

Human Computer Interaction

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Preface

Human-computer interaction (HCI) is a multidisciplinary field of study focusing on the design of computer technology and, in particular, the interaction between humans (the users) and computers. While initially concerned with computers, HCI has since expanded to cover almost all forms of information technology design.

HCI soon became the subject of intense academic investigation, however, with the rise of technologies such as the Internet and the smart phone, computer use would increasingly move away from the desktop to embrace the mobile world. Also, HCI has steadily encompassed more fields:

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Chapter - 1

Introduction

User Interface Design Definition

- User interface design is a subset of a field of study called human-computer interaction (HCI). Human-computer interaction is the study, planning, and design of how people and computers work together so that a person's needs are satisfied in the most effective way.
- The user interface is the part of a computer and its software that people can see, hear, touch, talk to, or otherwise understand or direct. The user interface has essentially two components: input and output.
- Input is how people communicate his needs to the system using keyboard or any pointing device and output is how the system returns processing result to user through screen or sound.
- The best interface is one which has proper design with combination of effective input and output mechanisms.

Importance of Good Design

- In spite of today's rich technologies and tools we are unable to provide effective and usable screen because lack of time and care.
- A well-designed interface and screen is terribly important to our users. It is their window to view the capabilities of the system and it is also the vehicle through which complex tasks can be performed.
- A screen's layout and appearance affect a person in a variety of ways. If they are confusing and inefficient, people will have greater difficulty in doing their jobs and will make more mistakes.
- Poor design may even chase some people away from a system permanently. It can also lead to aggravation, frustration, and increased stress.

Benefits of Good Design

- The benefits of a well-designed screen have also been under experimental scrutiny for many years. One researcher, for example, attempted to improve screen clarity and readability by making screens less crowded. The result: screen users of the modified screens completed transactions in 25 percent less time and with 25 percent fewer errors than those who used the original screens.
- Another researcher has reported that reformatting inquiry screens following good design principles reduced decision-making time by about 40 percent, resulting in a savings of 79 person-years in the affected system.
- Other benefits also accrue from good design (Karat, 1997). Training costs are lowered because training time is reduced, support line costs are lowered because fewer assist calls are necessary, and employee satisfaction is increased because aggravation and frustration are reduced.
- Another benefit is, ultimately, that an organization's customers benefit because of the improved service they receive.
- Identifying and resolving problems during the design and development process also has significant economic benefits.

GUI Definition

- In brief, a graphical user interface can be defined as follows. A user interface, as recently described, is a collection of techniques and mechanisms to interact with something. In a graphical interface, the primary interaction mechanism is a pointing device of some kind.
- What the user interacts with is a collection of elements referred to as objects. They can be seen, heard, touched, or otherwise perceived. Objects are always visible to the user and are used to perform tasks. They are interacted with as entities independent of all other objects.
- People perform operations, called actions, on objects. The operations include accessing and modifying objects by pointing, selecting, and manipulating.

Popularity of Graphics

- Graphics revolutionized design and the user interface. Graphics assumes three dimensional look whereas text based system assumes one dimensional look.
- Information can appear or disappear through floating windows and navigation and commands can be done through menu or pull downs or screen controls
- Increased computer power and the vast improvement in the display enable the user's actions to be reacted to quickly, dynamically, and meaningfully.
- If properly used graphics can reduce mental and perceptual load and increases information transfer between men and machine because of visual comparisons and simplification of the perception of structure.

Concept of Direct Manipulation

The term used to describe this style of interaction for graphical systems was first used by Shneiderman (1982). He called them –direct manipulation systems, suggesting that they possess the following characteristics:

- **The system is portrayed as an extension of the real world:** A person is allowed to work in a familiar environment and in a familiar way, focusing on the data, not the application and tools. The physical organization of the system, which most often is unfamiliar, is hidden from view and is not a distraction.
- **Continuous visibility of objects and actions:** objects are continuously visible. Reminders of actions to be performed are also obvious. Nelson (1980) described this concept as –virtual reality, a representation of reality that can be manipulated. Hatfield (1981) is credited with calling it “WYSIWYG” (what you see is what you get) and Rutkowski (1982) described it as “transparency”
- **Actions are rapid and incremental with visible display of results:** the results of actions are immediately displayed visually on the screen in their new and current form. Auditory feedback may also be provided. The impact of a previous action is quickly seen, and the evolution of tasks is continuous and effortless.
- **Incremental actions are easily reversible:** Finally, actions, if discovered to be incorrect or not desired, can be easily undone.

Indirect Manipulation

- In practice, direct manipulation of all screen objects and actions may not be feasible because of the following:
 - The operation may be difficult to conceptualize in the graphical system.
 - The graphics capability of the system may be limited.
 - The amount of space available for placing manipulation controls in the window border may be limited.
 - It may be difficult for people to learn and remember all the necessary operations and actions.
- When this occurs, indirect manipulation is provided. Indirect manipulation substitutes words and text, such as pull-down or pop-up menus, for symbols, and substitutes typing for pointing.

Graphical system advantages

The success of graphical systems has been attributed to a host of factors. The following have been commonly referenced in literature and endorsed by their advocates as advantages of these systems.

- **Symbols recognized faster than text:** symbols can be recognized faster and more accurately than text. An example of a good classification scheme that speeds up recognition is the icons. These icons allow speedy recognition of the type of message being presented.
- **Faster learning:** a graphical, pictorial representation aids learning, and symbols can also be easily learned.
- **Faster use and problem solving:** Visual or spatial representation of information has been found to be easier to retain and manipulate and leads to faster and more successful problem solving.
- **Easier remembering:** Because of greater simplicity, it is easier for casual users to retain operational concepts.
- **More natural:** symbolic displays are more natural and advantageous because the human mind has a powerful image memory.
- **Fewer errors:** Reversibility of actions reduces error rates because it is always possible to undo the last step. Error messages are less frequently needed.
- **Increased feeling of control:** The user initiates actions and feels in control. This increases user confidence
- **Immediate feedback:** The results of actions furthering user goals can be seen immediately. If the response is not in the desired direction, the direction can be changed quickly.
- **Predictable system responses:** Predictable system responses also speed learning.
- **Easily reversible actions:** This ability to reverse unwanted actions also increases user confidence
- **More attractive:** Direct-manipulation systems are more entertaining, cleverer, and more appealing.
- **May consume less space:** Icons may take up less space than the equivalent in words but this is not the case always.

- **Replaces national languages:** Icons possess much more universality than text and are much more easily comprehended worldwide.
- **Easily augmented with text displays:** Where graphical design limitations exist, direct-manipulation systems can easily be augmented with text displays. The reverse is not true.
- **Low typing requirements:** Pointing and selection controls, such as the mouse or trackball, eliminate the need for typing skills.

Graphical system disadvantages

The body of positive research, hypotheses, and comment concerning graphical systems is being challenged by some studies, findings, and opinions that indicate that graphical representation and interaction may not necessarily always be better. Indeed, in some cases, it may be poorer than pure textual or alphanumeric displays. Sometimes arcane, and even bizarre. Among the disadvantages put forth are these:

- **Greater design complexity:** Controls and basic alternatives must be chosen from a pile of choices numbering in excess of 50. This design potential may not necessarily result in better design unless proper controls and windows are selected. Poor design can undermine acceptance.
- **Learning still necessary:** The first time one encounters many graphical systems, what to do is not immediately obvious. A severe learning and remembering requirement is imposed on many users because meanings of icons or using pointing device have to be learned.
- **Lack of experimentally-derived design guidelines:** today there is a lack of widely available experimentally-derived design guidelines. Earlier only few studies to aid in making design decisions were performed and available for today now. Consequently, there is too little understanding of how most design aspects relate to productivity and satisfaction.
- **Inconsistencies in technique and terminology:** Many differences in technique, terminology, and look and feel exist among various graphical system providers, and even among successive versions of the same system. So the user has to learn or relearn again while shifting to next terminology.
- **Not always familiar:** Symbolic representations may not be as familiar as words or numbers. Numeric symbols elicit faster responses than graphic symbols in a visual search task.
- **Window manipulation requirements:** Window handling and manipulation times are still excessive and repetitive. This wastes time
- **Production limitations:** The number of symbols that can be clearly produced using today's technology is still limited. A body of recognizable symbols must be produced that are equally legible and equally recognizable using differing technologies. This is extremely difficult today.
- **Few tested icons exist:** Icons must be researched, designed, tested, and then introduced into the marketplace. The consequences of poor or improper design will be confusion and lower productivity for users.
- **Inefficient for touch typists:** For an experienced touch typist, the keyboard is a very fast and powerful device.

- ❑ **Not always the preferred style of interaction:** Not all users prefer a pure iconic interface. User will also prefer alternatives with textual captions.
- ❑ **Not always fastest style of interaction:** graphic instructions on an automated bank teller machine were inferior to textual instructions.
- ❑ **May consume more screen space:** Not all applications will consume less screen space. A listing of names and telephone numbers in a textual format will be more efficient to scan than a card file.
- ❑ **Hardware limitations:** Good design also requires hardware of adequate power, processing speed, screen resolution, and graphic capability.

Characteristics of the Graphical User Interface

Sophisticated Visual Presentation

- ❑ Visual presentation is the visual aspect of the interface. It is what people see on the screen. The sophistication of a graphical system permits displaying lines, including drawings and icons. It also permits the displaying of a variety of character fonts, including different sizes and styles.
 - ❑ The meaningful interface elements visually presented to the user in a graphical system include windows (primary, secondary, or dialog boxes), menus (menu bar, pull down, pop-up, cascading), icons to represent objects such as programs or files, assorted screen-based controls (text boxes, list boxes, combination boxes, settings, scroll bars, and buttons), and a mouse pointer and cursor. The objective is to reflect visually on the screen the real world of the user as realistically, meaningfully, simply, and clearly as possible.

Pick-and-Click Interaction

- ❑ To identify a proposed action is commonly referred to as pick, the signal to perform an action as click.
- ❑ The primary mechanism for performing this pick-and-click is most often the mouse and its buttons and the secondary mechanism for performing these selection actions is the keyboard.

Restricted Set of Interface Options

- ❑ The array of alternatives available to the user is what is presented on the screen or what may be retrieved through what is presented on the screen, nothing less, and nothing more. This concept fostered the acronym WYSIWYG.

Visualization

- ❑ Visualization is a cognitive process that allows people to understand information that is difficult to perceive, because it is either too voluminous or too abstract.
- ❑ The goal is not necessarily to reproduce a realistic graphical image, but to produce one that conveys the most relevant information. Effective visualizations can facilitate mental insights, increase productivity, and foster faster and more accurate use of data.

Object Orientation

- A graphical system consists of objects and actions. Objects are what people see on the screen as a single unit.
- Objects can be composed of sub objects. For example, an object may be a document and its sub objects may be a paragraph, sentence, word, and letter.
- Objects are divided into three meaningful classes as Data objects, which present information, container objects to hold other objects and Device objects represent physical objects in the real world.
- Objects can exist within the context of other objects, and one object may affect the way another object appears or behaves. These relationships are called collections, constraints, composites, and containers.
- **Properties or Attributes of Objects :** Properties are the unique characteristics of an object. Properties help to describe an object and can be changed by users.
- **Actions:** People take actions on objects. They manipulate objects in specific ways (commands) or modify the properties of objects (property or attribute specification).
- The following is a typical property/attribute specification sequence:
 - o The user selects an object—for example, several words of text.
 - o The user then selects an action to apply to that object, such as the action **BOLD**.
 - o The selected words are made bold and will remain bold until selected and changed again.
- **Application versus Object or Data Orientation** An application-oriented approach takes an action: object approach, like this:
 - Action> 1. An application is opened (for example, word processing).
 - Object> 2. A file or other object selected (for example, a memo).An object-oriented object: action approach does this: Object> 1. An object is chosen (a memo).
 - Action> 2. An application is selected (word processing).
- **Views:** Views are ways of looking at an object's information. IBM's SAA CUA describes four kinds of views: composed, contents, settings, and help.

