. Simpler diagrams will also load faster on a Web page. To illustrate key points, provide cutaway diagrams or exploded diagram views. An extensive series of design guidelines for diagrams are provided by Fowler and Stanwick. The required diagram features are summarized in Table 11.2. For an additional listing of optional features see Fowler and Stanwick (2004).

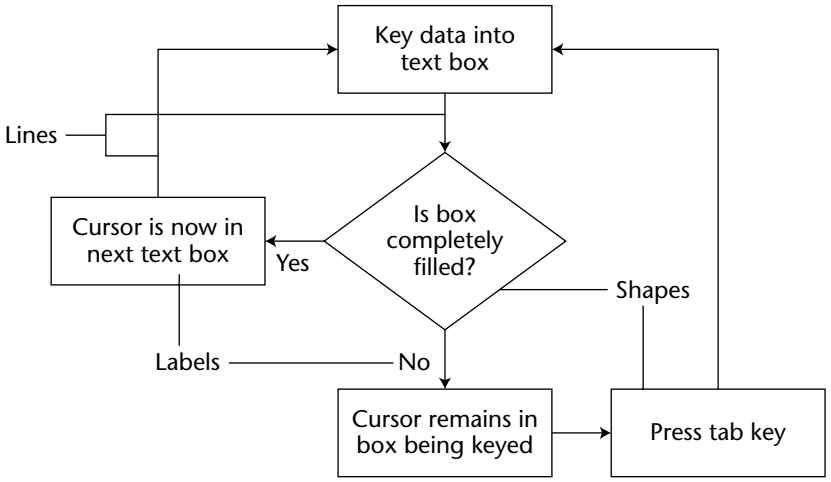

Figure 11.8: Diagram elements.

Table 11.2: Required Features of Diagrams

Diagram Creation	Let users resize shapes and lines. Let users align elements automatically and by hand. Let users arrange elements automatically and by hand. Let users arrange diagrams using an algorithm that minimizes crossing lines and makes the picture more compact. Let users select single or multiple elements using standard selection methods. Provide a grid and a method to turn it on or off. Provide a snap-to-grid option. Provide a method for changing the grids cell size. Make a table or text version of the diagram's data readily available. Make sure the typefaces, sizes, and colors are not hard-coded so accessibility options will work. Provide methods for printing.
Palette	Let users select shapes and lines from a palette. Set the selected shape or line in repeat mode so users don't have to continually reselect it. Provide a method for docking and undocking the palette. Provide a method for keeping the palette on top or visible. Provide palettes of the standard shapes for the domain.
Shapes	Let users move shapes. Let users nudge shapes into position using the arrow keys. Let users add color and texture to shapes. Provide regularly spaced anchor points onto which the lines snap (attach themselves automatically).

Table 11.2 *(continued)*

Lines	Let users add lines to the shapes at anchor points. Let users move lines independent of the shapes (creation only). Let users move the endpoints of lines from one spot on the shape to another. Offer various styles of lines as appropriate (straight, curved, and so forth).
Labels	Provide labels for shapes and lines. Ensure that labels stay visually attached to the elements they describe. If labels can be turned off, show the label automatically when the user holds the pointer over the element (like a ToolTip). Make sure that labels do not overlap.

Adapted from Fowler and Stanwick (2004).

Drawings

- Use:
  — When selective parts need to be emphasized or represented.
- Guidelines:
  — Provide simple drawings showing minimal detail.
  — Provide a link to a complete drawing.

Use. Use a drawing when only certain parts of an image are of relevance, and these parts must be emphasized or clearly represented. If the working of a specific object is to be described, a diagram illustrating its relevant parts should be used.

Guidelines. Provide simple drawings showing minimal detail. They are easier to view and understand and they also load more quickly. Photographs are likely to be less effective because they contain information that is not relevant, they lack clarity, and they take longer to load on a Web page. If the user is also in need of a detailed drawing, provide a link to a page containing a complete drawing.

Animation

- Uses:
  — To explain ideas involving a change in
    - Time.
    - Position.
  — To illustrate the location or state of a process.
  — To provide feedback.
  — To show continuity in transitions.

— To enrich graphical representations.
— To aid visualization of three-dimensional structures.
— To attract attention.

- Disadvantages:
  — Very distracting.
  — Can potentially create problems for people with some disabilities.
  — Slow loading.
- Guidelines:
  — Use only when an integral and meaningful part of the content.
  — Introduce animation.
  — Create short segments.
  — Provide a freeze frame, stop, and replay mode.
  — Avoid distracting animation.

Uses. Use animation only when it serves a useful purpose. Animation has been found to be effective when presenting complex concepts (Weiss et al., 2002). Animations can be used to enhance textual explanations of objects changing over *time*. A map illustrating population growth can be animated to illustrate population densities and patterns over a sequence of years or centuries. Proper sequential body *positions* needed to skillfully perform a sport can also be illustrated as they are textually described. The acceptance and impact of animation is enhanced when (1) animation is introduced, (2) users are warned to expect it, and (3) users are allowed to start it when they want (Weiss et al., 2002).

The current *location* within, or the state of, a process can be highlighted through animating flow arrows or process steps. Dynamic feedback can be provided to confirm something is happening. When copying files in some operating systems, an animation appears showing files flying from one file to another.

Continuity in transitions can also be illustrated. The changing of states of an element with two or more states will be easier to understand if the transitions are animated instead of being instantaneous. In Windows, actually seeing an icon moving as it is dragged from a desktop to the Recycle Bin or the My Documents file strengthens one's understanding of the task and the results. *Graphical representations* can also be enriched. Some kinds of information are easier to visualize with movement rather than with still pictures. *Visualization* of three-dimensional structures can also be aided. While a two-dimensional screen can never provide a full understanding of a three-dimensional element, animating the element by slowly turning it aids in understanding its structure. Animation can also be used to *attract attention*. The user's attention can be directed to an important screen element or alerted to an important condition.

MAXIM **Content is always more important than graphics.**

Disadvantages. Any discussion of screen image animation includes a strong caution concerning animation's side effects. Screen animation is difficult to ignore, often overpowering a person's peripheral vision. As is discussed in Step 1,

peripheral vision competes with foveal vision for a person's attention. That sensed in the periphery is passed on to our information-processing system along with what is actively being viewed foveally. It is, in a sense, visual noise. Mori and Hayashi (1993) experimentally evaluated the effect of windows in both a foveal and peripheral relationship and found that performance on a foveal window deteriorates when there are peripheral windows, and the performance degradation is even *greater* if the information in the peripheral is dynamic or moving. Reeves and Nass (1996) measured brain waves with an EEG and found that attention increased every time motion appeared on a screen. Permanently moving animation on a screen makes it very hard for people to concentrate on reading text, if the brain wants to attend to the motion. Animation can also be very annoying. Banner animation has been found to significantly increase perceived workload and frustration of users (Burke and Hornoff, 2001).

Animation can also potentially create problems for people with some disabilities. Flickering images can trigger some forms of epilepsy, and moving images can be distracting for people with attention deficits. Rapid image changes can make it harder for visually-impaired people with some sight to focus on the images.

Another current negative side effect of Web page animation is its close association with advertising. Animation, including scrolling text, is frequently being used by advertisers to try and gather the users' attention. Studies suggest that people have started equating animation with advertising, so animation as a screen element is being routinely ignored. Important animation may, therefore, be missed. Animated images also take longer to load.

Guidelines. Use animation sparingly. Only use it when it is an *integral part* of the textual content, or reinforces the content. Create short segments. There are many distractions people may encounter while watching animation, so long segments should be avoided. Animation, when used, should be capable of being *stopped* by the user so an image may be studied in detail. It should also be capable of being replayed, and ended entirely so it is eliminated as a visual distraction. In conclusion, always avoid animation or special effects that detract from the screen's message.

Audition

- Uses:
  - — As a supplement to text and graphics.
  - — To establish atmosphere.
  - — To create a sense of place.
  - — To teach.
  - — To sample.
  - — For users
    - With disabilities.
    - In an eyes-busy and hands-busy situation.
    - Who do not have access to keyboard and/or monitor.

- Advantages:
  - — Does not obscure information on the screen.
  - — Shorter downloading time than video.
- Disadvantages:
  - — Is annoying to many people, including users and nonusers in the vicinity.
  - — Can easily be overused, increasing the possibility that it will be ignored.
  - — Is not reliable because
    - Some people are hard of hearing.
    - If it is not heard, it may leave no permanent record of having occurred.
    - The user can turn it off.
    - Audio capability may not exist for the user.
- Guidelines:
  - — When words are spoken
    - The content should be simple.
    - The speed of narration should be about 160 words per minute.
  - — When used to introduce new ideas or concepts, the narration should be slowed.
  - — Off-screen narration should be used rather than on-screen narration.
    - Unless the narrator is a recognized authority on the topic.
  - — Create short segments.
  - — Provide segments of high quality.
  - — Provide audio controls.
  - — Play background audio softly.

This discussion of audition focuses on sound as a communication medium for presenting meaningful information, words, music, and so on. A discussion of sounds used to alert the user is found in Step 9.

Uses. Use audio as a *supplement* to text and graphics and only to reinforce visual content. Audio should never be used alone because of the disadvantages listed previously. Audio can also be used to establish *atmosphere*. A particular type of music reflecting a Web site's content can be played to establish ambience and also to create orientation signposts fostering a *sense of place*. Audio can also be used to teach word pronunciation or to provide *samples* of music.

Nielsen (2003) suggests that pure voice interfaces have the greatest potential in the following situations: (1) For people with various disabilities who cannot use a mouse and/or keyboard or who cannot see elements on the screen. (2) For people whose eyes and hands are busy in tasks such as driving an auto or repairing equipment. (3) For people who do not have access to a keyboard and/or monitor and might have to access a system through a standard telephone.

Advantages. An advantage of audio is its ability to offer commentary or help for a visual display. Audio does not obscure information on the screen, and it downloads faster than most other types of graphics.

Disadvantages. Audio's disadvantages are similar to those of sounds described in Step 9. Audio can be annoying to many people, including users and nonusers in the vicinity. It can be easily overused, increasing the possibility that it will be ignored. Audio is also not reliable because some people are hard of hearing, it

may leave no permanent record of having occurred, it may not be available to the user, or it may be turned off. Loud audio can also be irritating, especially to those with sensitive hearing.

Guidelines. Williams (1998), in a multimedia literature review, extracted most of the following guidelines. When words are spoken, the content should be simple, and the speed of narration should be about 160 words per minute. When the narration is used to introduce new ideas or new concepts the narration should be slowed. Off-screen (invisible) narration should be used rather than on-screen narration. On-screen narration is acceptable, however, if the narrator is a recognized authority on the topic being presented.