Use of Recognition Memory

- Continuous visibility of objects and actions encourages to eliminate –out of sight, out of mind problem

Concurrent Performance of Functions

- Graphic systems may do two or more things at one time. Multiple programs may run simultaneously.
- It may process background tasks (cooperative multitasking) or preemptive multitasking.
- Data may also be transferred between programs. It may be temporarily stored on a –clipboard for later transfer or be automatically swapped between programs.

The Web User Interface

- Web interface design is essentially the design of navigation and the presentation of information.
- Proper interface design is largely a matter of properly balancing the structure and relationships of menus, content, and other linked documents or graphics. The design goal is to build a hierarchy of menus and pages that feels natural, is well structured, is easy to use, and is truthful.
- The Web is a navigation environment where people move between pages of information, not an application environment. It is also a graphically rich environment.
- Web interface design is difficult for a number of reasons. First, its underlying design language, HTML. Next, browser navigation retreated to the pre-GUI era.
- Web interface design is also more difficult because the main issues concern information architecture and task flow, neither of which is easy to standardize. It is more difficult because of the availability of the various types of multimedia, and the desire of many designers to use something simply because it is available. It is more difficult because users are ill defined, and the user's tools so variable in nature.

The popularity of Web

- While the introduction of the graphical user interface revolutionized the user interface, the Web has revolutionized computing. It allows millions of people scattered across the globe to communicate, access information, publish, and be heard. It allows people to control much of the display and the rendering of Web pages.
- Web usage has reflected this popularity. The number of Internet hosts has risen dramatically.
- Users have become much more discerning about good design. Slow download times, confusing navigation, confusing page organization, disturbing animation, or other undesirable site features often results in user abandonment of the site for others with a more agreeable interface.

Characteristics of Web Design

- A Web interface possesses a number of characteristics, some similar to a GUI interface, and, as has already been shown, some different.

GUI versus Web Design

Characteristics	GUI	WEB
Devices	User hardware variations limited. User hardware characteristics well defined Screens appear exactly as specified.	User hardware variations enormous. Screen appearance influenced by hardware being used.
User Focus	Data and applications.	Information and navigation.
Data	Typically created and used by known and trusted	Full of unknown content.
Information	Sources are trusted. Properties generally known. Typically placed into system by users or known people and organizations.	Source not always trusted. Often not placed onto the Web by users or known people and organizations. Highly variable organization.
User Tasks	Install, configure, personalize, start, use, and Open, use, and close data files. Familiarity with applications often achieved.	Link to a site, browse or read pages, fill out forms, upgrade programs. register for services, participate in transactions, download and save things. Familiarity with many sites not established.
Presentation	Windows, menus, controls, data, toolbars Presented as specified by designer. Generally standardized by toolkits and style specifications. guides.	Two components, browser and page Within page, any combination of text, images, audio, video, and animation. May not be presented as specified by the designer dependent on browser, monitor, and user Little standardization.
Navigation	Through menus, lists, trees, dialogs, and wizards.	Through links, bookmarks, and typed URLs.

Interaction	Interactions such as clicking menu choices, pressing buttons, selecting list choices, and cut/copy/paste occur within context of active program.	Basic interaction is a single click. This can cause extreme changes in context, which may not be noticed.
Response Time	Nearly instantaneous	Quite variable, depending on transmission speeds, page content, and so on. Long times can upset the user.
System Capability	Unlimited capability proportional to sophistication of hardware and software.	Limited by constraints imposed by the hardware, browser, software, client support, and user willingness to allow features because of response time, security, and Privacy concerns.
Task Efficiency	Targeted to a specific audience with specific tasks. Only limited by the amount of programming undertaken to support it.	Limited by browser and network capabilities. Actual user audience usually not well understood. Often intended for anyone and everyone.
Consistency	Major objective exists within and across applications. Aided by platform toolkit and design guidelines. Universal consistency in GUI products generally	Sites tend to establish their own identity. Frequently standards set within a site. Frequent ignoring of GUI guidelines for identical created through toolkits and design guidelines. Components, especially controls.
User Assistance	Integral part of most systems and applications. Documentation, both online and offline, Customer service support, if provided, usually provided. Personal support desk also usually provided.	No similar help systems. Accessed through standard mechanisms. The little available help is built into the page oriented to product or service offered.

Integration	Seamless integration of all applications into the platform environment is a major objective.	Apparent for some basic functions within most Web sites (navigation, printing, and so on.) in accomplishing this objective Sites tend to achieve individual distinction rather than integration.
Security	Tightly controlled, proportional to degree of willingness to invest resources and effort. Not an issue for most home PC users.	Renowned for security exposures. Browser-provided security options typically understood by average users. When employed, may have function-limiting side effects
Reliability	Tightly controlled in business systems,	Susceptible to disruptions caused by user, telephone proportional to degree of willingness line and cable providers, Internet service providers, to invest resources and effort. Hosting servers, and remotely accessed sites.

Printed Pages versus Web Pages

- **Page size:** Printed pages are generally larger than their Web counterparts. They are also fixed in size, not variable like Web pages. The visual impact of the printed page is maintained in hard-copy form, while on the Web all that usually exists are snapshots of page areas. The visual impact of a Web page is substantially degraded, and the user may never see some parts of the page because their existence is not known or require scrolling to bring into view. The design implications: the top of a Web page is its most important element, and signals to the user must always be provided that parts of a page lie below the surface.
- **Page rendering:** Printed pages are immensely superior to Web pages in rendering. Printed pages are presented as complete entities, and their entire contents are available for reading or review immediately upon appearance. Web pages elements are often rendered slowly, depending upon things like line transmission speeds and page content. Design implications: Provide page content that downloads fast, and give people elements to read immediately so the sense of passing time is diminished.
- **Page layout:** With the printed page, layout is precise with much attention given to it. With Web pages layout is more of an approximation, being negatively influenced by deficiencies in design toolkits and the characteristics of the user's browser and hardware, particularly screen sizes. Design implication: Understand

the restrictions and design for the most common user tools.

- **Page resolution:** the resolution of displayed print characters still exceeds that of screen characters, and screen reading is still slower than reading from a document. Design implication: Provide an easy way to print long Web documents.
- **Page navigation:** Navigating printed materials is as simple as page turning. Navigating the Web requires innumerable decisions concerning which of many possible links should be followed. Design implications are similar to the above provide overviews of information organization schemes and clear descriptions of where links lead.
- **Interactivity:** Printed page design involves letting the eyes traverse static information, selectively looking at information and using spatial combinations to make page elements enhance and explain each other. Web design involves letting the hands move the information (scrolling, pointing, expanding, clicking, and so on) in conjunction with the eyes.
- **Page independence:** Because moving between Web pages is so easy, and almost any page in a site can be accessed from anywhere else, pages must be made freestanding. Every page is independent. Printed pages, being sequential, fairly standardized in organization, and providing a clear sense of place, are not considered independent. Design implication: Provide informative headers and footers on each Web page.

Principles of User Interface Design

- It should be useful, accomplishing some business objectives faster and more efficiently than the previously used method or tool did. It must also be easy to learn, for people want to do, not learn to do.
- The interface itself should serve as both a connector and a separator: a connector in that it ties the user to the power of the computer, and a separator in that it minimizes the possibility of the participants damaging one another. We will begin with the first set of published principles, those for the Xerox STAR.

Principles for the Xerox STAR

- The illusion of manipulable objects: Displayed objects that are selectable and manipulable must be created. A design challenge is to invent a set of displayable objects that are represented meaningfully and appropriately for the intended application. It must be clear that these objects can be selected,
- Visual order and viewer focus: Effective visual contrast between various components of the screen is used to achieve this goal. Animation is also used to draw attention, as is sound. Feedback must also be provided to the user.
- Revealed structure: The distance between one's intention and the effect must be minimized. The relationship between intention and effect must be tightened and made as apparent as possible to the user.
- Consistency: Consistency aids learning. Consistency is provided in such areas as element location, grammar, font shapes, styles, and sizes, selection indicators, and contrast and emphasis techniques.
- Appropriate effect or emotional impact: The interface must provide the appropriate emotional effect for the product and its market. Is it a corporate, professional, and secure business system? Should it reflect the fantasy, wizardry, and bad puns of computer games?

- A match with the medium: The interface must also reflect the capabilities of the device on which it will be displayed. Quality of screen images will be greatly affected by a device's resolution and color-generation capabilities.

General Principles

The design goals in creating a user interface are described below. They are fundamental to the design and implementation of all effective interfaces, including GUI and Web ones. These principles are general characteristics of the interface, and they apply to all aspects.

- Aesthetically Pleasing
 - Provide visual appeal by following these presentation and graphic design principles:
 - Provide meaningful contrast between screen elements.
 - Create groupings.
 - Align screen elements and groups.
 - Provide three-dimensional representation.
 - Use color and graphics effectively and simply.
- Clarity
 - The interface should be visually, conceptually, and linguistically clear, including:
 - Visual elements
 - Functions
 - Metaphors
 - Words and text
- Compatibility
 - Provide compatibility with the following:
 - The user
 - The task and job
 - The product
 - Adopt the user's perspective.
- Comprehensibility
 - A system should be easily learned and understood. A user should know the following:
 - What to look at
 - What to do
 - When to do it
 - Where to do it
 - Why to do it
 - How to do it
 - The flow of actions, responses, visual presentations, and information should be in a sensible order that is easy to recollect and place in context.
- Configurability
 - Permit easy personalization, configuration, and reconfiguration of settings.
 - Enhances a sense of control.
 - Encourages an active role in understanding.
- Consistency
 - A system should look, act, and operate the same throughout. Similar components should:
 - Have a similar look.
 - Have similar uses.
 - Operate similarly.
 - The same action should always yield the same result.

- The function of elements should not change.
- The position of standard elements should not change.

- In addition to increased learning requirements, inconsistency in design has a number of other prerequisites and by-products, including:
- More specialization by system users.
- Greater demand for higher skills.
- More preparation time and less production time.
- More frequent changes in procedures.
- More error-tolerant systems (because errors are more likely).
- More kinds of documentation.
- More time to find information in documents.
- More unlearning and learning when systems are changed.
- More demands on supervisors and managers.
- More things to do wrong.

□ Control

- The user must control the interaction.
 - Actions should result from explicit user requests.
 - Actions should be performed quickly.
 - Actions should be capable of interruption or termination.
 - The user should never be interrupted for errors.
- The context maintained must be from the perspective of the user.
- The means to achieve goals should be flexible and compatible with the user's skills, experiences, habits, and preferences.
- Avoid modes since they constrain the actions available to the user.
- Permit the user to customize aspects of the interface, while always providing a proper set of defaults.

□ Directness

- Provide direct ways to accomplish tasks.
 - Available alternatives should be visible.
 - The effect of actions on objects should be visible.

□ Efficiency

- Minimize eye and hand movements, and other control actions.
 - Transitions between various system controls should flow easily and freely.
 - Navigation paths should be as short as possible.
 - Eye movement through a screen should be obvious and sequential.
- Anticipate the user's wants and needs whenever possible.

□ Familiarity

- Employ familiar concepts and use a language that is familiar to the user.
- Keep the interface natural, mimicking the user's behavior patterns.
- Use real-world metaphors.

□ Flexibility

- A system must be sensitive to the differing needs of its users, enabling a level and type of performance based upon:
 - Each user's knowledge and skills.
 - Each user's experience.
 - Each user's personal preference.
 - Each user's habits.
 - The conditions at that moment.

- Forgiveness
 - Tolerate and forgive common and unavoidable human errors.
 - Prevent errors from occurring whenever possible.
 - Protect against possible catastrophic errors.
- Predictability
 - The user should be able to anticipate the natural progression of each task.
 - Provide distinct and recognizable screen elements.
 - Provide cues to the result of an action to be performed.
 - All expectations should be fulfilled uniformly and completely.
 - When an error does occur, provide constructive messages.
- Recovery
 - A system should permit:
 - Commands or actions to be abolished or reversed.
 - Immediate return to a certain point if difficulties arise.
 - Ensure that users never lose their work as a result of:
 - An error on their part.
 - Hardware, software, or communication problems.
- Responsiveness
 - The system must rapidly respond to the user's requests.
 - Provide immediate acknowledgment for all user actions:
 - Visual.
 - Textual.
 - Auditory.
- Simplicity
 - Provide as simple an interface as possible.
 - Five ways to provide simplicity:
 - Use progressive disclosure, hiding things until they are needed.
 - Present common and necessary functions first.
 - Prominently feature important functions.
 - Hide more sophisticated and less frequently used functions.
 - Provide defaults.
 - Minimize screen alignment points.
 - Make common actions simple at the expense of uncommon actions being made harder.
 - Provide uniformity and consistency.
- Transparency
 - Permit the user to focus on the task or job, without concern for the mechanics of the interface.
 - Workings and reminders of workings inside the computer should be invisible to the user.
- Trade-Offs
 - Final design will be based on a series of trade-offs balancing often-conflicting design principles.
 - People's requirements always take precedence over technical requirements.

Unit-II

Design Process

Obstacles and Pitfalls in the Development Path

- Gould (1988) has made these general observations about design:
 - o Nobody ever gets it right the first time.
 - o Development is chock-full of surprises.
 - o Good design requires living in a sea of changes.
 - o Making contracts to ignore change will never eliminate the need for change.
 - o Even if you have made the best system humanly possible, people will still make mistakes when using it.
 - o Designers need good tools.
- You must have behavioral design goals like performance design goals.
- The first five conditions listed will occur naturally because people are people, both as users and as developers. These kinds of behavior must be understood and accepted in design. User mistakes, while they will always occur, can be reduced.
- Pitfalls in the design process exist because of a flawed design process, including a failure to address critical design issues, an improper focus of attention, or development team organization failures. Common pitfalls are:
 - o No early analysis and understanding of the user's needs and expectations.
 - o A focus on using design features or components that are neat or -glitzy.
 - o Little or no creation of design element prototypes.
 - o No usability testing.
 - o No common design team vision of user interface design goals.
 - o Poor communication between members of the development team.

Designing for People: The Five Commandments

- The complexity of a graphical or Web interface will always magnify any problems that do occur. Pitfalls can be eliminated if the following design commandments remain foremost in the designer's mind.
 - Gain a complete understanding of users and their tasks: The users are the customers. Today, people expect a level of design sophistication from all interfaces, including Web sites. The product, system or Web site must be geared to people's needs, not those of the developers.
 - Solicit early and ongoing user involvement: Involving the users in design from the beginning provides a direct conduit to the knowledge they possess about jobs, tasks, and needs. Involvement also allows the developer to confront a person's resistance to change, a common human trait. People dislike change for a variety of reasons, among them fear of the unknown and lack of identification with the system.

- Perform rapid prototyping and testing: Prototyping and testing the product will quickly identify problems and allow you to develop solutions. Prototyping and testing must be continually performed during all stages of development to uncover all potential defects. If thorough testing is not performed before product release, the testing will occur in the user's office. Encountering a series of problems early in system use will create a negative first impression in the customer's mind, and this may harden quickly, creating attitudes that may be difficult to change. It is also much harder and more costly to fix a product after its release.
- Modify and iterate the design as much as necessary: While design will proceed through a series of stages, problems detected in one stage may force the developer to revisit a previous stage.. Establish user performance and acceptance criteria and continue testing and modifying until all design goals are met.
- Integrate the design of all the system components: The software, the documentation, the help function, and training needs are all important elements of a graphical system or Web site and all should be developed concurrently. Time will also exist for design trade-offs to be thought out more carefully.

Usability

- ☐ The term usability used to describe the effectiveness of human performance. The term usability is defined as –the capability to be used by humans easily and effectively, where,
 easily = to a specified level of subjective assessment,
 effectively = to a specified level of human performance.

Common Usability Problems

- ☐ Mandel (1994) lists the 10 most common usability problems in graphical systems as reported by IBM usability specialists. They are:
 1. Ambiguous menus and icons.
 2. Languages that permit only single-direction movement through a system.
 3. Input and direct manipulation limits.
 4. Highlighting and selection limitations.
 5. Unclear step sequences.
 6. More steps to manage the interface than to perform tasks.
 7. Complex linkage between and within applications.
 8. Inadequate feedback and confirmation.
 9. Lack of system anticipation and intelligence.
 10. Inadequate error messages, help, tutorials, and documentation.

Some Practical Measures of Usability

- ☐ Are people asking a lot of questions or often reaching for a manual?
- ☐ Are frequent exasperation responses heard?
- ☐ Are there many irrelevant actions being performed?
- ☐ Are there many things to ignore?

- ☐ Do a number of people want to use the product?

Some Objective Measures of Usability

- ☐ Shackel (1991) presents the following more objective criteria for measuring usability.
- ☐ How effective is the interface? Can the required range of tasks be accomplished:
 - At better than some required level of performance (for example, in terms of speed and errors)?
 - By some required percentage of the specified target range of users?
 - Within some required proportion of the range of usage environments?
- ☐ How learnable is the interface? Can the interface be learned:
 - Within some specified time from commissioning and start of user training?
 - Based on some specified amount of training and user support?
 - Within some specified relearning time each time for intermittent users?
- ☐ How flexible is the interface? Is it flexible enough to:
 - Allow some specified percentage variation in tasks and/or environments beyond those first specified?
 - What are the attitudes of the users? Are they: Within acceptable levels of human cost in terms of tiredness, discomfort, frustration, and personal effort?
 - Such that satisfaction causes continued and enhanced usage of the system?

The Design Team

- ☐ Provide a balanced design team, including specialists in:
 - Development
 - Human factors
 - Visual design
 - Usability assessment
 - Documentation
 - Training

Know your user or client

- ☐ To create a truly usable system, the designer must always do the following:
 - Understand how people interact with computers.
 - Understand the human characteristics important in design.
 - Identify the user's level of knowledge and experience.
 - Identify the characteristics of the user's needs, tasks, and jobs.
 - Identify the user's psychological characteristics.
 - Identify the user's physical characteristics.
 - Employ recommended methods for gaining understanding of users.

Why People Have Trouble with Computers

- ☐ What makes a system difficult to use in the eyes of its user? Listed below are several contributing factors that apply to traditional business systems.
 - Use of jargon.

- Non-obvious design.
- Non-obvious design.
- Disparity in problem-solving strategies.
- Design inconsistency.

Responses to Poor Design

- Errors are a symptom of problems. The magnitude of errors in a computer-based system has been found to be as high as 46 percent for commands, tasks, or transactions. Errors, and other problems that befuddle one, lead to a variety of psychological and physical user responses.

Psychological

- Confusion.
- Annoyance.
- Frustration.
- Panic or stress.
- Boredom.

Physical

- Abandonment of the system.
- Partial use of the system.
- Indirect use of the system.
- Modification of the task.
- Compensatory activity.
- Misuse of the system.
- Direct programming.

Important Human Characteristics in Design

Perception

- Perception is our awareness and understanding of the elements and objects of our environment through the physical sensation of our various senses, including sight, sound, smell, and so forth. Perception is influenced, in part, by experience.
- Other perceptual characteristics include the following:
 - Proximity. Our eyes and mind see objects as belonging together if they are near each other in space.
 - Similarity. Our eyes and mind see objects as belonging together if they share a common visual property, such as color, size, shape, brightness, or orientation.
 - Matching patterns. We respond similarly to the same shape in different sizes. The letters of the alphabet, for example, possess the same meaning, regardless of physical size.
 - Succinctness. We see an object as having some perfect or simple shape because perfection or simplicity is easier to remember.
 - Closure. Our perception is synthetic; it establishes meaningful wholes. If something does not quite close itself, such as a circle, square, triangle, or word, we see it as closed anyway.
 - Unity. Objects that form closed shapes are perceived as a group.
 - Continuity. Shortened lines may be automatically extended.
 - Balance. We desire stabilization or equilibrium in our viewing

environment. Vertical, horizontal, and right angles are the most visually satisfying and easiest to look at.

- Expectancies. Perception is also influenced by expectancies; sometimes we perceive not what is there but what we expect to be there. Missing a spelling mistake in proofreading something we write is often an example of a perceptual expectancy error; we see not how a word is spelled, but how we expect to see it spelled.
- Context. Context, environment, and surroundings also influence individual perception. For example, two drawn lines of the same length may look the same length or different lengths, depending on the angle of adjacent lines or what other people have said about the size of the lines.
- Signals versus noise. Our sensing mechanisms are bombarded by many stimuli, some of which are important and some of which are not. Important stimuli are called signals; those that are not important or unwanted are called noise.

Memory

- Memory is viewed as consisting of two components, long-term and short-term (or working) memory.
- Short-term, or working, memory receives information from either the senses or long-term memory, but usually cannot receive both at once, the senses being processed separately. Within short-term memory a limited amount of information processing takes place. Information stored within it is variously thought to last from 10 to 30 seconds, with the lower number being the most reasonable speculation. Knowledge, experience, and familiarity govern the size and complexity of the information that can be remembered.
- Long-term memory contains the knowledge we possess. Information received in short-term memory is transferred to it and encoded within it, a process we call learning. It is a complex process requiring some effort on our part. The learning process is improved if the information being transferred from short-term memory has structure and is meaningful and familiar. Learning is also improved through repetition. Unlike short-term memory, with its distinct limitations, long-term memory capacity is thought to be unlimited. An important memory consideration, with significant implications for interface design, is the difference in ability to recognize or recall words.

Sensory Storage

- Sensory storage is the buffer where the automatic processing of information collected from our senses takes place. It is an unconscious process, large, attentive to the environment, quick to detect changes, and constantly being replaced by newly gathered stimuli. In a sense, it acts like radar, constantly scanning the environment for things that are important to pass on to higher memory.
- Repeated and excessive stimulation can fatigue the sensory storage mechanism, making it less attentive and unable to distinguish what is important (called habituation). Avoid unnecessarily stressing it.
- Design the interface so that all aspects and elements serve a definite purpose. Eliminating interface noise will ensure that important things will be less likely to be missed.