Other audition guidelines include these: Create *short segments*. There are many distractions people may encounter while listening to audio, so long segments should be avoided. Always provide audio segments of *high quality*. Research has found (Reeves and Nass, 1996) that while people will accept poor video, they are very affected by poor audio. Let users control the playing of audio. Provide the following *controls*: Play, Pause/Resume, Stop, Rewind, Fast Forward, and Volume. Any *background* audio should be subdued so it does not interfere with main information being presented on the screen.

Interactive Voice Response

- Limit to three or fewer levels.
- Limit to four or fewer choices per level.

Interactive voice response (IVR) systems have now become feasible and are being widely implemented. These systems synthesize both grammatical and statistical models of speech recognition to interpret spoken words reliably and accurately. For applications where the vocabulary of the speaker can be restricted, systems have been implemented with some success. For more complicated dialogues, the requirement for increased number of choices and a wider vocabulary pose more difficulties.

IVR systems have the potential to replace both human agents and the touch-tone (Press 2 for...) menu systems. Suhm et al. (2002) compared an IVR system with a touch-tone system using many factors. They found the following. The accuracy rates at the first decision point were similar. Touch-tone users had a 70 to 75 percent choice accuracy rate, whereas the IVR categorization rate was 78 percent. People, however, were more apt to use the IVR system than the touch-tone system. A larger portion of IVR users, 88.5 percent, when invited to describe their reason for calling, did so. Only 75.1 percent of the touch-tone users entered an initial selection. The remainder pressed "O" to escape the system. The IVR system, because of word recognition problems, re-prompted users more frequently than the touch-tone system. Overall, the researchers conclusion was that the IVR system improved the user experience, and routed callers more accurately and quickly to the right place. Users also preferred the IVR system to the touch-tone system.

Another study by Dulude (2002) compared senior adults with younger adults and found that older people had significantly more problems with the IVR system than did

younger people. While 82 percent of the younger people were able to complete five of the six presented tasks, the success rate of seniors was only 32 percent. Only 50 percent of the seniors could complete one or two of the six tasks. Older users were most challenged by the speed of the presentation, a failure to follow instructions, difficulty in understanding jargon, difficulty with selection entry, and an inability to recover from an error. This led Dulude to conclude that IVRs with three or fewer levels, and four or fewer choices per level, work best.

IVRs also appear to have a significant advantage over touch-tone telephones (like cell phones) that have the keypad on the receiver, not the base. It is more difficult to follow and implement touch-tone instructions when the telephone must be continually removed from one's ear to press the required numbers.

Combining Mediums

- Combinations:
  - — Use sensory combinations that work best together:
    - Auditory text with visual graphics.
    - Screen text with visual graphics.
- Integration:
  - — Closely integrate screen text with graphics.
- Relevance:
  - — Both the visual and auditory information should be totally relevant to the task being performed.
- Presentation:
  - — Visual and auditory textual narrative should be presented simultaneously, or the visuals should precede the narrative by no more than 7 seconds.
  - — To control attention, reveal information systematically.
    - Limit elements revealed to one item at a time and use sequential revelations for related elements.
  - — Animation must show action initiation as well as the action's result.
  - — Avoid animation that distracts from other more important information.
- Downloading times:
  - — Consider downloading times when choosing a media.
- Testing:
  - — Thoroughly test all graphics for
    - Legibility.
    - Comprehensibility.
    - Acceptance.

Interface technology encourages inclusion of the various graphical media (images, photos, video, diagrams, drawings, and audio) along with text on a screen. The design issue is which mediums work best with other mediums, and which mediums should not be employed together. Before reviewing research on this topic, which does find performance advantages for certain combinations of multimedia, theories for why this may happen will be summarized.

The first theory is called the *dual code* theory. It proposes that people store information in two ways in memory: verbally and pictorially. This theory postulates that, because of this dual-storage capability, information communicated to a person in both a verbal and pictorial manner has a greater likelihood of being remembered than information arriving in only one format. Also postulated is that too much information arriving in one format can overtax that particular memory. Combining verbal audio with displayed text is one such overtaxing combination.

The second theory also proposes two independent working memories, but is slightly different in concept. The first type of memory is a visual-spatial sketchpad in which information accumulated visually is stored. This visual information may be graphical or textual in nature. The second type of working memory is a phonological loop for dealing with and storing auditory information. This theory postulates that performance may be improved for certain more complex tasks because working memory is expanded through the application of two senses. The general conclusion is that combining visual and verbal auditory information can lead to enhanced comprehension, when compared to relying on one sense alone.

The two theories diverge on the storage of audio. The former suggests that verbal audio and displayed text is stored together; the latter suggests that they are stored separately.

In learning, *elaborative processing* is another consideration. As summarized by Bailey (2002), to "elaborate" means that people take more time to analyze and store information. This extra cognitive processing aids integration of the material with prior knowledge, which aids learning. Multimedia tends to elicit more elaborative processing of information than text does because graphics contain more features than words. These extra features enhance learning.

Interactivity in user interfaces also appears to enhance learning. Interactive interfaces let people control, manipulate and explore material. Interactivity also allows computers to periodically ask learners to answer questions that help them to integrate the material.

Combinations and integration. Williams (1998) in a literature review found that combining visual and verbal auditory information in multimedia design can lead to enhanced comprehension, when compared to use of these medias alone. Several recent studies have also explored the effects of various media, or combinations of media, on user performance. One such study is that of Lee and Bowers (1997). These researchers evaluated various mediums to see which yielded the best learning. The results, summarized in Table 11.3, compared a control group to groups learning material by the various methods described.

Another series of three studies were those of Tindall-Ford et al. (1997). They compared combinations of the following multimedia conditions for learning and performance:

- A visual diagram or table and separated visual text.
- A visual diagram and integrated visual text.
- A visual diagram or table and spoken instructions.

Table 11.3: Learning Improvements for Various Media

MEDIUM	PERCENT MORE LEARNING
Hearing spoken text and viewing graphics	91%
Viewing graphics alone	63%
Viewing text and viewing graphics	56%
Hearing spoken text, viewing text, and viewing graphics	46%
Hearing spoken text and viewing text	32%
Viewing text alone	12%
Hearing spoken text alone	7%

From Lee and Bowers (1997).

They found that the visual-audio combinations yielded reliably better performance for complex tasks, but no differences were found for easy tasks. They also found that visual text integrated into a diagram yielded better performance than separated visual text. They attributed the better results for the audiovisual combination and the integrated text and diagram alternative to reduced demands on working memory. What can we conclude from these studies?

- The proper multimedia combinations can improve learning and performance. Hearing spoken text combined with a visual graphic is an especially useful combination, especially for complex tasks. All studies found this pairing useful.
- Visual graphics do enhance learning and performance. In the Lee and Bowers study, the various graphical combinations yielded higher learning rates.
- Single-dimensional textual media are not as successful when used alone. In the Lee and Bowers study, viewing text or hearing spoken text alone yielded the lowest learning rates.
- Hearing spoken text and viewing text at the same time may not be great, but it may not be terrible, either. This combination yielded "middle-of-the-road" results in the Lee and Bowers study. The dual code theory would suggest, however, that its use be minimized. Exercise caution in this area.
- Visual text should always be integrated with related visual graphics. Tindall-Ford et al. found much better user performance when visual text was closely integrated with, or adjacent to, related visual graphics. It will be much easier for users to coordinate and integrate the visual materials. Presenting spatially separated text and related graphics places greater demands on working memory.

Relevance. Both the visual and auditory information should be totally relevant to the task being performed. All spoken text should reinforce presented graphics.

Presentation. Faraday and Sutcliffe (1997) also conducted a series of studies addressing multimedia design. Like the aforementioned studies, they found displayed graphics (images and animation) improved user performance, specifically the recall of information. Based upon these studies, they developed the following guidelines. Provide sufficient *time* for reading screen graphic captions. Present simultaneously all visual and auditory *narrative information* to the user, or have the visual information precede the auditory narrative by no more than 7 seconds. To control the users' attention, *reveal* or expose information systematically on the screen, either from left to right or from top to bottom. Limit the information revealed to one item at a time, and sequentially reveal related elements. Finally, any *animation* must show an action being initiated as well as the action's result, and avoid any animation that distracts from other more important screen information.

Downloading times. Consider downloading times in choosing a graphical medium. In general, downloading times range from the fastest, audio, to the slowest, video.

Testing. Thoroughly test all graphics for *legibility*. Make sure visual graphics are easy to see from a variety of viewing distances. Also test them for *comprehensibility*. Are visual graphics and related audio clear and understandable? Are the graphics *acceptable* to the using audience? This is especially critical if the users are multicultural. Always test graphics with all representative user groups. Testing methods are described in more detail in Step 14.

Step 11 Exercise

An exercise for Step 11 can be found on this book's companion Website, www.wiley.com/college/galitz.

STEP

12

Choose the Proper Colors

Color adds dimension, or realism, to screen usability. Color draws attention because it attracts a person's eye. If used properly, it can emphasize the logical organization of information, facilitate the discrimination of screen components, accentuate differences among elements, and make displays more interesting and attractive. If used improperly, color can be distracting and possibly visually fatiguing, impairing the system's usability. This step will discuss

- Color's characteristics.
  - What color is.
  - The uses of color.
  - Possible problems and cautions when working with color.
  - Color connotations.
  - The results of color research.
  - Color and human vision.
- How to use color.
- How to choose the proper colors for textual graphic screens.
- How to choose the proper colors for statistical graphics screens.
- How to choose the proper color for Web screen text and images.

Effective use of color in screen design has taken great steps forward in the last four decades. Earlier text-based displays could only present a few colors, and many of the colors were not very legible. Color was often overused in combinations that reminded

one more of a Christmas tree than of an effective source of communication. The evolution to graphical screens expanded the use of color, but did not immediately eliminate some of the color problems. Today, because technology has improved, as well as our understanding of what constitutes good design, colors in screens are being used much more effectively. Pastels have replaced bright reds and dark blues, and the number of colors presented at one time on a screen has been reduced, dramatically in some cases. This is not to say, however, that all the problems have been solved. A tour around the office will usually uncover some questionable, or awful, uses of color. Two of the most common problems are screen backgrounds being more attention-grabbing than the screen data (which is the most important element of a screen), and overuse of color as a graphic language or code (the color itself meaning something to the screen viewer). This latter kind of use forces the user to interpret a color's meaning *before* the message it is communicating can be reacted to.

In recent years, the development of the Web and the availability of monitors with significantly-expanded color capability have initiated a replay of the early color-use problems that surfaced in both text-based and graphical systems. Infatuated with the almost unlimited supply of available colors, developers have eagerly raced to include a multitude of colors on Web pages, with too-little thought given to the consequences for users. The Christmas tree effect has lived on as users struggled with illegible text and numerous visual distractions. Today, the use of color in Web pages has improved somewhat. Too many site designers still, however, associate good design with splashy color.

The discussion to follow begins by defining color. Next is a review of how color may be used in screen design and some critical cautions on its use. Then, the human visual system and its implications for color are discussed. Continuing, a series of general screen guidelines are presented for choosing and using colors. This is followed by a compilation of guidelines for specific kinds of screens: textual and graphical, statistical graphics, and Web screens and their associated graphical elements.

Color — What Is It?

Wavelengths of light themselves are not colored. What is perceived as actual color results from the stimulation of the proper receptor in the eye by a received light wave. The name that a color is given is a learned phenomenon, based on previous experiences and associations of specific visual sensations with color names. Therefore, a color can only be described in terms of a person's report of his or her perceptions. The visual spectrum of wavelengths to which the eye is sensitive ranges from about 400 to 700 millimicrons. Objects in the visual environment often emit or reflect light waves in a limited area of this visual spectrum, absorbing light waves in other areas of the spectrum. The dominant wavelength being seen is the one that we come to associate with a specific color name. The visible color spectrum and the names commonly associated with the various light wavelengths are shown in Table 12.1.

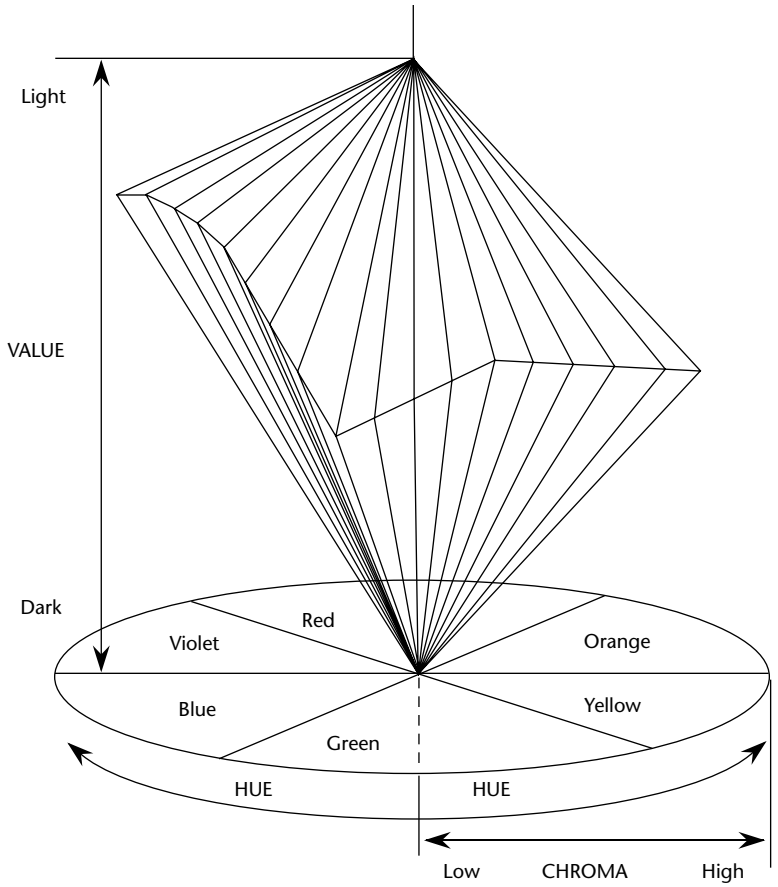

Figure 12.1: The relationship of hue, chroma, and value.

Table 12.1: The Visible Spectrum

APPROXIMATE COLOR WAVELENGTHS IN MILLIMICRONS	
Red	700
Orange	600
Yellow	570
Yellow-green	535
Green	500
Blue-green	493
Blue	470
Violet	400

To describe a color, it is useful to refer to the three properties it possesses: hue, chroma or saturation, and value or intensity, as illustrated in Figure 12.1. *Hue* is the spectral wavelength composition of a color. It is to this we attach a meaning such as green or red. *Chroma* or *saturation* is the purity of a color in a scale from gray to the most vivid version of the color. The more saturated a hue is, the more visible it is at a distance. The less saturated, the less visible it is. *Value* or *intensity* is the relative lightness or darkness of a color in a range from black to white. Two-word descriptors, such as light red or dark blue, are usually used to describe lightness differences. Some hues are inherently lighter or darker than others, for example, yellow is very light and violet is very dark.

The primary colors of illuminated light are red, green, and blue, whose wavelengths additively combine in pairs to produce magenta, cyan, and yellow, and all the other visible colors in the spectrum. The three primary colors additively combine to produce white. The long-wavelength colors (red) are commonly referred to as warm, and short-wavelength colors (blue) as cool.

Color, then, is a combination of hue, chroma, and value. In any one instance what we call "blue" may actually be one of several hundred thousand "blues." This problem has confounded color research over the years. A blue may be unacceptable in one situation because it is highly saturated and dark, but perfectly acceptable in another, being less saturated and light. The exact measures of a color are rarely reported in the literature.

Colors appearing on a computer screen are only a small portion of the colors visible to the human eye. Therefore, accurate color reproduction of the real world is impossible. Differences may also exist between different monitors. These differences can cause problems for some applications. There are also differences between color presentation on a screen and on a paper. Paper versions can appear more vibrant and real.

RGB

Many color monitors use the three primary colors of light, in various combinations, to create the many colors we see on screens. By adjusting the amounts of red, green, and blue light presented in a pixel, millions of colors can be generated. Hence, color palette editors exist with labels R, G, and B (or the words spelled out).

HSV

Some palette editors use a convention based on the Munsell method of color notation called HSV, for hue, saturation, and value (or HSL for hue, saturation, and lightness). Again, various combinations produce different colors.

Dithering

The eye is never steady, instead trembling slightly as we see. If pixels of different colors are placed next to each other, this tremor combines the two colors into a third color. This is referred to as *dithering*, and sometimes *texture mapping*. Taking advantage of this phenomena, an optical illusion, a third color can be created on a screen. Dithering

is often used to create a gray scale when only black and white pixels are available to work with. A difference of opinion exists on whether dithering should, or should not, be used on a screen.

In systems containing large palettes of colors, the color-mixing process a computer goes through when it encounters a color not in its palette is also called dithering. In this process, palette colors are mixed to approximate the appearance of the desired color.

Color Uses

- Use color to assist in formatting a screen
  - — Relating or tying elements into groupings.
  - — Breaking apart separate groupings of information.
  - — Associating information that is widely separated on the screen.
  - — Highlighting or calling attention to important information by setting it off from the other information.
- Use color as a visual code to identify
  - — Screen components.
  - — The logical structure of ideas, processes, or sequences.
  - — Sources of information.
  - — Status of information.
- Use color to
  - — Realistically portray natural objects.
  - — Increase screen appeal.

Color may be used as a formatting aid in structuring a screen, or it may be used as a visual code to categorize and identify information or data. It may also be used to portray objects naturally and make a screen more appealing to look at.

Color as a Formatting Aid

As a formatting aid, color can provide better structure and meaning to a screen. It can help users understand what does and does not go together. Research has found that people find it difficult to ignore the grouping principle of color similarity. It has a stronger perceptual influence than proximity or grouping (Beck and Palmer, 2002).

Color is especially useful when large amounts of information must be included on a screen and spacing to differentiate components is problematic. For example, displaying groupings of information in different colors can enhance differentiation of the groupings. Spatially separated but related fields can also be tied together through a color scheme.

Color can also replace highlighting as a means of calling attention to information. Color is much more flexible than other techniques because of the number of colors that are available. Color, as an attention-getting mechanism must, however, be chosen in light of the psychological and physiological considerations to be described shortly.

Color as a Visual Code

A color code indicates what category the information being displayed falls into. It has meaning to the screen's user. A properly selected color-coding scheme permits a person to identify a relevant information category quickly, without having to read its contents first. This permits focusing on this category, while the remaining information is excluded from attention.

One past common color-coding scheme used to differentiate screen components was to display screen captions and data in different colors. Another is to identify information from different sources — information added to a process from different locations, or text added to a message from different departments, may be colored differently. Using color-coding to convey status might involve displaying, in a different color, information that passed or failed system edits. Color can also be used as a prompt, guiding a person through a complex transaction.

To be effective, color as a visual code must be relevant and known. Relevance is achieved when the color enables a person to attend to only the information that is needed, and easily exclude that which is not needed. A relevant code, however, will be useless unless it's meaning is also understood by the person who must use it. If a color's meaning is not known, one must first interpret its meaning. This can place burdens on a person's memory. It can also impede performance, requiring one to consult a manual or a legend in order to understand it.

Other Color Uses

Color can also be used to more realistically portray objects in the world around us that must be displayed on a screen. It is also thought that the addition of color increases a screen's appeal and makes working with a display more pleasant.

Possible Problems with Color

The simple addition of color to a screen will not guarantee improved performance. What may have been a poorly designed product will simply become a colorful poorly designed product. When used improperly, color may even impair performance by distracting the viewer and interfering with the handling of information. Possible problems may be caused by the perceptual system itself, the physiological characteristics of the human eye, and user expectancies.

High Attention-Getting Capacity

Color has an extremely high attention-getting capacity. This quality causes the screen viewer to associate, or tie together, screen elements of the same color, whether or not such an association should be made. A person might search for relationships and differences that do not exist, or that are not valid. The result is often bewilderment, confusion, and slower reading. The effect achieved is often described as the Christmas tree mentioned earlier.

Interference with Use of Other Screens

Indiscriminate or poor use of color on some screens will diminish the effectiveness of color on other screens. The rationale for color will be difficult to understand and its attention-getting capacity severely restricted.

Varying Sensitivity of the Eye to Different Colors

All colors are not equal in the eye of the viewer. The eye is more sensitive to those in the middle of the visual spectrum (yellow and green), which appear brighter than those at the extremes (blue and red). Thus, text composed of colors at the extremes is thought to be more difficult to read. Research evidence on this topic is mixed. Several studies have found that acuity, contrast sensitivity, target recognition, legibility, and performance were not influenced by color. On the other hand, other studies have found advantages for central spectral colors in reaction times, resolution, and error rates.