Visual Acuity

- The capacity of the eye to resolve details is called visual acuity. It is the phenomenon that results in an object becoming more distinct as we turn our eyes toward it and rapidly losing distinctness as we turn our eyes away—that is, as the visual angle from the point of fixation increases.
- It has been shown that relative visual acuity is approximately halved at a distance of 2.5 degrees from the point of eye fixation
- The eye's sensitivity increases for those characters closest to the fixation point (the "O") and decreases for those characters at the extreme edges of the circle (a 50/50 chance exists for getting these characters correctly identified). This may be presumed to be a visual "chunk" of a screen

Foveal and Peripheral Vision

- Foveal vision is used to focus directly on something; peripheral vision senses anything in the area surrounding the location we are looking at, but what is there cannot be clearly resolved because of the limitations in visual acuity just described.
- Foveal and peripheral vision maintain, at the same time, a cooperative and a competitive relationship. Peripheral vision can aid a visual search, but can also be distracting.
- In its cooperative nature, peripheral vision is thought to provide clues to where the eye should go next in the visual search of a screen.
- In its competitive nature, peripheral vision can compete with foveal vision for attention. What is sensed in the periphery is passed on to our information-processing system along with what is actively being viewed foveally.

Information Processing

- The information that our senses collect that is deemed important enough to do something about then has to be processed in some meaningful way.
- There are two levels of information processing going on within us. One level, the highest level, is identified with consciousness and working memory. It is limited, slow, and sequential, and is used for reading and understanding.
- In addition to this higher level, there exists a lower level of information processing, and the limit of its capacity is unknown. This lower level processes familiar information rapidly, in parallel with the higher level, and without conscious effort.
- Both levels function simultaneously, the higher level performing reasoning and problem solving, the lower level perceiving the physical form of information sensed.

Mental Models

- A mental model is simply an internal representation of a person's current

understanding of something. Usually a person cannot describe this mental mode and most often is unaware it even exists.

- Mental models are gradually developed in order to understand something, explain things, make decisions, do something, or interact with another person. Mental models also enable a person to predict the actions necessary to do things if the action has been forgotten or has not yet been encountered.
- A person already familiar with one computer system will bring to another system a mental model containing specific visual and usage expectations. If the new system complies with already-established models, it will be much easier to learn and use.
- The key to forming a transferable mental model of a system is design consistency and design standards.

Movement Control

- Particularly important in screen design is Fitts' Law (1954). This law states that:
- The time to acquire a target is a function of the distance to and size of the target.
- This simply means that the bigger the target is, or the closer the target is, the faster it will be reached. The implications in screen design are:
 - Provide large objects for important functions.
 - Take advantage of the "pinning" actions of the sides, top, bottom, and corners of the screen.

Learning

- Learning, as has been said, is the process of encoding in long-term memory information
- A design developed to minimize human learning time can greatly accelerate human performance. People prefer to stick with what they know, and they prefer to jump in and get started that is contained in short-term memory.
- Learning can be enhanced if it:
 - Allows skills acquired in one situation to be used in another somewhat like it. Design consistency accomplishes this.
 - Provides complete and prompt feedback.
 - Is phased, that is, it requires a person to know only the information needed at that stage of the learning process.

Skill

- The goal of human performance is to perform skillfully. To do so requires linking inputs and responses into a sequence of action. The essence of skill is performance of actions or movements in the correct time sequence with adequate precision.
- Skills are hierarchical in nature, and many basic skills may be integrated to form increasingly complex ones. Lower-order skills tend to become routine and may drop out of consciousness.

Individual Differences

- In reality, there is no average user. A complicating but very advantageous human characteristic is that we all differ—in looks, feelings, motor abilities, intellectual abilities, learning abilities and speed, and so on.

- Individual differences complicate design because the design must permit people with widely varying characteristics to satisfactorily and comfortably learn the task or job, or use the Web site.
- Multiple versions of a system can easily be created. Design must provide for the needs of all potential users.

Human Considerations in Design

- The kinds of user/task characteristics that must be established are summarized in Table

KNOWLEDGE/EXPERIENCE

Knowledge/Experience

Computer Literacy	Highly technical or experienced, moderate computer experience, or none.
System Experience	High, moderate, or low knowledge of a particular system and its methods of interaction.
Application Experience	High, moderate, or low knowledge of similar systems.
Task Experience	Level of knowledge of job and job tasks.
Other Systems	Use Frequent or infrequent use of other systems in doing job.
Education	High school, college, or advanced degree.
Reading Level	Less than 5th grade, 5th–12th, more than 12th grade.
Typing Skill	Expert (135 WPM), skilled (90 WPM), good (55 WPM), average (40 WPM), or "hunt and peck" (10 WPM).
Native Language or Culture	English, another, or several.

JOB/TASK/NEED

Type of System	Use Mandatory or discretionary use of the system.
Frequency of Use	Continual, frequent, occasional, or once-in-a-lifetime use of system.
Task or Need Importance	High, moderate, or low importance of the task being performed.
Task Structure	Repetitiveness or predictability of tasks being automated, high, moderate, or low.
Social Interactions	Verbal communication with another person required or not required.
Primary Training	Extensive or formal training, self-training through manuals, or no training.
Turnover Rate	High, moderate, or low turnover rate for jobholders.
Job Category	Executive, manager, professional, secretary, clerk.
Lifestyle	For Web e-commerce systems, includes hobbies, recreational pursuits, and economic status.

PSYCHOLOGICAL CHARACTERISTICS

Attitude	Positive, neutral, or negative feeling toward job or system.
Motivation	Low, moderate, or high due to interest or fear.
Patience	Patience or impatience expected in accomplishing goal.
Expectations	Kinds and reasonableness.
Stress Level	High, some, or no stress generally resulting from task performance.
Cognitive Style	Verbal or spatial, analytic or intuitive, concrete or abstract.

PHYSICAL CHARACTERISTICS

Age	Young, middle aged, or elderly.
Gender	Male or female.
Handedness	Left, right, or ambidextrous.
Disabilities	Blind, defective vision, deafness, motor handicap.

The User's Knowledge and Experience

- ☐ The following kinds of knowledge and experiences should be identified.

Computer Literacy

- ☐ Are the users highly technical such as programmers or experienced data entry clerks or vice versa?

System Experience

Novice Vs Experts

- ☐ Words to describe the new, relatively new, or infrequent user have included naive, casual, inexperienced, or novice. At the other end of the experience continuum lie terms such as experienced, full-time, frequent, power, or expert. In between these extremes is a wide range of intermediate or intermittent users.
- ☐ In business systems, novice users have been found to:
 - Depend on system features that assist recognition memory: menus, prompting information, and instructional and help screens.
 - Need restricted vocabularies, simple tasks, small numbers of possibilities, and very informative feedback.
 - View practice as an aid to moving up to expert status.
- ☐ Experts, on the other hand:
 - Rely upon free recall.
 - Expect rapid performance.
 - Need less informative feedback.
 - Seek efficiency by bypassing novice memory aids, reducing keystrokes, chunking and summarizing
- ☐ Novice users often have difficulties:
 - Dragging and double-clicking using the mouse. Distinguishing between double-clicks and two separate clicks is particularly confusing
 - In window management. That overlapping windows represent a three-dimensional space is not always realized. Hidden windows are assumed to be gone and no longer exist.
 - In file management. The organization of files and folders nested more than two levels deep is difficult to understand. Structure is not as apparent as with physical files and folders.
- ☐ Experts possess the following traits:
 - They possess an integrated conceptual model of a system.
 - They possess knowledge that is ordered more abstractly and more procedurally.
 - They organize information more meaningfully, orienting it toward their task.
 - They structure information into more categories.
 - They are better at making inferences and relating new knowledge to their

- objectives and goals.
 - They pay less attention to low-level details.
 - They pay less attention to surface features of a system.
- Novices exhibit these characteristics:
 - They possess a fragmented conceptual model of a system.
 - They organize information less meaningfully, orienting it toward surface features of the system.
 - They structure information into fewer categories.
 - They have difficulty in generating inferences and relating new knowledge to their objectives and goals.
 - They pay more attention to low-level details.
 - They pay more attention to surface features of the system.

Application Experience

- Have users worked with a similar application (for example, word processing, airline reservation, and so on)? Are they familiar with the basic application terms? Or does little or no application experience exist?

Task Experience

- Are users experienced with the task being automated? Or do users possess little or no knowledge of the tasks the system will be performing?

Other System Use

- Will the user be using other systems while using the new system?

Education

- What is the general educational level of users? Do they generally have high school degrees, college degrees, or advanced degrees?

Reading Level

- For textual portions of the interface, the vocabulary and grammatical structure must be at a level that is easily understood by the users.

Typing Skill

- Is the user a competent typist or of the hunt-and-peck variety? Is he or she familiar with the standard keyboard layout or other newer layouts?

Native Language and Culture

- Do the users speak English, another language, or several other languages? Will the screens be in English or in another language? Other languages often impose different screen layout requirements.
- Are there cultural or ethnic differences between users?

The User's Tasks and Needs

- The user's tasks and needs are also important in design. The following should be determined:

Mandatory Vs Discretionary Use

- Users of the earliest computer systems were mandatory or nondiscretionary. That is, they required the computer to perform a task that, for all practical purposes, could be performed no other way.

- ☐ This newer kind of user is the office executive, manager, or other professional, whose computer use is completely discretionary.

Characteristics of mandatory use can be summarized as follows:

- ☐ The computer is used as part of employment.
- ☐ Time and effort in learning to use the computer are willingly invested.
- ☐ High motivation is often used to overcome low usability characteristics.
- ☐ The user may possess a technical background.
- ☐ The job may consist of a single task or function.

Common general characteristics of the discretionary user are as follows:

- ☐ Use of the computer or system is not absolutely necessary.
- ☐ Technical details are of no interest.
- ☐ Extra effort to use the system may not be invested.
- ☐ High motivation to use the system may not be exhibited.
- ☐ May be easily disenchanted.
- ☐ Voluntary use may have to be encouraged.
- ☐ Is from a heterogeneous culture.

Frequency of Use

- ☐ Is system use a continual, frequent, occasional, or once-in-a-lifetime experience? Frequency of use affects both learning and memory.
- ☐ Occasional or infrequent users prefer ease of learning and remembering,

Task or Need Importance

- ☐ How important is the task or need for the user?
- ☐ People are usually willing to spend more time learning something if it makes the task being performed or need being fulfilled more efficient.

Task Structure

- ☐ How structured is the task being performed? Is it repetitive and predictable or not so?

Social Interactions

- ☐ Will the user, in the normal course of task performance, be engaged in a conversation with another person, such as a customer, while using the system? If so, design should not interfere with the social interaction.
- ☐ Neither the user nor the person to whom the user is talking must be distracted in any way by computer interaction requirements. The design must accommodate the social interaction.

Job Category

- ☐ In a business system, is the user an executive, manager, professional, secretary, or clerk? While job titles have no direct bearing on design per se, they do enable one to predict some job characteristics when little else is known about the user.
- ☐ For example, executives and managers are most often discretionary users, while clerks are most often mandatory ones.

The User's Psychological Characteristics

- ☐ A person's psychological characteristics also affect one's performance of tasks requiring motor, cognitive, or perceptual skills.

Attitude and Motivation

- ☐ Is the user's attitude toward the system positive, neutral, or negative? Is motivation high, moderate, or low?
- ☐ While all these feelings are not caused by, and cannot be controlled by, the designer, a positive attitude and motivation allows the user to concentrate on the productivity qualities of the system.

Patience

- ☐ Is the user patient or impatient?
- ☐ They are exhibiting less tolerance for Web use learning requirements, slow response times, and inefficiencies in navigation and locating desired content.