Also, it is thought that some combinations of screen colors can strain the eye's accommodation mechanism. The wavelengths of light that produce blue are normally focused in front of the eye's retina, the red wavelengths behind it. Simultaneous or sequential viewing of red and blue causes the eye to continually refocus to bring the image directly onto the retina, thereby increasing the potential for eye fatigue. Again, the research evidence is mixed. Some studies have found this a problem while others have not.

What does one conclude after looking at the research addressing the aforementioned problems? The reasonable assumption is that they have neither been proved nor disproved. We have not properly defined all the screen-based tasks being performed, and the exact qualities of the colors being studied. Also, the studies have used only a few of the many devices in existence. And, a firm definition of "visual fatigue" remains elusive. Finally, none of the studies have addressed extended screen viewing. The prudent course is to be cautious and avoid using colors and combinations that color theory suggests can create problems.

The perceived appearance of a color is also affected by a variety of other factors, including the size of the area of color, the ambient illumination level, and other colors in the viewing area. Also, larger changes in wavelength are needed in some areas of the visual spectrum for a color change to be noticed by the eye. Small changes in extreme reds and purples are more difficult to detect than small changes in yellow and blue-green. Failure to consider the eye and how it handles color, then, can also lead to mistakes in color identification, misinterpretations, slower reading, and, perhaps, visual fatigue.

Color-Viewing Deficiencies

Another disadvantage of color is that about 8 percent of males and 0.4 percent of females have some form of color-perception deficiency—color blindness, as it is commonly called. In actuality, very few people are truly color-blind; most of those with problems simply have difficulties discriminating certain colors. A red viewing deficiency is called

protanopia, a green deficiency is called *deuteranopia*, and a blue deficiency is called *tritanopia*. These common color deficiencies, their results, and the percentage of people who experience these problems, are summarized in Table 12.2. Total color blindness affects no more than 0.005 percent of both sexes. For an individual with color-perception deficiency, all the normal colors may not be discernible, but often differences in lightness or intensity can be seen. The important point: A person experiencing any form of color deficiency must not be prohibited from effectively using a screen.

Color Connotations

Human reactions to colors are formed in many ways. They may be due to color associations learned in childhood or to how color has been consistently applied to objects and entities in the environment around us. As a result, colors have developed certain meanings to people in certain situations, either personally in a discipline, or in a culture. A color used in an unexpected way can cause confusion. An error signaled in green would contradict the expected association of red with stop or danger. The same color may also have a different connotation, in the eyes of its viewer. Some common color connotations are presented in Table 12.3. This Table is based upon Gotz (1998) and Stone et al. (2005).

Table 12.2: Results of Color-Defective Vision

	COLOR SEEN WITH:		
	RED-VIEWING	GREEN-VIEWING	BLUE-VIEWING
ACTUAL COLOR	DEFICIENCY (2.04%)	DEFICIENCY (6.39%)	DEFICIENCY (0.003%)
Red	Brown	-	-
Yellow	Greenish-Yellow	Orange	Deeper Yellow
Purple	Dark Blue	Red	Deep Red
Green	-	Light Brown	-
Brown	-	Reddish-Brown	-
Blue	-	-	Green

From Barnett (1993); Fowler and Stanwick (1995).

Table 12.3: Common Color Connotations

COLOR	POSITIVE	NEGATIVE
Red	Active Attractive Dominating Exciting Invigorating Powerful Strong	Aggressive Alarming Energetic

Table 12.3 *(continued)*

COLOR	POSITIVE	NEGATIVE
Blue	Abstinent Controlled Deep Dreamy Faithful Harmonious Intellectual Mysterious Pornography Rational Sensible Tenderness	Aggressive Cold Introverted Melancholic
Blue-green or Turquoise	Refreshing	Aloof Cold Self-willed Sterile Unemotional
Green	Calm Close to nature Conciliatory Gentle Harmonious Optimistic Refreshing Strong willed	Envious Inexperienced Jealous
Yellow	Cheerful Colorful Extroverted Full of fun Light Lively Youthful	Cowardly Exaggerated Superficial Vain
Orange	Alive Communicative Direct Exciting Joyful Warm	Cheap Intimate Possessive Vigorous
Purple	Luxurious Royal Serious	Sad

Derived from Gotz (1998) and Stone et al. (2005).

Cross-Disciplinary and Cross-Cultural Differences

Disciplinary-wise, the color blue has the following quite different meanings:

- For financial managers — Corporate qualities or reliability.
- For health care professionals — Death.
- For nuclear reactor monitors — Coolness or water.
- For American movie audiences — Tenderness or pornography.

Differences in color connotations also exist between cultures. Red, for example, in the United States, is associated with danger, in Egypt with death, and in India with life. Incorrect use in a different culture may cause severe problems. A listing of some common cultural associations with color can be found in Table 10.2 in Step 10.

Color appeal is also subjective. People have different tastes in color, what is pleasing to one person may be distasteful or unusable by someone else.

The proper use of color, then, requires an analysis of the expectations and experiences of the screen viewer. The use of color in design must always keep these possible problems clearly in focus. The designer must work to minimize their disruptive and destructive effects.

MAXIM **Poor use of color is worse than not using it at all.**

Color — What the Research Shows

The effectiveness of color in improving the usability of a display has been studied for many years. The research results have been mixed. To illustrate, on a positive note, color has been shown to improve performance (Kopala, 1981; Nagy and Sanchez, 1992; Sidorsky, 1982), to improve visual search time (Christ, 1975; Carter, 1982), to be useful for organizing information (Engel, 1980), to aid memory (Marcus, 1986b), and to demarcate a portion of a screen (as opposed to lines or type font, Wopking et al., 1985). Color has also created positive user reactions (Tullis, 1981), was preferred to monochromatic screens for being less monotonous and reducing eyestrain and fatigue (Christ, 1975), and is more enjoyable (Marcus, 1986b).

On the other hand, it has also been shown that color does not improve performance (Tullis, 1981), does not have much of an effect on reading text (Legge and Rubin, 1986), may impair performance (Christ and Teichner, 1973; Christ, 1975), and is less important than display spacing (Haubner and Benz, 1983). It has also been demonstrated that poor character-background color combinations lead to poorer performance (McTyre and Frommer, 1985). Finally, no evidence has been produced that color, as compared to black and white, can significantly improve aesthetics or legibility or reduce eyestrain (Pastoor, 1990).

Research has found, moreover, that as the number of colors on a display increases, the time to respond to a single color increases, and the probability of color confusion increases (Luria et al., 1986). Many studies have found that the maximum number of colors that a person can handle is in the range of 4 to 10, with emphasis on the lower numbers (for example, Brooks, 1965; Halsey and Chapanis, 1951; Luria et al., 1986).

The conclusion to be derived from these studies is that for simple displays, color may have no dramatic impact. Indeed, a monochromatic display may serve the purpose just as well. As display complexity increases, however, so does the value of color. A second conclusion is that people like using color and think it has a positive influence on their productivity, even though it may not.

To be effective, color must be properly used. Poor use of color will actually impair performance, not help it. When using color, keep in mind its value will be dependent upon the task being performed, the colors selected, the number of colors used, and the viewing environment.

Color and Human Vision

To understand how color should be used on a screen, it is helpful to know something of the physiology of the human eye.

The Lens

Muscles control the lens of the eye. These muscles focus received wavelengths of light on the retina. The lens itself is not color corrected. The wavelengths of light that create different colors are focused at different distances behind the lens, the longer wavelengths (red) being focused farther back than the shorter wavelengths (blue). The result is that colors of a different wavelength from the color actually being focused by the lens will appear out of focus. To create a sharp image of the out-of-focus colors requires a refocusing of the eye. Excessive refocusing (such as between red and blue) can lead to eye fatigue.

The effect of this focusing for most people is that blues appear more distant and reds appear closer. This can give a three-dimensional appearance to what is being viewed. A critical problem is that the wavelength of light that creates blues can never be brought into focus on the retina but is always focused in front of it. A sharp blue image is impossible to obtain. Very pure or saturated colors require more refocusing than less pure or unsaturated colors. Therefore, a color with a large white component will require less refocusing.

The lens does not transmit all light wavelengths equally. It absorbs more wavelengths in the blue region of the spectrum than those in the other regions. Additionally, as the lens ages, it tends to yellow, filtering out the shorter blue wavelengths. Thus, as people get older, their sensitivity to blue decreases. The lens also refocuses for light waves of different brightness. Sharp contrasts in brightness in things being viewed can lead to visual fatigue as the eye continually makes muscular adjustments. Driving an automobile through a forest of trees on a bright sunny day illustrates this effect. The eye continually adjusts as the auto sequentially moves through areas of bright sunlight and patches of shadows.

The Retina

The retina is the light-sensitive surface of the eye. It comprises two kinds of receptors, rods and cones, which translate the incoming light into nervous impulses. Rods are

sensitive to lower light levels and function primarily at night. Cones are stimulated by higher light levels and react to color. The sensitivity of cones to colors varies, different cones possessing maximum sensitivity to different wavelengths of light. About two-thirds (64 percent) of the cones are maximally sensitive to longer light wavelengths, showing a peak response at about 575 millimicrons. These cones have traditionally been referred to as "red" sensitive cones. In actuality, however, the peak sensitivity is in the yellow portion of the visual spectrum (see Table 12.1). About one-third (32 percent) of the cones achieve maximum sensitivity at about 535 millimicrons and are commonly referred to as "green" sensitive cones. The remainder (2 percent) primarily react to short light wavelengths, achieving maximum sensitivity at about 445 millimicrons. These are known as "blue" sensitive cones. Any light wave impinging on the retina evokes a response, to a greater or lesser degree, from most or all of these cones. A perceived color results from the proportion of stimulation of the various cone kinds.

Rods and cones vary in distribution across the retina. The center is tightly packed with cones and has no rods. Toward the periphery of the retina, rods increase and cones decrease. Thus, color sensitivity does not exist at the retina's outer edges, although yellows and blues can be detected further into the periphery than reds and greens. The very center of the retina is devoid of blue cones, creating a "blue-blindness" for small objects being looked at.

The receptors in the eye also adjust, or adapt, their level of sensitivity to the overall light level and the color being viewed. Adaptation to increases in brightness improves color sensitivity. Color adaptation softens colors.

The brightness sensitivity of the eye to different colors also varies. It is governed by output from the red and green cones. The greater the output, the higher the brightness, which results in the eye being most sensitive to colors in the middle of the visual spectrum and less sensitive to colors at the extremes. A blue or red must be of a much greater intensity than a green or yellow even to be perceived.

The ability of the eye to detect a form is accomplished by focusing the viewed image on the body of receptors to establish edges. Distinct edges yield distinct images. Edges formed by color differences alone cannot be accurately brought into focus and thus create fuzzy and indistinct images. A clear, sharp image requires a difference in brightness between adjacent objects, as well as differences in color.

The components of the eye — the lens and retina — govern the choices, and combinations, of colors to be displayed on a screen. The proper colors will enhance performance; improper colors will have the opposite effect, as well as increase the probability of visual fatigue.

MYTH **If we can't do it right, do it big. If we can't do it big, do it in color.**

Choosing Colors

When choosing colors for display, one must consider these factors: the human visual system, the possible problems that the colors' use may cause, the viewing environment in which the display is used, the task of the user, how the colors will be used, and

the hardware on which the colors will be displayed. The primary objective in using color is communication, to aid the transfer of information from the screen to the user.

Choosing Colors for Categories of Information

- Choosing colors for categories of information requires a clear understanding of how the information will be used. Some examples:
  - — If different parts of the screen are attended to separately, color-code the different parts to focus selective attention on each in turn.
  - — If decisions are made based on the status of certain types of information on the screen, color-code the types of status that the information may possess.
  - — If screen searching is performed to locate information of a particular kind or quality, color-code these kinds or qualities for contrast.
  - — If the sequence of information use is constrained or ordered, use color to identify the sequence.
  - — If the information displayed on a screen is packed or crowded, use color to provide visual groupings.
- Use color as a redundant screen code.

Categories. Color chosen to organize information or data on a screen must aid the transfer of information from the display to the user. This requires a clear understanding of how the information is selected and used. The examples above describe some common ways of classifying information for color-coding purposes.

Redundancy. Never rely on color as the only way of identifying a screen element or process. Users with a color-viewing deficiency may not be able identify a specific color when it is important. It is also important to remember that information on one screen may be used in more than one way. What is useful in one context may not be in another and may only cause interference. Therefore, when developing a color strategy, always consider how spatial formatting, highlighting, and messages may also be useful and employ these structural and coding methods as well.

Colors in Context

Colors are subject to contextual effects. The size of a colored image, the color of images adjacent to it, and the ambient illumination all exert an influence on what is actually perceived. At the normal viewing distance for a screen, maximal color sensitivity is not reached until the size of a colored area exceeds about a 3-inch square. Smaller images become desaturated (having a greater white component) and change slightly in color. Also, small differences in actual color may not be discernible. Blues and yellows are particularly susceptible to difficulties in detecting slight changes. Finally, small adjacent colored images may appear to the eye to merge or mix. Red and green, for example, might appear as yellow.

Adjacent images can influence the perceived color. A color on a dark background will look lighter and brighter than the same color on a light background, for example. A color can be *induced* into a neutral foreground area (gray) by the presence of a colored background. A red background can change a gray into a green. Induced colors are the complement of the inducing color. Looking at a saturated color for a period of time can also induce complementary afterimages. Colors also change as light levels change. Higher levels of ambient light tend to desaturate colors. Saturated colors will also appear larger than desaturated colors.

Usage

- Design for monochrome first.
- Use colors conservatively.
  — Do not use color where other identification techniques, such as location, are available.

Monochrome. Design for monochrome first, or in shades of black, white and gray. A screen should be as capable of being effectively used as if it were located in a monochrome environment. Spatial formatting, consistent locations, and display techniques such as highlighting and multiple font styles, should all be utilized to give information a structure independent of the color. Doing this will permit the screen to be effectively used

- By people with a color-viewing deficiency.
- On monochrome displays.
- In conditions where ambient lighting distorts the perceived color.
- If the color ever fails.

Conservative Use. Use color sparingly because it has such a high attention-getting quality. Only enough colors to achieve the design objective should be used. More colors increase response times, increase the chance of errors due to color confusion, and increase the chance of the Christmas tree effect. If two colors serve the need, use two colors. If three colors are needed, by all means use three. A way to minimize the need for too many colors is not to use color in situations where other identification methods are available. A menu bar, for example, will always be located at the top of the screen. Its position and structure will identify it as a menu bar. To color-code it would be redundant.

Discrimination and Harmony

- For best absolute discrimination, select no more than four or five colors widely spaced on the color spectrum.
  — Good colors: red, yellow, green, blue, and brown.

- For best comparative discrimination, select no more than six or seven colors widely spaced on the color spectrum.
  — Other acceptable colors: orange, yellow-green, cyan, violet, and magenta.
- Choose harmonious colors.
  — One color plus two colors on either side of its complement.
  — Three colors at equidistant points around the color circle.
- For extended viewing or older viewers, use brighter colors.

Absolute discrimination. The population of measurable colors is about 7.5 million. From this vast number, the eye cannot effectively distinguish many more than a handful. If color memorization and absolute discrimination is necessary (a color must be correctly identified while no other color is in the field of vision), select no more than four to five colors widely spaced along the color spectrum. Selecting widely spaced colors will maximize the probability of their being correctly identified. Good choices are red, yellow, green, blue, and brown.

Two good color opponent pairs are red/green and yellow/blue. All of these colors except blue are easy to resolve visually. Again, be cautious in using blue for data, text, or small symbols on screens because it may not always be legible. If the meaning for each of more than five colors is absolutely necessary, a legend should be provided illustrating the colors and describing their associated meanings.

Comparative discrimination. If comparative discrimination will be performed (a color must be correctly identified while other colors are in the field of vision), select no more than six or seven colors widely spaced along the visual spectrum. In addition to those above, other colors could be chosen from orange, yellow-green, cyan, violet, and magenta. Again, be cautious of using blue for data, text, or small symbols. If the intent is to portray natural objects realistically, the use of more colors is acceptable.

Harmony. Choose harmonious colors. Harmonious colors are those that work well together or meet without sharp contrast. Harmony is most easily achieved with a monochromatic palette. For each background color, different lightness or values are established through mixing it with black and white. Marcus (1986a) suggests a minimum of three values should be obtained.

Harmonious combinations in a multicolor environment are more difficult to obtain. Marcus recommends avoiding complementary colors — those at opposite sides of the circle of hues in the Munsell color system, a standard commercial color system. He suggests using split complements, one color plus two colors on either side of its complement, or choosing three colors at equidistant points around the color circle.

Extended viewing. For older viewers or extended viewing, use bright colors. As eye capacity diminishes with age, data, text, and symbols in the less-bright colors may be harder to read. Distinguishing colors may also become more difficult. For any viewer, long viewing periods result in the eye adapting to the brightness level. Brighter colors will be needed if either of these conditions exists.

Emphasis

- To draw attention or to emphasize elements, use bright or highlighted colors. To deemphasize elements, use less bright colors.
  — The perceived brightness of colors from most to least is white, yellow, green, red, blue.
- To emphasize separation, use contrasting colors.
  — Red and green, blue and yellow.
- To convey similarity, use similar colors.
  — Orange and yellow, blue and violet.

Drawing attention. To draw attention or emphasize, use bright colors. The eye is drawn to brighter or highlighted colors, so use them for the more important screen components. The data or text is the most important component on most screens, so it is a good candidate for highlighting or the brightest color. Danger signals should also be brighter or highlighted. The perceived brightness of colors, from most to least, is white, yellow, green, red, and blue. Contrasts in brightness should not be to extreme, however, because of the eye's inability to focus properly when two complementary saturated colors are used together. The result may be a perceived vibrating effect.

Also, keep in mind that under levels of high ambient illumination, colors frequently appear washed out or unsaturated. If some means of light attenuation is not possible, or if the colors chosen are not bright enough to counter the illumination, color should be used with caution.

Emphasizing separation. Use contrasting colors to emphasize separation. The greater the contrast, the better the visibility of adjacent elements. To emphasize the separation of screen components, use contrasting colors. Possible pairs would be red/green and blue/yellow.

Similarity. Use similar colors to convey similarity. Displaying elements in a similar color can bring related screen components together. Blue and green, for example, are more closely related than red and green.

Common Meanings

- To indicate that actions are necessary, use warm colors.
  — Red, orange, yellow.
- To provide status or background information, use cool colors.
  — Green, blue, violet, purple.
- Conform to human expectations.
  — In the job.
  — In the world at large.

Actions. The warm colors, red, yellow, and orange, imply active situations or that actions are necessary. Warm colors advance, forcing attention.

Status or background. The cool colors, green, blue, violet, and purple, imply background or status information. Cool colors recede or draw away.

Expectations. Conform to human expectations. Use color meanings that already exist in a person's job or the world at large. They are ingrained in behavior and difficult to unlearn. Some common color associations are the following:

- Red — Stop, fire, hot, danger.
- Yellow — Caution, slow, test.
- Green — Go, OK, clear, vegetation, safety.
- Blue — Cold, water, calm, sky, neutrality.
- Gray — Neutrality.
- White — Neutrality.
- Warm colors — Action, response required, spatial closeness.
- Cool colors — Status, background information, spatial remoteness.

Some typical implications of color with dramatic portrayal are

- High illumination — Hot, active, comic situations.
- Low illumination — Emotional, tense, tragic, melodramatic, romantic situations.
- High saturation — Emotional, tense, hot, melodramatic, comic situations.
- Warm colors — Active, leisure, recreation, comic situations.
- Cool colors — Efficiency, work, tragic and romantic situations.

Proper use of color also requires consideration of the experiences and expectations of the screen viewers.

Location

- In the center of the visual field, use red and green.
- For peripheral viewing, use blue, yellow, black, and white.
- Use adjacent colors that differ by hue and value or lightness.

Central vision. The eye is most sensitive to red and green in the center of the visual field. The edges of the retina are not sensitive to these colors. If used in the viewing periphery, some other attention-getting method such as blinking must also be used.

Peripheral vision. For peripheral viewing, use blue, yellow, black, or white. The periphery of the retina is most sensitive to these colors.

Adjacent colors. Colors that appear adjacent to one another should differ in hue and lightness for a sharp edge and maximum differentiation. Also, adjacent colors that differ only in their blue component should not be used so that differentiation is possible. The eye is poorly suited for dealing with blue.

Ordering

- Order colors by their spectral position.
  — Red, orange, yellow, green, blue, indigo, violet.

If an ordering of colors is needed, such as from high to low, by levels of depth, and so on, arrange colors by their spectral position. There is evidence that people see the spectral order as a natural one. The spectral order is red, orange, yellow, green, blue, indigo, and violet, most easily remembered as "ROY G. BIV."