Stress Level

- ☐ Will the user be subject to high levels of stress while using the system? Interacting with an angry boss, client, or customer, can greatly increase a person's stress level.
- ☐ System navigation or screen content may have to be redesigned for extreme simplicity in situations that can become stressful.

Expectations

- ☐ What are user's expectations about the system or Web site? Are they realistic?
- ☐ Is it important that the user's expectations be realized?

Cognitive Style

- ☐ People differ in how they think about and solve problems.
- ☐ Some people are better at verbal thinking, working more effectively with words and equations.
- ☐ Others are better at spatial reasoning—manipulating symbols, pictures, and images.
- ☐ Some people are analytic thinkers, systematically analyzing the facets of a problem.
- ☐ Others are intuitive, relying on rules of thumb, hunches, and educated guesses.
- ☐ Some people are more concrete in their thinking, others more abstract.

The User's Physical Characteristics

- ☐ The physical characteristics of people can also greatly affect their performance with a system.

Age

- ☐ Are the users children, young adults, middle-aged, senior citizens, or very elderly? Age can have an affect on both computer and system usage.

Young Adults VS Older Adults

Young adults (aged 18–36), in comparison to older adults (aged 64–81)

- ☐ Use computers and ATMs more often.
- ☐ Read faster.
- ☐ Possess greater reading comprehension and working memory capacity.
- ☐ Possess faster choice reaction times.
- ☐ Possess higher perceptual speed scores.
- ☐ Complete a search task at a higher success rate.
- ☐ Use significantly less moves (clicks) to complete a search task.
- ☐ Are more likely to read a screen a line at a time.

Older adults, as compared to young adults:

- ☐ Are more educated.
- ☐ Possess higher vocabulary scores.
- ☐ Have more difficulty recalling previous moves and location of previously viewed information.
- ☐ Have more problems with tasks that require three or more moves (clicks).
- ☐ Are more likely to scroll a page at a time.
- ☐ Respond better to full pages rather than long continuous scrolled pages.

Methods for Gaining an Understanding of Users

- ☐ Visit user locations, particularly if they are unfamiliar to you, to gain an understanding of the user's work environment.
- ☐ Talk with users about their problems, difficulties, wishes, and what works well now. Establish direct contact; avoid relying on intermediaries.
- ☐ Observe users working or performing a task to see what they do, their difficulties, and their problems.
- ☐ Videotape users working or performing a task to illustrate and study problems and difficulties.
- ☐ Learn about the work organization where the system may be installed.
- ☐ Have users think aloud as they do something to uncover details that may not otherwise be solicited.
- ☐ Try the job yourself. It may expose difficulties that are not known, or expressed, by users.
- ☐ Prepare surveys and questionnaires to obtain a larger sample of user opinions.
- ☐ Establish testable behavioral target goals to give management a measure for what progress has been made and what is still required.

Hearing

- ☐ As people age, they require louder sounds to hear, a noticeable attribute in almost any everyday activity.

Age in Years	Sound Level in dB
25	57
45	65
65	74
85	85

Vision

- ☐ Older adults read prose text in smaller type fonts more slowly than younger adults
- ☐ (Charness and Dijkstra, 1999). For older adults they recommend:

- 14-point type in 4-inch wide columns.
- 12-point type in 3-inch wide columns.
- Ellis and Kurniawan (2000) recommend the following fonts for older users:
 - San serif (Arial, Helvetica, and Verdana).
 - Black type on a white background.
- Ellis and Kurniawan (2000) and Czaja (1997) suggest Web links should be:
 - Distinct and easy to see.
 - Large (at least 180 × 22 pixels for a button).
 - Surrounded by a large amount of white space.

Cognitive Processing

- Brain processing also appears to slow with age. Working memory, attention capacity, and visual search appear to be degraded.
- Tasks where knowledge is important show the smallest age effect and tasks dependent upon speed show the largest effect

Gender

- A user's sex may have an impact on both motor and cognitive performance because
 - Women are not as strong as men,
 - Women also have smaller hands than men, and
 - Significantly more men are color-blind than women

Handedness

- A user's handedness, left or right, can affect ease of use of an input mechanism, depending on whether it has been optimized for one or the other hand.

Disabilities

- Blindness, defective vision, color-blindness, poor hearing, deafness, and motor handicaps can affect performance on a system not designed with these disabilities in mind.
- People with special needs must be considered in design especially for systems like web design.

Human Interaction Speeds

- The speed at which people can perform using various communication methods has been studied by a number of researchers. The following, are summarized as table below

Reading

Prose text:	250–300 words per minute.
Proofreading text on paper:	200 words per minute.
Proofreading text on a monitor:	180 words per minute.

Listening:

150–160 words per minute.

Speaking to a computer:

105 words per minute.

After recognition corrections:

25 words per minute.

Keying

Typewriter

Fast typist: 150 words per minute and higher.

Average typist:	60–70 words per minute.
Computer	
Transcription:	33 words per minute.
Composition:	19 words per minute.
Two finger typists	
Memorized text:	37 words per minute.
Copying text:	27 words per minute.
Hand printing	
Memorized text:	31 words per minute.
Copying text:	22 words per minute.

Methods for Gaining an Understanding of Users

- Gould (1988) suggests using the following kinds of techniques to gain an understanding of users, their tasks and needs, the organization where they work, and the environment where the system may be used.
 - Visit user locations, particularly if they are unfamiliar to you, to gain an understanding of the user's work environment.
 - Talk with users about their problems, difficulties, wishes, and what works well now. Establish direct contact; avoid relying on intermediaries.
 - Observe users working or performing a task to see what they do, their difficulties, and their problems.
 - Videotape users working or performing a task to illustrate and study problems and difficulties.
 - Learn about the work organization where the system may be installed.
 - Have users think aloud as they do something to uncover details that may not otherwise be solicited.
 - Try the job yourself. It may expose difficulties that are not known, or expressed, by users.
 - Prepare surveys and questionnaires to obtain a larger sample of user opinions.
 - Establish testable behavioral target goals to give management a measure for what progress has been made and what is still required.

Understand the Business Function

The general steps to be performed are:

- Perform a business definition and requirements analysis.
- Determine basic business functions.
- Describe current activities through task analysis.
- Develop a conceptual model of the system.
- Establish design standards or style guides.
- Establish system usability design goals.
- Define training and documentation needs.

Business Definition and Requirements Analysis

- The objective of this phase is to establish the need for a system. A requirement is an objective that must be met.
- A product description is developed and refined, based on input from users or marketing. There are many techniques for capturing information for determining

requirements.

DIRECT METHODS

Advantages

- ☐ The significant advantage of the direct methods is the opportunity they provide to hear the user's comments in person and firsthand.
- ☐ Person-to-person encounters permit multiple channels of communication (body language, voice inflections, and so on) and provide the opportunity to immediately follow up on vague or incomplete data.

Here are some recommended direct methods for getting input from users.

Individual Face-to-Face Interview

- ☐ A one-on-one visit with the user to obtain information. It may be structured or somewhat open-ended.
- ☐ A formal questionnaire should not be used, however. Useful topics to ask the user to describe in an interview include:
 - ☐ The activities performed in completing a task or achieving a goal or objective.
 - ☐ The methods used to perform an activity.
 - ☐ What interactions exist with other people or systems?
- ☐ It is also very useful to also uncover any:
 - ☐ Potential measures of system usability
 - ☐ Unmentioned exceptions to standard policies or procedures.
 - ☐ Relevant knowledge the user must possess to perform the activity.
- ☐ **Advantages**
 - ☐ Advantages of a personal interview are that you can give the user your full attention, can easily include follow-up questions to gain additional information, will have more time to discuss topics in detail, and will derive a deeper understanding of your users, their experiences, attitudes, beliefs, and desires.
- ☐ **Disadvantages**
 - ☐ Disadvantages of interviews are that they can be costly and time-consuming to conduct, and someone skilled in interviewing techniques should perform them.

Telephone Interview or Survey

- ☐ A structured interview conducted via telephone.
- ☐ **Advantages**
 - ☐ Arranging the interview in advance allows the user to prepare for it.
 - ☐ Telephone interviews are less expensive and less invasive than personal interviews.
 - ☐ They can be used much more frequently and are extremely effective for very specific information.
- ☐ **Disadvantage**
 - ☐ It is impossible to gather contextual information, such as a description of the working environment, replies may be easily influenced by the interviewer's comments, and body language cues are missing.
 - ☐ Also, it may be difficult to contact the right person for the telephone

interview.

Traditional Focus Group

- ☐ A small group of users and a moderator brought together to verbally discuss the requirements.
- ☐ The purpose of a focus group is to probe user's experiences, attitudes, beliefs, and desires, and to obtain their reactions to ideas or prototypes
- ☐ Setting up focus group involves the following:
 - o Establish the objectives of the session.
 - o Select participants representing typical users, or potential users.
 - o Write a script for the moderator to follow.

 - o Find a skilled moderator to facilitate discussion, to ensure that the discussion remains focused on relevant topics, and to ensure that everyone participates.
 - o Allow the moderator flexibility in using the script.
 - o Take good notes, using the session recording for backup and clarification

Facilitated Team Workshop

- ☐ A facilitated, structured workshop held with users to obtain requirements information. Similar to the traditional Focus Group
- ☐ Like focus groups, they do require a great deal of time to organize and run.

Observational Field Study

- ☐ Users are observed and monitored for an extended time to learn what they do.
- ☐ Observation provides good insight into tasks being performed, the working environment and conditions, the social environment, and working practices
- ☐ Observation, however, can be time-consuming and expensive.
- ☐ Video recording of the observation sessions will permit detailed task analysis.

Requirements Prototyping

- ☐ A demo, or very early prototype, is presented to users for comments concerning functionality.

User-Interface Prototyping

- ☐ A demo, or early prototype, is presented to users to uncover user-interface issues and problems

Usability Laboratory Testing

- ☐ Users at work are observed, evaluated, and measured in a specially constructed laboratory to establish the usability of the product at that point in time.
- ☐ Usability tests uncover what people actually do, not what they think they do a common problem with verbal descriptions
- ☐ The same scenarios can be presented to multiple users, providing comparative data from several users.

Card Sorting for Web Sites

- ☐ A technique to establish groupings of information for Web sites.

- Briefly, the process is as follows:
 - From previous analyses, identify about 50 content topics and inscribe them on index cards. Limit topics to no more than 100.
 - Provide blank index cards for names of additional topics the participant may want to add, and colored blank cards for groupings that the participant will be asked to create.
 - Number the cards on the back.
 - Arrange for a facility with large enough table for spreading out cards.
 - Select participants representing a range of users. Use one or two people at a time and 5 to 12 in total.
 - Explain the process to the participants, saying that you are trying to determine what categories of information will be useful, what groupings make sense, and what the groupings should be called.
 - Ask the participants to sort the cards and talk out loud while doing so. Advise the participants that additional content cards may be named and added as they think necessary during the sorting process.
 - Observe and take notes as the participants talk about what they are doing. Pay particular attention to the sorting rationale.
 - Upon finishing the sorting, if a participant has too many groupings ask that they be arranged hierarchically.
 - Ask participants to provide a name for each grouping on the colored blank cards, using words that the user would expect to see that would lead them to that particular grouping.
 - Make a record of the groupings using the numbers on the back of each card.
 - Reshuffle the cards for the next session.
 - When finished, analyze the results looking for commonalities among the different sorting sessions.