Foregrounds and Backgrounds

- Foregrounds:
  — Use colors that highly contrast with the background color.
  — For text or data, use
    - Black.
    - Desaturated or spectrum center colors such as white, yellow, or green.
    - Warmer more active colors.
  — Use colors that possess the same saturation and lightness.
  — To emphasize an element, highlight it in a light value of the foreground color, pure white, or yellow.
  — To deemphasize an element, lowlight it in a dark value of the foreground color.
- Backgrounds:
  — Use a background color to organize a group of elements into a unified whole.
  — Use colors that do not compete with the foreground.
  — Use
    - Light-colored backgrounds of low intensity: off-white or light gray.
    - Desaturated colors.
    - Cool, dark colors such as blue or black.
    - Colors on the spectral extremes.

Foregrounds

Foreground colors should be as different as possible from background colors. A widely different foreground will maximize text legibility. With today's high-resolution monitors, the most recommended text color is black presented on a light-colored background of low intensity, either off-white or light gray. Bright white backgrounds should be avoided because of the harsh contrast between the dark text and the background.

Desaturated spectrum center colors, such white, yellow, or green, on dark backgrounds also work well. These colors do not excessively stimulate the eye and appear brighter to the eye. Saturated colors excessively stimulate the eye. Color theory also suggests using warmer, more active colors for foregrounds. Warmer colors advance, forcing attention. Exercise caution in using more fully saturated red and orange, however. They may be difficult to distinguish from one another.

Use foreground colors that possess the same saturation and lightness. Highlight elements in a light value of the foreground color. If off-white is the foreground color, highlight elements in pure white. Yellow can also be used to highlight elements. To deemphasize an element, lowlight it in a darker value of the foreground color. When lowlighting, a strong enough contrast with both the background and the non-lowlighted element must be maintained so that legibility and visual differentiation is possible.

The simultaneous use of highlighting and lowlighting should be avoided. Used together they may confuse the viewer. Also, as with other display techniques, be conservative in using highlighting and lowlighting, so that simplicity and clarity are maintained.

Backgrounds

A background color should organize a group of elements into a unified whole, isolating them from the remainder of the screen. Use colors that do not compete with the foreground. A background must be subtle and subservient to the data, text, or symbols on top of it.

As previously mentioned, with today's high-resolution monitors, the most-recommended background color is a low-intensity off-white or gray with black text. Pastoor (1990), in a study to be described shortly, also found that desaturated backgrounds in almost any color work well. Foreground colors must be chosen with consideration of the background color, however.

For dark backgrounds, use the cool, dark colors. Cool, dark colors visually recede, providing good contrast to the advancing lighter, foreground colors. Blue is especially good because of the eye's lack of sensitivity to it in the retina's central area and increased sensitivity to it in the periphery. Lalomia and Happ (1987), in a study to be described shortly, found the best background colors to be black and blue. In a similar study, Pastoor (1990) found that cool colors, blue and bluish cyan, were preferred for dark background screens.

Also consider colors at the extreme end of the color spectrum. Marcus (1986a) recommends, in order of priority, the following background colors: blue, black, gray, brown, red, green, and purple.

Three-Dimensional Look

- Use at least five colors or color values to create a 3-D look on a screen.
  - — Background: the control itself and the window on which it appears.
  - — Foreground: captions and lines for buttons, icons, and other objects.
    - Usually black or white.

— Selected mode: the color used when the item is selected.
— Top shadow: the bezel on the top and left of the control.
— Bottom shadow: the bezel on the bottom and right of the control.

At least five colors or color values are needed to create a three-dimensional look on a screen (Fowler and Stanwick, 1995): the backgrounds of the control and the surface on which it is placed, the foreground (captions, lines, and so on), the selected mode, and the top and bottom shadows of the controls. These shadows assume an upper-left light source. Motif has created an algorithm to automatically calculate the top and bottom shadows, and the select color based upon the background (Kobara, 1991). Briefly, it recommends the following:

- **Background.** Midrange colors, 155 to 175 on the RGB scale.
- **Foreground.** Black or white, depending on the lightness or darkness of the background.
- **Selected mode.** About 15 percent darker than the background color, halfway between the background and bottom shadow. (Calculate this by multiplying the background color's RGB value by 0.85.)
- **Top shadow.** About 40 to 50 percent brighter than the background color. (Calculate this by multiplying the background color's RGB by 1.50.)
- **Bottom shadow.** About 45 to 60 percent darker than the background color. (Calculate this by multiplying the background's RGB values by 0.50.)

One reminder: A raised look should be used only on operable controls.

Color Palette, Defaults, and Customization

- Permit users to customize their colors.
- Provide a default set of colors for all screen components.
- Provide a palette of six or seven foreground colors.
  — Provide two to five values or lightness shades for each foreground color.
- Provide a palette of six or seven background colors.
- Never refer to a screen element by its color.

Customization. Because color preference is subjective, permit users to customize their displayed colors. While little research has been performed on color customization, Familant and Detweiler (1995) have measured the frequency of color changes by users. Compared were displayed color combinations that were judged to be "good" or "poor." They found that users with the poorer color combinations changed their screen colors more often than those with good combinations. Color satisfaction for those with poor color combinations must be fleeting. When color customization is permitted, whenever possible allow users to see the results of their color choices before they are applied. Include a sample screen in a preview function within the customization process.

Default set. While some users experiment with different color combinations, many others take what is provided them and never attempt to change it. Actually, many people do not know how to apply color to create a clear and appealing screen. Others may have the talent and skills, but not the time to choose a proper combination. For these users, a preselected set of default colors should be developed for all screen elements.

Both the Macintosh and Microsoft Windows provide standard, well-thought-out color schemes. While thousands of colors may be available for display on a screen, most platforms recommend the use of restricted palettes. This is actually a good thing, reducing the probability of very poor color combinations and Christmas trees. Most Macintosh colors are subdued to avoid a circus effect on the screen (Apple, 1992b). Microsoft offers several predefined schemes, such as "Arizona."

Do not provide the color spectrum; limit the number of choices available. A maximum of six or seven foreground and background colors will provide the necessary variety. It is also worthwhile to note that two to five values or lightnesses for each foreground color should be developed.

With these palettes, however, some sort of guidance concerning maximum number of colors to use and what are good and poor combinations should be provided. Macintosh, for example, suggests that, if you create your own color schemes, colors compatible with the ones on the Color Control Panel be used. Guidelines will make the color selection process more efficient and reduce the likelihood of visually straining conditions developing.

Color reference. Finally, never refer to a screen element by its designed color. What was originally on the screen in yellow may not now be so on some users' screens.

Grayscale

- For fine discriminations use a black-gray-white scale.
  — Recommended values are white, light gray, medium gray, dark gray, black.

The perception of fine detail is poor with color. The eye resolves fine detail much better on a black-white scale. Marcus (1986b) recommends five tonal values for black and white, higher-resolution screens: black, dark gray, medium gray, light gray, and white. He suggests the following general uses:

White:	Screen background.
	Text located in any black area.
Light Gray:	Pushbutton background area.
Medium Gray:	Icon background area.
	Menu drop shadow.
	Window drop shadow.
	Inside area of system icons.
	Filename bar.
Dark gray:	Window border.

Black:	Text.
	Window title bar.
	Icon border.
	Icon elements.
	Ruled lines.

Motif presents the following scheme for designing windows in a grayscale (Kobara, 1991).

Background:	A 30 percent light gray (RGB 79, 79, 79).
Foreground:	White (RGB 0, 0, 0).
Selected mode:	A 70 percent dark gray (RGB 181, 181, 181).
Top Shadow:	White.
Bottom Shadow:	Black (RGB 255, 255, 255).

Grayscale values must differ by at least 20 to 30 percent (White, 1990).

Text in Color

- When switching text from black to color,
  — Double the width of lines.
  — Use bold or larger type.
    - If originally 8 to 12 points, increase by 1 to 2 points.
    - If originally 14 to 24 points, increase by 2 to 4 points.
- Check legibility by squinting at text.
  — Too-light type will recede or even disappear.

Text in color is not as visible as it is in black. Fowler and Stanwick (1995) report that the size of text has to be increased to maintain legibility when the text is switched from black to color. Lines should be doubled in width and type made larger or bolder. If the existing type ranges from 8 to 12 points, increase it 1 or 2 points. If the existing type ranges from 14 to 24 points, increase it by 2 to 4 points. They suggest that by squinting at it, you can check the legibility of type. A type that is too light will recede, or even disappear, from view.

Monochromatic Screens

- At the standard viewing distance, white, orange, or green are acceptable colors.
- At a far viewing distance, white is the best choice.
- Over all viewing distances, from near to far, white is the best choice.

Monochromatic, or one-color, screens are still occasionally found in graphical systems, most frequently on notebook PCs. In a study by Hewlett-Packard (Wichansky, 1986) white, orange, and green monochrome desktop display device screens were evaluated for performance and readability at various viewing distances. At the standard

screen viewing distance (18 to 24 inches), no performance differences were found between white, orange, and green phosphor in either polarity (light characters on a dark background, or dark characters on a light background). Subjective ratings of ease of reading were highest for green and orange light-background screens as compared to dark-background screens, while no differences in ease of reading were found for either polarity with white phosphor at this distance. At a far viewing distance (4 to 5 feet), orange and green light-background screens could be seen more clearly than dark-background screens, while white screens were equally legible in either polarity. More errors were found with green than the other two colors.

A green screen yielded red or pink afterimages for 35 percent of the screen viewers; orange, blue afterimages for 20 percent; white yielded afterimages for 5 percent. A 35 percent pink afterimage rate for green screen viewing was also found by Galitz (1968).

Some conclusions:

- At standard viewing distances, no significant performance differences exist for white, orange, or green. All are acceptable. Subjective preferences may vary, however, so providing the viewer a choice of any of these colors is desirable.
- At far viewing distances, white is the more legible color and therefore the best choice.
- For all viewing distances, white is the best choice.
- White has the lowest probability for creating visual afterimages.

Consistency

- Be consistent in color use.

Consistency in color usage should exist within a screen, a set of screens, and a system. A person can sense the relatedness of color in space and over time, thereby linking elements not seen immediately together. An identical background color in windows on different screens, for example, will be seen as related. Changing specific color meanings must be avoided. It will lead to difficulties in interpretation, confusion, and errors. In general, broadly defined meanings (such as red indicating a problem) permit more scope for variations without inconsistency.

Considerations for People with Color-Viewing Deficiencies

- Use color combinations that can be easily discriminated.
- Ensure that the lightness contrast between foreground colors is high.
- Increase the lightness contrast between colors on either end of the visual spectrum (blues and reds).
- Avoid combining light colors from either end of the spectrum with dark colors from the middle of the spectrum.
- Use tools to see what screens or pages will look like to color deficient viewers.

Also consider people with a color-viewing deficiency. If color is used as a code, it must be recognizable by all users. It is best to use color as a supplement to other coding methods such as location, size, or element orientation. Colors chosen must also be legible. An adequate contrast between foreground and background, and different colors, must be maintained. Proper combinations must also be used. See Table 12.2 for a summary of problem-creating colors for people with defective color vision. All colors chosen should be reviewed with the proper tool to verify what they will look like, and that they are acceptable to color-deficient viewers.

Cultural, Disciplinary, and Accessibility Considerations

- Consider the impact of specific colors on
  - — Users of various cultures.
  - — Users of various disciplines.
  - — Users relying on accessibility utilities.

As previously described, colors may possess different meanings and interpretations in different cultures and disciplines. Where applicable, color choices for screen elements should reflect these differences and not be offensive. See Table 10.2 in Step 10 for a summary of some cultural color differences. Colors chosen should also consider the impact of users relying on accessibility utilities. Some utilities, such as the Magnifier accessory included with Windows, alter the colors displayed on a screen.

Choosing Colors for Textual Graphic Screens

For displaying data, text, and symbols on a textual graphical screen (as opposed to statistical graphics screens to be described shortly) colors selected should have adequate visibility, meaning, contrast, and harmony.

- Use effective foreground/background combinations.
- Use effective foreground combinations.
- Choose the background color first.
- Display no more than four colors at one time.
- Use colors in toolbars sparingly.
- Test the chosen colors.

Effective Foreground/Background Combinations

Lalomia and Happ (1987) established effective foreground/background color combinations for the IBM 5153 Color Display. From a color set of 16 different foregrounds and 8 different backgrounds, 120 color combinations were evaluated for (1) response time to identify characters, and (2) subjective preferences of users. The results from each measure were ranked and combined to derive an overall measure of color combination

effectiveness. The best and poorest color combinations are summarized in Table 12.4. In this table "Good" means the specified combination was in the top 20 percent for overall effectiveness; "Poor" means it was in the bottom 20 percent. Those combinations composing the "middle" 60 percent are not marked.

The results yield some interesting conclusions:

- The majority of good combinations possess a bright or high-intensity color as the foreground color.
- The majority of poor combinations are those with low contrast.
- The best overall color is black.
- The poorest overall color is brown.
- Maximum flexibility and variety in choosing a foreground color exists with black or blue backgrounds. (These backgrounds account for almost one-half of the good combinations.)
- Brown and green are the poorest background choices.

Table 12.4: Effective Foreground/Background Combinations

	BACKGROUND							
FOREGROUND	BLACK	BLUE	GREEN	CYAN	RED	MAGENTA	BROWN	WHITE
BLACK	x			Good		Good		Good
BLUE		x			Poor			Good
H.I. BLUE			Poor	Poor			Poor	Poor
CYAN	Good		Poor	x			Poor	
H.I. CYAN	Good	Good		Good	Good	Good		
GREEN	Good	Good	x	Poor	Good		Poor	Poor
H.I. GREEN		Good						
YELLOW	Good	Good		Good		Good		
RED			Poor		x	Poor	Poor	
H.I. RED			Poor					
MAGENTA			Poor		Poor	x	Poor	
H.I. MAGENTA	Good		Good			Poor		
BROWN			Poor			Poor	x	
GRAY		Poor			Poor		Poor	
WHITE		Good		Poor				x
H.I. WHITE	Good		Good	Good				

(H.I. = High Intensity)
From Lalomia and Happ (1987).

Bailey and Bailey (1989), in their screen creation utility Protoscreens, had a table summarizing research-derived good foreground/background combinations. This table, which uses the results of the Lalomia and Happ study plus some others, is shown in modified form in Table 12.5.

The preceding studies referenced did not control character-background luminance-contrast ratios. Because of the characteristics of the eye, some colors appear brighter to it than others. A conclusion of the Lalomia and Happ study was that good combinations usually possessed a bright or high-intensity foreground color.

Pastoor (1990) equalized luminance-contrast ratios at preoptimized levels for about 800 foreground/background color combinations. For light foregrounds and dark backgrounds, the ratio was 10:1; for light backgrounds and dark foregrounds, 1:6.5. He then had the combinations rated with the following results:

- For dark on light polarity:
  - Any foreground color is acceptable if the background color is chosen properly.
  - Increased saturation of the foreground only marginally affected ratings, implying that any dark, saturated, foreground color is satisfactory.
  - Saturated backgrounds yield unsatisfactory ratings.
  - Less saturated backgrounds generally receive high ratings with any foreground color.
- For light on dark polarity:
  - Combinations involving saturated colors tend to be unsatisfactory.
  - As foreground color saturation increases, the number of background colors yielding high ratings diminishes.
  - Generally, desaturated foreground/background color combinations yielded the best ratings.
  - Short wavelength, cool colors were preferred for backgrounds (blue, bluish cyan, cyan).

In general, Pastoor concluded that: (1) There was no evidence suggesting a differential effect of color on subjective ratings or performance (except that for light on dark polarity, blue, bluish cyan, or cyan were preferred as backgrounds), and (2) overall, desaturated color combinations yielded the best results.

Table 12.5: Preferred Foreground/Background Combinations

BACKGROUNDS	ACCEPTABLE FOREGROUNDS	
Black	Dark Cyan	Light Green
	Dark Yellow	Light Cyan
	Dark White	Light Magenta
		Light Yellow
		Light White

Table 12.5 *(continued)*

BACKGROUNDS	ACCEPTABLE FOREGROUNDS	
Blue	Dark Green Dark Yellow Dark White	Light Green Light Cyan Light Yellow Light White
Green	Black Dark Blue	Light Yellow Light White
Cyan	Black Dark Blue	Light Yellow Light White
Red		Light Green Light Cyan Light Yellow Light White
Magenta	Black	Light Cyan Light Yellow Light White
Yellow	Black Dark Blue Dark Red	
White	Black Dark Blue	

Choose the Background First

When choosing colors to display, it is best to select the background color first. Then, choose acceptable foreground colors.

Maximum of Four Colors

While not experimentally verified, experience indicates that displaying more than four colors at one time on a textual screen gives rise to a feeling of "too much." Marcus (1986a) suggests an even more conservative approach, a maximum of three foreground colors and, even better, only two. An application of good use of color can often be viewed in one's living room. Note the use of color by the television networks when textual or tabular information is presented (for example, sport scores, news highlights, and so on). The use of only two, or sometimes three, colors is most commonly seen.

So, while more than four colors may be displayed over a period of time or on a series of screens, do not display more than four colors at one time on a single screen. For most cases, restrict the number of colors to two or three.

Use Colors in Toolbars Sparingly

Toolbar icons are usually small in size. Presenting them in color is rarely useful, most often disrupting legibility. Use color in toolbar icons simply and conservatively, and only if the color aids icon identification, makes it easier to distinguish icons, or adds meaning. A file folder in yellow or a "stop" icon in red are examples of good uses of color.

Test the Colors

Because color is such a complex phenomenon, because definitions of a color can vary, and because the hardware on which a color is used can affect its look, always test all chosen colors as part of the system testing process (see Step 14).

Choosing Colors for Statistical Graphics Screens

The visual, spatial, or physical representation of information — as opposed to numeric, alphanumeric, textual, or symbol representation — is known as statistical or data graphics. Common kinds of statistical graphics include bar graphs, line graphs, scatterplots, and pie charts. Color can also be used to render a statistical graphic screen more legible and meaningful.

Emphasis

- Emphasize the graphic's data.

The main emphasis of color in a statistical graphics screen should be in the data area. Brighter colors and highlighting should attract the eye to the presented data so that trends and conclusions can be quickly perceived. Supporting text, numbers, and legends should receive slightly less emphasis. Aids in data interpretation such as grids should receive the least emphasis.

Number of Colors

- Use no more than six colors at one time.
- Use one color of five values or lightness.

Experience indicates that displaying more than six colors at one time on statistical graphics screens is too much. Even five or six colors, however, may be distracting or confusing if they are not properly chosen or are not harmonious. Marcus (1986a) suggests a more pleasing arrangement can often be achieved for graphics with five or less segments by using one color and displaying each segment in a different value or lightness.

Backgrounds

- Surround images
  — In a neutral color.
  — In a color complementary to the main image.

A neutral background will help set off a full color. A background in the complementary color of the main image will minimize visual afterimages.

Size

- Provide images of an adequate size for the task.
- If the image changes in size, use colors that exhibit a minimum shift in hue or lightness.
  — White, yellow, and red on dark backgrounds.

As color areas decrease in size, they appear to change in lightness and saturation. Similar colors may look different, and different colors may look similar. Interactions with the background color also increase. Thin gray images (lines or borders, for example) appear as a desaturated color complement of their background.

Provide *adequately sized* images. Where color identification is important, an image should be large enough to eliminate these distortions. For images *changing in size*, use colors that exhibit minimal hue or lightness shifts. Marcus (1986b) recommends that white, yellow, and red be used for light text, thin lines, and small shapes on dark backgrounds (blue, green, red, light gray).

Status

- To indicate a status, use the following colors:
  — Proper, normal, or OK: Green, white, or blue.
  — Caution: Yellow or gold.
  — Emergency or abnormal: Red.

To indicate a status, use green, white, or blue to indicate OK; yellow or gold for caution; and red for emergency or abnormal. The use of red, yellow, and green are well-learned color conventions.

Measurements and Area-Fill Patterns

- Display measurements in the following colors:
  — Grids: Gray.
  — Data points: Yellow.
  — Variance or error bars: Blue.

— Out-of-specified-range data: Red.
— Captions and labels: Lavender, lime green, or cyan.

- Display area-fill patterns in the following colors:
  — Widely spaced dots: Red.
  — Closely spaced dots: Green.
  — Wide dashed lines: Magenta.
  — Narrow dashed lines: Cyan.
  — Wide crosshatch: Blue.
  — Narrow crosshatch: Yellow.

For *measurements*, Smith (1986) recommends the above. They balance emphasis considerations (gray for grids, yellow for data points, lavender, lime green, or cyan for labels) and human expectations (red for out-of-specified range). Marcus (1986a) recommends that all text and the horizontal and vertical axis lines of a statistical graphic should be off-white. This will aid in focusing users' main attention on the colored data. To ensure that fill-in area patterns are identifiable, discriminable, and free from unintended brightness effects, Smith (1988) recommends the above.