INDIRECT METHODS

- An indirect method of requirements determination is one that places an intermediary between the developer and the user. This intermediary may be electronic or another person

Problems of Indirect Method

- First, there may be a filtering or distortion of the message, either intentional or unintentional.
- Next, the intermediary may not possess a complete, or current, understanding of user's needs, passing on an incomplete or incorrect message.
- Finally, the intermediary may be a mechanism that discourages direct user-developer contact for political reasons.

MIS Intermediary

- A company representative defines the user's goals and needs to designers and developers.
- This representative may come from the Information Services department itself, or he or she may be from the using department.

Paper Survey or Questionnaire

- A survey or questionnaire is administered to a sample of users using traditional mail methods to obtain their needs.

- **Advantage**
 - Questionnaires have the potential to be used for a large target audience located most anywhere, and are much cheaper than customer visits.
 - They generally, however, have a low return rate
- **Disadvantage**
 - They may take a long time to collect and may be difficult to analyze.
- Questionnaires should be composed mostly of closed questions
- Questionnaires should be relatively short and created by someone experienced in their design.

Electronic Survey or Questionnaire

- A survey or questionnaire is administered to a sample of users using e-mail or the Web to obtain their needs.
- In creating an electronic survey:
 - Determine the survey objectives.
 - Determine where you will find the people to complete the survey.
 - Create a mix of multiple choice and open-ended questions requiring short answers addressing the survey objectives.
 - Keep it short, about 10 items or less is preferable.
 - Keep it simple, requiring no more than 5–10 minutes to complete
- **Iterative survey**
 - Consider a follow-up more detailed survey, or surveys, called *iterative surveys*. Ask people who complete and return the initial survey if they are willing to answer more detailed questions. If so, create and send the more detailed survey.
 - A third follow-up survey can also be designed to gather additional information about the most important requirements and tasks
 - Iterative surveys, of course, take a longer time to complete.

Electronic Focus Group

- A small group of users and a moderator discuss the requirements online using workstations.
- advantages
 - Advantages of electronic focus groups over traditional focus groups are that the discussion is less influenced by group dynamics; has a smaller chance of being dominated by one or a few participants; can be anonymous, leading to more honest comments and less caution in proposing new ideas
- **Disadvantages**
 - The depth and richness of verbal discussions does not exist and the communication enhancement aspects of seeing participant's body language are missing.

Marketing and Sales

- Company representatives who regularly meet customers obtain suggestions or needs, current and potential.

Support Line

- Information collected by the unit that helps customers with day-to-day problems is analyzed (Customer Support, Technical Support, Help Desk, etc.).

E-Mail or Bulletin Board

- ☐ Problems, questions, and suggestions from users posted to a bulletin board or through e-mail are analyzed.

User Group

- ☐ Improvements are suggested by customer groups who convene periodically to discuss software usage. They require careful planning.

Competitor Analyses

- ☐ A review of competitor's products or Web sites is used to gather ideas, uncover design requirements and identify tasks.

Trade Show

- ☐ Customers at a trade show are presented a mock-up or prototype and asked for comments.

Other Media Analysis

- ☐ An analysis of how other media, print or broadcast, present the process, information, or subject matter of interest.

System Testing

- ☐ New requirements and feedback are obtained from ongoing product testing
Requirements Collection Guidelines
- ☐ Establish 4 to 6 different developer-user links.
- ☐ Provide most reliance on direct links.

Determining Basic Business Functions

- ☐ A detailed description of what the product will do is prepared. Major system functions are listed and described, including critical system inputs and outputs. A flowchart of major functions is developed. The process the developer will use is summarized as follows:
 - Gain a complete understanding of the user's mental model based upon:
 - The user's needs and the user's profile.
 - A user task analysis.
 - Develop a conceptual model of the system based upon the user's mental model.
This includes:
 - Defining objects.
 - Developing metaphors.

Understanding the User's Mental Model

- ☐ A goal of task analysis, and a goal of understanding the user, is to gain a picture of the user's mental model. A mental model is an internal representation of a person's current conceptualization and understanding of something.
- ☐ Mental models are gradually developed in order to understand, explain, and do something. Mental models enable a person to predict the actions necessary to do things if the actions have been forgotten or have not yet been encountered.

Performing a Task Analysis

- User activities are precisely described in a task analysis. Task analysis involves breaking down the user's activities to the individual task level. The goal is to obtain an understanding of why and how people currently do the things that will be automated.
- Knowing why establishes the major work goals; knowing how provides details of actions performed to accomplish these goals. Task analysis also provides information concerning workflows, the interrelationships between people, objects, and actions, and the user's conceptual frameworks. The output of a task analysis is a complete description of all user tasks and interactions.
- One result of a task analysis is a listing of the user's current tasks. This list should be well documented and maintained. Changes in task requirements can then be easily incorporated as design iteration occurs. Another result is a list of objects the users see as important to what they do. The objects can be sorted into the following categories:
 - Concrete objects—things that can be touched.
 - People who are the object of sentences—normally organization employees, customers,
 - for example.
 - Forms or journals—things that keep track of information.
 - People who are the subject of sentences—normally the users of a system.
 - Abstract objects—anything not included above.

Developing Conceptual Models

- The output of the task analysis is the creation, by the designer, of a conceptual model for the user interface. A conceptual model is the general conceptual framework through which the system's functions are presented. Such a model describes how the interface will present objects, the relationships between objects, the properties of objects, and the actions that will be performed.
- The goal of the designer is to facilitate for the user the development of useful mental model of the system. This is accomplished by presenting to the user a meaningful conceptual model of the system. When the user then encounters the system, his or her existing mental model will, hopefully, mesh well with the system's conceptual model.

Guidelines for Designing Conceptual Models

- **Reflect the user's mental model not the designer's:** A user will have different expectations and levels of knowledge than the designer. So, the mental models of the user and designer will be different. The user is concerned with the task to be performed, the business objectives that must be fulfilled.
- **Draw physical analogies or present metaphors:** Replicate what is familiar and well known. Duplicate actions that are already well learned. A metaphor, to be effective, must be widely applicable within an interface.

- **Comply with expectancies, habits, routines, and stereotypes:** Use familiar associations, avoiding the new and unfamiliar. With color, for example, accepted meanings for red, yellow, and green are already well established. Use words and symbols in their customary ways.
- **Provide action-response compatibility:** All system responses should be compatible with the actions that elicit them. Names of commands, for example, should reflect the actions that will occur.
- **Make invisible parts and process of a system visible:** New users of a system often make erroneous or incomplete assumptions about what is invisible and develop a faulty mental model. As more experience is gained, their mental models evolve to become more accurate and complete. Making invisible parts of a system visible will speed up the process of developing correct mental models.
- **Provide proper and correct feedback:** Be generous in providing feedback. Keep a person informed of what is happening, and what has happened, at all times, including:
 - Provide visible results of actions.
 - Display actions in progress.
 - Provide a continuous indication of status.
 - Present as much context information as possible.
 - Provide clear, constructive, and correct error messages.
- **Avoid anything unnecessary or irrelevant:** Never display irrelevant information on the screen. People may try to interpret it and integrate it into their mental models, thereby creating a false one.
- **Provide design consistency:** Design consistency reduces the number of concepts to be learned. Inconsistency requires the mastery of multiple models. If an occasional inconsistency cannot be avoided, explain it to the user.
- **Provide documentation and a help system that will reinforce the conceptual model:** Do not rely on the people to uncover consistencies and metaphors themselves. The help system should offer advice aimed at improving mental models.
- **Promote the development of both novice and expert mental models :** Novices and experts are likely to bring to bear different mental models when using a system.

Defining Objects

- Determine all objects that have to be manipulated to get work done. Describe:
 - The objects used in tasks.
 - Object behavior and characteristics that differentiate each kind of object.
 - The relationship of objects to each other and the people using them.
 - The actions performed.
 - The objects to which actions apply.
 - State information or attributes that each object in the task must preserve,

display, or allow to be edited.

- ☐ Identify the objects and actions that appear most often in the workflow.
- ☐ Make the several most important objects very obvious and easy to manipulate.

Developing Metaphors

- ☐ A metaphor is a concept where one's body of knowledge about one thing is used to understand something else. Metaphors act as building blocks of a system, aiding understanding of how a system works and is organized.
- ☐ Real-world metaphors are most often the best choice. Replicate what is familiar and well known. A common metaphor in a graphical system is the desktop and its components,
 - Choose the analogy that works best for each object and its actions.
 - Use real-world metaphors.
 - Use simple metaphors.
 - Use common metaphors.
 - Multiple metaphors may coexist.
 - Use major metaphors, even if you can't exactly replicate them visually.
 - Test the selected metaphors.

Design Standards or Style Guides

- ☐ A design standard or style guide documents an agreed-upon way of doing something. It also defines the interface standards, rules, guidelines, and conventions that must be followed in detailed design.

Value of Standards and Guidelines

- ☐ Developing and applying design standards or guidelines achieve design consistency.
- ☐ This is valuable to users because the standards and guidelines:
 - Allow faster performance.
 - Reduce errors.
 - Reduce training time.
 - Foster better system utilization.
 - Improve satisfaction.
 - Improve system acceptance.
- ☐ They are valuable to system developers because they:
 - Increase visibility of the human-computer interface.
 - Simplify design.
 - Provide more programming and design aids, reducing programming time.
 - Reduce redundant effort.
 - Reduce training time.
 - Provide a benchmark for quality control testing.

Document Design

- ☐ Include checklists to present principles and guidelines.
- ☐ Provide a rationale for why the particular guidelines should be used.

- ☐ Provide a rationale describing the conditions under which various design alternatives are appropriate.
- ☐ Include concrete examples of correct design.
- ☐ Design the guideline document following recognized principles for good document design.
- ☐ Provide good access mechanisms such as a thorough index, a table of contents, glossaries, and checklists.

Design Support and Implementation

- ☐ Use all available reference sources in creating the guidelines.
- ☐ Use development and implementation tools that support the guidelines.
- ☐ Begin applying the guidelines immediately.

System Training and Documentation Needs

Training

- ☐ System training will be based on user needs, system conceptual design, system learning goals, and system performance goals.
- ☐ Training may include such tools as formal or video training, manuals, online tutorials, reference manuals, quick reference guides, and online help.
- ☐ Any potential problems can also be identified and addressed earlier in the design process, reducing later problems and modification costs.

Documentation

- ☐ System documentation is a reference point, a form of communication, and a more concrete design—words that can be seen and understood based on user needs, system conceptual design, and system performance goals.
- ☐ It will also be Creating documentation during the development progress will uncover issues and reveal omissions that might not otherwise be detected until later in the design process.

UNIT-III

Screen Designing

Understand the Principles of Good Screen Design

- ☐ A well-designed screen:
 - o Reflects the capabilities, needs, and tasks of its users.
 - o Is developed within the physical constraints imposed by the hardware on which it is displayed.
 - o Effectively utilizes the capabilities of its controlling software.
 - o Achieves the business objectives of the system for which it is designed.

How to Distract the Screen User

- ☐ Unclear captions and badly worded questions. These cause hesitation, and rereading, in order to determine what is needed or must be provided. They may also be interpreted incorrectly, causing errors.
- ☐ Improper type and graphic emphasis. Important elements are hidden. Emphasis is drawn away from what is important to that which is not important.
- ☐ Misleading headings. These also create confusion and inhibit one's ability to see existing relationships.
- ☐ Information requests perceived to be irrelevant or unnecessary. The value of what one is doing is questioned, as is the value of the system.
- ☐ Information requests that require one to backtrack and rethink a previous answer, or look ahead to determine possible context. Inefficiency results, and mistakes increase.
- ☐ Cluttered, cramped layout. Poor layout creates a bad initial impact and leads to more errors. It may easily cause system rejection.
- ☐ Poor quality of presentation, legibility, appearance, and arrangement. Again, this degrades performance, slowing the user down and causing more errors.
- ☐ Visual inconsistency in screen detail presentation and with the operating system.
- ☐ Lack of restraint in the use of design features and elements.
- ☐ Overuse of three-dimensional presentations.
- ☐ Overuse of too many bright colors.
- ☐ Poorly designed icons.
- ☐ Bad typography
- ☐ Metaphors that are either overbearing or too cute, or too literal thereby restricting design options.