Physical Impressions

- Size:
  — To convey an impression of
    - Larger: Use bright or saturated colors.
    - Smaller: Use dark or desaturated colors.
    - Similar: Use colors of equal lightness.
- Weight:
  — To convey an impression of
    - Heavy: Use dark, saturated colors.
    - Light: Use light, desaturated colors.
- Distance:
  — To convey an impression of
    - Close: Use saturated, bright, long-wavelength (red) colors.
    - Far: Use saturated, dark, short-wavelength (blue) colors.
- Height:
  — To convey an impression of height, use desaturated, light colors.
- Depth:
  — To convey an impression of depth, use saturated, dark colors.
- Concentration level:
  — To convey an impression of concentration level, use
    - High: Saturated colors.
    - Low: Desaturated colors.
- Magnitude of change:
  — To convey an impression of magnitude of change, use
    - Lowest: Short-wavelength (blue) colors.
    - Highest: Long-wavelength (red) colors.

- Actions:
  - To convey an impression of action, use
    - Required: Long-wavelength (red) colors.
    - Not required: Short-wavelength (blue) colors.
- Order:
  - To convey an impression of order with color, use
    - Low end of a continuum: Short-wavelength (blue) colors.
    - High end of a continuum: Long-wavelength (red) colors.
  - When displaying an array of ordered colors, position
    - Short-wavelength colors at the left side or at the bottom.
    - Long-wavelength colors at the right side or at the top.
  - To convey an impression of order with value or lightness, use the lightness order of a color (darkest to lightest or vice versa).
- Neutrality:
  - To convey an impression of neutrality, use black, gray, and white.

Colors yield different physical impressions. Bright, saturated colors convey a feeling of large and close. Dark, saturated colors mean heavy, far, and impression of depth. Desaturated, light colors indicate a light weight and height. Desaturated dark colors mean smaller. Long-wavelength (red) colors are associated with high rate of change, action required, and the high end of a continuum. Short-wavelength (blue) colors are associated with low rate of change, no actions required, and the low end of a continuum. Neutrality is best indicated by black, gray, or white.

Choosing Colors for Web Pages

- Purpose:
  - Color must always have a meaningful purpose.
- Palette:
  - Use the browser 216-color palette.
- Presentation:
  - Minimize the number of presented colors.
  - Always consider color in context.
  - Use similar or the same color schemes throughout.
  - For foregrounds: Use black or strong colors for text and headings.
  - For backgrounds: Use weaker contrasting colors such as off-white or light gray.
  - Use a uniform color in large areas.
  - The smaller the element, the more contrast is required between it and its background.
  - Larger images should use
    - Flat, Web-safe colors.
    - Fewer colors than small images.
  - Select colors that can be easily reproduced in black and white.

- Links:
  — Use default colors for links.
    - Make unselected/unvisited links blue.
    - Make selected/visited links purple.
  — Do not display non-link text in link colors.
- Testing:
  — Test all colors.

Purpose. Color should always be used for a meaningful purpose. Acceptable uses include highlighting or calling attention to information, grouping related information, designating selected links, giving a site an identity, or communicating realism for images. Color without a purpose is gratuitous and visually distracting.

Palette. Use colors that succeed on a variety of platforms or browsers. There are 216 colors (out of the standard 256 colors) that will always look the same on any monitor at any resolution. This is called the *browser-safe* palette, and it is illustrated on several Web sites. A search on "color palette" or a similar term will lead to these Web sites.

Presentation. Colors should be carefully chosen to aid users in understanding content, to keep a page well balanced, and to keep it graphically simple. Always *minimize* the number of presented colors. Too much color makes it difficult for people to notice something that might be really important, and makes it difficult to comprehend how color is being used to aid in understanding the screen's content. Christmas trees should be reserved for December 25; the "Las Vegas effect" (as the gratuitous use of color is also sometimes called) should be confined to a region in southern Nevada. Minimizing the use of color will also have page download benefits. Fewer colors means faster downloads.

Always consider color in *context*, never in isolation. One background color interacts with other background colors. Foreground text colors and graphics interact with background colors. When choosing colors, consider these interactions and use colors that work well together. Use *similar* or the same color schemes throughout a Web site. This will give the site an identity and help the user maintain a sense of place.

Foreground colors should be as different as possible from background colors. A contrasting foreground will maximize text legibility. A *background* color should organize a group of elements into a unified whole, isolating them from the remainder of the screen. Use background colors that do not compete with the foreground. A background must be subtle and subservient to the data, text, or symbols on top of it. With today's high-resolution monitors, the most recommended foreground text color is black presented on a light-colored background of low intensity, either off-white or light gray. Most other pastel colors, especially spectrum center colors, have also been found to be acceptable as backgrounds (Pastoor, 1990). Use dark backgrounds only when establishing contrast between an area of the screen and the main screen body. High intensity colors as backgrounds (such as red, magenta and bright green) must be avoided as they can be visually fatiguing when viewed for a period of time. Short-wavelength, cool

colors (blue and black) have been found to be preferred for dark backgrounds (Lalomia and Happ, 1987). Cool, dark colors visually recede, providing good contrast to the advancing lighter, foreground colors. Blue is especially good because of the eye's lack of sensitivity to it in the retina's central area and increased sensitivity to it in the periphery.

When choosing foreground and background colors, ensure that contrasting combinations are selected. See Tables 12.3 and 12.4 for color selection guidance. Also, always test all selected foreground and background colors. What may look good in theory may not always look as good in reality.

Use a *uniform* color in large screen areas. Large areas of the same color download faster. They compress well and are an efficient use of the GIF format. The *smaller* the element, the more contrast is required between it and its background. To reduce image file sizes for *larger* images, use flat Web-safe colors. Also use fewer colors with smaller images. Finally, select colors that can be easily *reproduced* in black and white on a screen or printer. This ensures that those who use a monochrome display or print in black and white will have a faithful reproduction of the intended screen.

MAXIM **Content is always more important than color.**

Links. Unselected/unvisited links must be distinguishable from selected/visited links. Stick with the default colors of blue for links already followed and purple for links not yet ventured down. While the choice of blue as a text color was poor because of its degraded reading ability, it is well learned, its use is recommended because it is now very familiar. Using nonstandard link colors can lead to severe problems. It is difficult to remember what color means what, increasing link selection errors. It can also lead to confusion with normal underlined text in a document. Never display general screen text in the link colors of blue and purple. This will create confusion between linked and non-linked text. It is acceptable, however, to use these colors in text that is large and decorative in nature and acting as a graphic and not plain text.

Testing. The possibility always exists that identical colors may appear differently on different monitors and platforms. Color choices should be tested on a variety of displays.

Uses of Color to Avoid

- Relying exclusively on color.
- Too many colors at one time.
- Highly saturated, spectrally extreme colors together:
  — Red and blue, yellow and purple.
- Low-brightness colors for extended viewing or older viewers.
- Colors of equal brightness.

- Colors lacking contrast:
  — For example, yellow and white; black and brown; reds, blues, and browns against a light background.
- Fully saturated colors for text or other frequently-read screen components.
- Pure blue for text, thin lines, and small shapes.
- Colors in small areas.
- Color for fine details.
- Non-opponent colors.
- Red and green in the periphery of large-scale displays.
- Adjacent colors that only differ in the amount of blue they possess.
- Single-color distinctions for color-deficient users.
- Using colors in unexpected ways.
- Using color to improve legibility of densely packed text.

The proper use of color in screen design also suggests some things to avoid.

Relying exclusively on color. Consider the needs of color-blind viewers and the effects of ambient lighting on color perception. Do not underestimate the value and role of other techniques, such as spatial formatting and component locations in good screen design.

Too many colors at one time. Using too many colors at one time can eliminate the benefits of color. Response times are increased, erroneous associations made, the handling of information is interfered with, and confusion is created. The objective is a screen that communicates; a colorful screen is not the objective. Use just enough colors to create effective communication. Again, consider the value of other techniques such as spatial formatting and consistent component locations in good design.

Highly saturated, spectrally extreme colors together. Spectrally extreme combinations can create eye focus problems, vibrations, illusions of shadows, and afterimages. In addition to red/blue and yellow/purple, other combinations that might cause problems are yellow/blue, green/blue, and red/green.

Low-brightness colors for extended viewing or older viewers. The eye adapts to color during extended viewing. The eye's capability also diminishes with age as the amount of light passing through the lens decreases. All colors will look less bright, and colors that are dim to begin with may not be legible. Brighter colors are needed to prevent reading problems.

Colors of equal brightness. Colors of equal brightness cannot be easily distinguished. A brightness difference must exist between adjacent colors.

Colors lacking contrast. Colors lacking contrast also cannot be easily distinguished. Similar foreground and background colors often do not have sufficient contrast with each other.

Fully saturated colors for frequently read screen components. Fully saturated colors excessively stimulate the eye, possibly causing visual confusion and fatigue.

Pure blue for text, thin lines, and small shapes. Because of its physical make-up, the eye has difficulty creating a clear and legible image of small blue shapes. They will look fuzzy.

Colors in small areas. Distortions in color, lightness, and saturation may occur for small areas of color.

Colors for fine details. Black, gray, and white will provide much better resolution. Reserve other colors for large areas or attracting attention.

Non-opponent colors. Non-opponent colors, red/yellow or green/blue, produce poorer images. Opponent colors, red/green or yellow/blue are good combinations for simple displays.

Red and green in the periphery of large-scale displays. The edges of the retina are not particularly sensitive to red and green. Avoid these colors in the periphery, especially for small symbols and shapes. Yellow and blue are much better peripheral colors.

Adjacent colors only differing in the amount of blue they possess. Because of the eye's difficulty in dealing with blue, differences in color based upon varying amounts of blue in the color's mixture will not be noticed.

Single color distinctions for color-deficient users. For those people with color-viewing deficiencies, distinguishing certain colors may be difficult or impossible. Always provide a redundant coding scheme.

Using colors in unexpected ways. Colors have become associated with certain meanings. Red, for example, is always associated with stop or danger. To display a critical or error message in green would violate an ingrained association and cause confusion. Always use colors in the way people expect them to be used.

Using color to improve legibility of densely-packed text. Space lines between paragraphs of text or after about every five lines of data will work much better.

Too many colors at one time (again). Never overuse color (again, this is important). Too many colors at one time may make a screen confusing or unpleasant to look at. Use only enough color to fulfill the system's objectives.

Step 12 Exercise

An exercise for Step 12 can be found on this book's companion Web site, www.wiley.com/college/galitz.

FUTURE VISION BIE

By K B Hemanth Raj

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