What Screen Users Want

- ☐ An orderly, clean, clutter-free appearance.
- ☐ An obvious indication of what is being shown and what should be done with it.
- ☐ Expected information located where it *should* be.
- ☐ A clear indication of what relates to what, including options, headings, captions, data, and so forth.
- ☐ Plain, simple English.
- ☐ A simple way of finding out what is in a system and how to get it out.

- ☐ A clear indication of when an action can make a permanent change in the data or system.

What Screen Users Do

- ☐ When interacting with a computer, a person
 - Identifies a task to be performed or need to be fulfilled: The task may be very structured or semi structured or structured with free form activities.
 - Decides how the task will be completed or the need fulfilled: set of transaction screens will be used. The proper transaction is identified and the relevant screen series retrieved.
 - Manipulates the computer's controls: To perform the task or satisfy the need, the keyboard, mouse, and other similar devices are used
 - Gathers the necessary data: Screens information is collected from its source through forms or coworker and placed on the screen, through control manipulation.
 - Forms judgments resulting in decisions relevant to the task or need: Structured transactions will require minimal decision-making. Semi-structured transactions, in addition, may require decisions such as: Which set of screens, from all available.

Interface Design Goals

- ☐ To make an interface easy and pleasant to use, then, the goal in design is to:
 - Reduce visual work.
 - Reduce intellectual work.
 - Reduce memory work.
 - Reduce motor work.
 - Minimize or eliminate any burdens or instructions imposed by technology.

The Test for a Good Design

- ☐ Can all screen elements be identified by cues other than by reading the words that make them up?
- ☐ A simple test for good screen design does exist. A screen that passes this test will have surmounted the first obstacle to effectiveness. The test is this: Can all screen elements (field captions, data, title, headings, text, types of controls, and so on) be identified without reading the words that identify or comprise them? That is, can a component of a screen be identified through cues independent of its content?
- ☐ If this is so, a person's attention can quickly be drawn to the part of the screen that is relevant at that moment. People look at a screen for a particular reason, perhaps to locate a piece of information such as a customer name, to identify the name of

the screen, or to find an instructional or error message.

- ☐ The signal at that moment is that element of interest on the screen. The noise is everything else on the screen. Cues independent of context that differentiate the components of the screen will reduce visual search times and minimize confusion.

Screen Meaning and Purpose

- ☐ Each screen element . . .
 - Every control
 - All text
 - The screen organization
 - All emphasis
 - Each color
 - Every graphic
 - All screen animation
 - Each message
 - All forms of feedback
- ☐ Must . . .
 - Have meaning to screen users.
 - Serve a purpose in performing tasks.

Organizing Screen Elements Clearly and Meaningfully

- ☐ Visual clarity is achieved when the display elements are organized and presented in meaningful and understandable ways. A clear and clean organization makes it easier to recognize screen's essential elements and to ignore its secondary information when appropriate.

Consistency

- ☐ Provide real-world consistency. Reflect a person's experiences, expectations, work conventions, and cultural conventions.
- ☐ Provide internal consistency. Observe the same conventions and rules for all aspects of an interface screen, and all application or Web site screens, including:
 - Operational and navigational procedures.
 - Visual identity or theme.
 - Component.
 - Organization.
 - Presentation.
 - Usage.
 - Locations.
- ☐ Follow the same conventions and rules across all related interfaces.
- ☐ Deviate only when there is a clear benefit for the user.
- ☐ Quite simply, consistency greatly aids learning. It establishes an expectation

Ordering of Screen Data and Content

- ☐ Divide information into units those are logical, meaningful, and sensible.
- ☐ Organize by the degree interrelationship between data or information.
- ☐ Provide an ordering of screen units of information and elements that is prioritized according to the user's expectations and needs.
- ☐ Possible ordering schemes include:

- Conventional.
- Sequence of use.
- Frequency of use.
- Function.
- Importance.
- General to specific.
- ☐ Form groups that cover all possibilities.
- ☐ Ensure that information that must be compared is visible at the same time.
- ☐ Ensure that only information relative to the users tasks or needs is presented on the screen.
- ☐ An organizational scheme's goal is to keep to a minimum the number of information

Upper-Left Starting Point

- ☐ Provide an obvious starting point in the screen's upper-left corner.

Screen Navigation and Flow

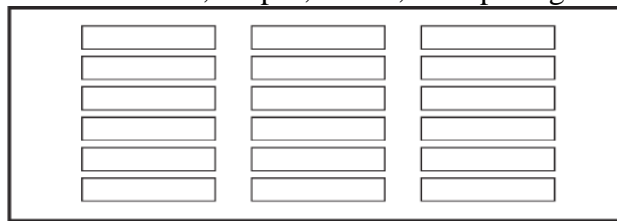
- ☐ Provide an ordering of screen information and elements that:
 - Is rhythmic, guiding a person's eye through the display.
 - In establishing eye movement through a screen, also consider that the eye tends to move sequentially, for example:
 - From dark areas to light areas.
 - From big objects to little objects.
 - From unusual shapes to common shapes.
 - From highly saturated colors to unsaturated colors.
 - Encourages natural movement sequences.
 - Minimizes pointer and eye movement distances.
- ☐ Locate the most important and most frequently used elements or controls at the top left.
- ☐ Maintain a top-to-bottom, left-to-right flow.
- ☐ Assist in navigation through a screen by:
 - Aligning elements.
 - Grouping elements.
 - Using of line borders.
- ☐ Through focus and emphasis, sequentially, direct attention to items that are:
 1. Critical.
 2. Important.
 3. Secondary.
 4. Peripheral.
- ☐ Tab through window in logical order of displayed information.
- ☐ Locate command buttons at end of the tabbing order sequence.
- ☐ When groups of related information must be broken and displayed on separate screens, provide breaks at logical or natural points in the information flow.

Visually Pleasing Composition

- ☐ Provide visually pleasing composition with the following qualities:
 - o Balance
 - o Symmetry
 - o Regularity.
 - o Predictability.
 - o Sequentially.
 - o Economy.
 - o Unity.
 - o Proportion.
 - o Simplicity.
 - o Groupings.

Regularity

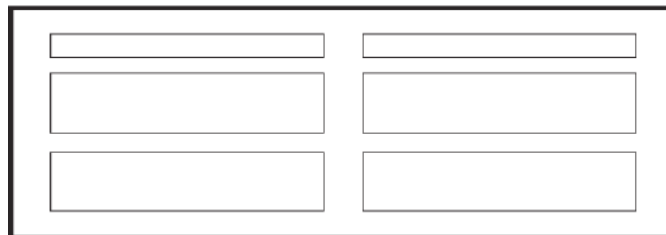
- ☐ Create regularity by establishing standard and consistently spaced horizontal and vertical alignment points.
- ☐ Also, use similar element sizes, shapes, colors, and spacing.



Regularity

Balance

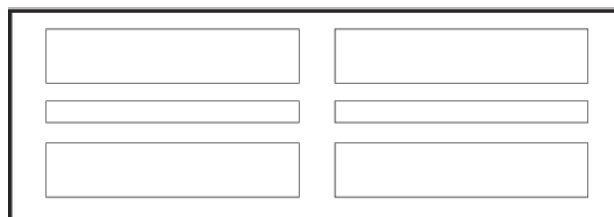
- ☐ Create screen balance by providing an equal weight of screen elements, left and right, top and bottom.



Balance

Symmetry

- ☐ Create symmetry by replicating elements left and right of the screen centerline.



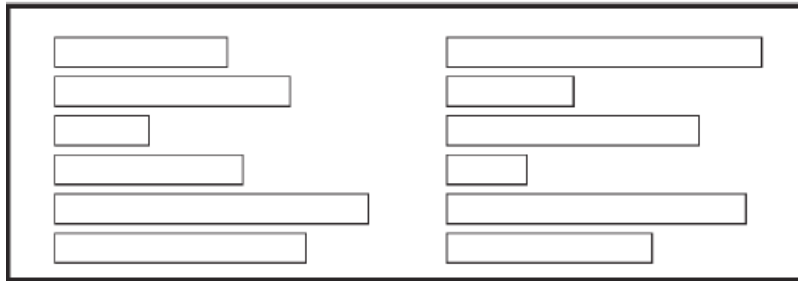
Symmetry

Predictability

- ☐ Create predictability by being consistent and following conventional orders or arrangements.

Sequentiality

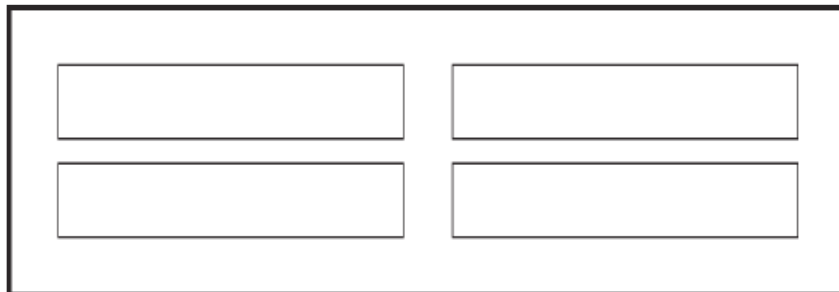
- ☐ Provide sequentiality by arranging elements to guide the eye through the screen in an obvious, logical, rhythmic, and efficient manner.
- ☐ The eye tends to be attracted to:
 - A brighter element before one less bright.
 - Isolated elements before elements in a group.
 - Graphics before text.
 - Color before black and white.
 - Highly saturated colors before those less saturated.
 - Dark areas before light areas.
- A big element before a small one.
- An unusual shape before a usual one.
- Big objects before little objects.



Sequentiality

Unity

- ☐ Create unity by:
 - Using similar sizes, shapes, or colors for related information.
 - Leaving less space between elements of a screen than the space left at the margins.



Unity

Proportion

- Create windows and groupings of data or text with aesthetically pleasing proportions.

Pleasing proportions.

Square	1:1
Square-root of two	1:1.414
Square-root of three	1:1.732
Double square	1:2
Golden rectangle	1:1.618

Simplicity (Complexity)

- Optimize the number of elements on a screen, within limits of clarity.
- Minimize the alignment points, especially horizontal or columnar.
 - Provide standard grids of horizontal and vertical lines to position elements.
- complexity guidelines:
 - Optimize the number of elements on a screen, within limits of clarity.
 - Minimize the alignment points, especially horizontal or columnar.

Groupings

- Provide functional groupings of associated elements.
- Create spatial groupings as closely as possible to five degrees of visual angle (1.67 inches in diameter or about 6 to 7 lines of text, 12 to 14 characters in width).
- Evenly space controls within a grouping, allowing 1/8 to 1/4 inch between each.
- Visually reinforce groupings:
 - Provide adequate separation between groupings through liberal use of white space.
 - Provide line borders around groups.
- Provide meaningful titles for each grouping.

Perceptual Principles and Functional Grouping

- Use visual organization to create functional groupings.
 - Proximity: 000 000 000
 - Similarity: AAABBBCCCC
 - Closure: [] [] []
 - Matching patterns: >> <>

Combine visual organization principles in logical ways.

- Proximity and similarity: AAA BB CCC
- Proximity and closure: [] [] []
- Matching patterns and closure: () <> { }

— Proximity and ordering:

1234	1	5
5678	2	6
3	7	
4	8	

Avoid visual organization principles that conflict.

— Proximity opposing similarity: AAA ABB BBC CCC

— Proximity opposing closure:] [] [] [

— Proximity opposing ordering: 1357 1 2

2468	3	4
5	6	
7	8	

Grouping Using White Space

- ☐ Provide adequate separation between groupings through liberal use of white space.
- ☐ For Web pages, carefully consider the trade-off between screen white space and the requirement for page scrolling.

Grouping Using Borders

- ☐ Incorporate line borders for:
 - Focusing attention on groupings or related information.
 - Guiding the eye through a screen.
- ☐ Do not exceed three line thicknesses or two line styles on a screen, however.
 - Use a standard hierarchy for line presentation.
- ☐ Create lines consistent in height and length.
- ☐ Leave sufficient padding space between the information and the surrounding borders.
- ☐ For adjacent groupings with borders, whenever possible, align the borders left, right, top, and bottom.
- ☐ Use rules and borders sparingly.
- ☐ In Web page design:
 - be cautious in using horizontal lines as separators between page sections.
 - Reserve horizontal lines for situations in which the difference between adjacent areas must be emphasized.

Grouping Using Backgrounds

- ☐ Consider incorporating a contrasting background for related information.
 - The background should not have the –emphasis‖ of the screen component that should be attended to. Consider about a 25 percent gray screening.
 - Reserve higher contrast or –emphasizing‖ techniques for screen components to which attention should be drawn.

Visual Style in Web Page Design

- ☐ Maintain a consistent and unified visual style throughout the pages of an entire Web site.
- ☐ Base the visual style on:

- The profile and goals of the Web site owner.
- The profile, tastes, and expectations of the Web site user.

Amount of Information

- ☐ Present the proper amount of information for the task.
 - Too little is inefficient.
 - Too much is confusing.
- ☐ Present all information necessary for performing an action or making a decision on one screen, whenever possible.
 - People should not have to remember things from one screen to the next.
- ☐ Restrict screen or window density levels to no more than about 30 percent.

Web Page Size

- ☐ Minimize page length.
 - Restrict to two or three screens of information.
- ☐ Place critical or important information at the very top so it is always viewable when the page is opened.
 - Locate it within the top 4 inches of page.
- ☐ Determining an optimum page length will require balancing these factors. Arguments for shorter pages and against longer pages are that longer pages:
 - Tax the user's memory, as related information is more scattered and not always visible.
 - Can lead to a lost sense of context as navigation buttons and major links disappear from view.
 - Display more content and a broader range of navigation links making it more difficult for users to find and then decide upon what path to follow.
 - Require excessive page scrolling, which may become cumbersome and inefficient.
 - Are less conducive to the –chunking‖ information organization scheme commonly employed in Web sites.
- ☐ Arguments for longer pages are that they:
 - Resemble the familiar structure of paper documents.
 - Require less –clicks‖ for navigating through a Web site.
 - Are easier to download and print for later reading.
 - Are easier to maintain because they possess fewer category navigation links to other pages.

Deciding on Long versus Short Pages

- ☐ To find specific information quickly:
 - Create many links to short pages.
- ☐ To understand an entire concept without interruption:
 - Present the entire concept in one page with internal links to subtopics.
- ☐ To print all or most of the content to read offline:
 - Use one long page or prepare a version that uses one page.
- ☐ If page will be loading over slow modems and all pages are not needed:
 - Create a comprehensive contents page with links to many short pages.

Scrolling and Paging

- Scrolling:
 - Avoid scrolling to determine a page's contents.
 - Minimize vertical page scrolling.
 - When vertical scrolling is necessary to view an entire page:
- Provide contextual cues within the page that it must be scrolled to view its entire contents.
- Provide a unique and consistent –end of page structure.
 - Avoid horizontal page scrolling.
- Paging:
 - Encourage viewing a page through paging
 - Create a second version of a Web site, one consisting of individual screens that are viewed through paging

Focus and Emphasis

- Visually emphasize the:
 - Most prominent element.
 - Most important elements.
 - Central idea or focal point.
- To provide emphasis use techniques such as:
 - Higher brightness.
 - Reverse polarity or inverse video.
 - Larger and distinctive font.
 - Underlining.
 - Blinking.
 - Line rulings and surrounding boxes or frames.
 - Contrasting color.
 - Larger size.
 - Positioning.
 - Isolation.
 - Distinctive or unusual shape.
 - White space.
- De-emphasize less important elements.
- To ensure that emphasized screen elements stand out, avoid:
 - Emphasizing too many screen elements.
 - Using too many emphasis techniques.
 - Screen clutter.
- In Web page design:
 - Call attention to new or changed content.
 - Ensure that page text is not overwhelmed by page background.

Presenting Information Simply and Meaningfully

- Provide legibility.
 - Information is noticeable and distinguishable.
- Provide readability.
 - Information is identifiable, interpretable, and attractive.
- Present information in usable form.
 - Translations, transpositions, and references to documentation should not be required to interpret and understand information.

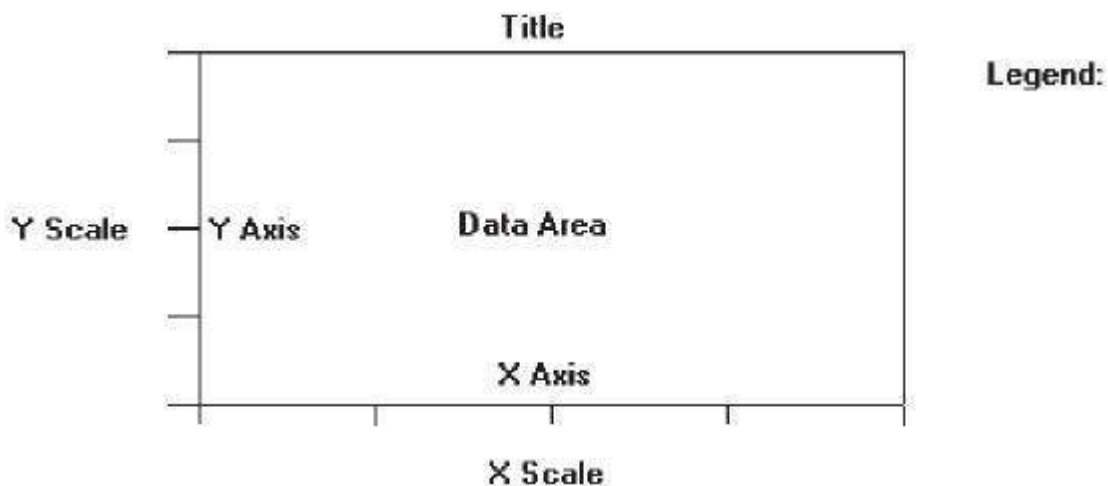
- Utilize contrasting display features.
 - To attract and call attention to different screen elements.
- Create visual lines.
 - Implicit and explicit, to guide the eye.
- Be consistent.
 - In appearance and procedural usage.

Statistical Graphics:

A statistical graphic is data presented in a graphical format. A well-designed statistical graphic, also referred to as a **chart** or **graph** which consists of complex ideas communicated with clarity, precision, and efficiency.

It gives its viewer the greatest number of ideas, in the shortest time, and in the smallest space, and with least possible clutter. It will provide coherence to large amounts of information by tying them together in meaningful way, and it will encourage data comparisons of its different pieces by the eye.

A well designed statistical graphic display also avoids distortions by telling the truth about the data.



Components of a Statistical Graphic:

Most statistical graphics have at least two axes, two scales, an area to present the data, a title, and sometimes a legend or key. Guidelines for graphic components include the following.

Data Presentation:

- Emphasize the data.
- Minimize the non data elements.
- Minimize redundant data.
- Show data variation, not design variation.
- Provide the proper context for data interpretation.
- Restrict the number of information-carrying dimensions depicted to the number of data dimensions being illustrated.
- Employ data in multiple ways, whenever possible.
- Avoid unnecessary embellishment of:
 - Grids.
 - Vibration.

— Ornamentation.

- Fill the graph's available area with data.

Axes: Values on an axis should increase as they move away from the origin.

- Use the horizontal axis (X) to show time or cause of an event (the independent variable).
- Use the vertical axis (Y) to show a caused effect (the dependent variable).

Values on an axis should increase as they move away from the origin. If the numeric values displayed are positive, the origin point will be the lower-left point of the graphic. If the data includes negative values and the axes must extend in both directions from the zero point, position the origin in the center of the graph.

Use the horizontal axis (X) to show time or cause of an event (the independent variable). Use the vertical axis (Y) to show a caused effect (the dependent variable). When the X-axis plots time intervals, the labeled points should represent the end of each time interval. The X-axis may also be called *abscissa* or *category* axis, the Y-axis the *ordinal* or *value* axis. If the graphic possesses three dimensions, the third axis is called the Z-axis, reflecting the graph's plane.

Scales and Scaling:

- Place ticks to mark scales on the outside edge of each axis.
- Employ a linear scale & Mark scales at standard or customary intervals.
- Start a numeric scale at zero (0).
- Keep the number of digits in a scale to a minimum.
- Display only a single scale on each axis.
- For large data matrices, consider displaying duplicate axes.
- Provide aids for scale interpretation.
- Provide scaling consistency across two or more related graphics.
- Clearly label each axis in a left-to-right reading orientation.

A scale is a set of measurement points or markers. Scaling is the positioning of data in relation to these points or markers. Choose an appropriate scale for both graph axes. If the scale is too expanded, the effect may be exaggerated, if too small, the effect may be underreported.

Proportion:

- Provide accurate proportion of the displayed surfaces to the data they represent.
- Provide proper proportion by:
 - Conforming to the shape of the data.

Failure to display the correct proportions can create false impressions of magnitudes of differences in sizes or changes. This kind of graphical distortion can be eliminated through clear, detailed, and thorough labeling, a topic to be addressed shortly.

Provide proper proportion. When the relative proportions of a graphic are in balance, it looks better. Graphics should tend toward the horizontal, assuming a greater length than height. There are a number of reasons for this recommendation.

First, people prefer this shape.

Second, it is easier to read words arrayed left-to-right.

Third, many graphics plot cause and effect relationships, with effect on the vertical axis and cause on the horizontal.

An elongated horizontal axis helps describe the causal variable in more detail. If, however, the

Lines:

- Data lines should be the heaviest & Axes lines should be of medium weight.
 - Extend the lines entirely around the graphic.
- Grid lines should be very thin or absent.

Labeling:

- Employ clear, detailed and thorough labeling.
- Maintain a left-to-right reading orientation.
- Integrate the labeling with the drawing.
 - Do not curve letters to match the shape of curved lines.
- Use only one typeface, font, and weight.
 - For emphasis, use different type sizes.
- Do not separate labeling from the data through ruled lines.
- Provide information about the source of the data.
- Use a legend for complicated graphs.

Title: Create a short, simple, clear, and distinctive title describing the purpose of the graphic.

- Position the title above, centered, or left-aligned to the rectangle formed by the extended axes.
- Spell it out fully, using a mixed-case or uppercase font.
- A title should be brief and descriptive of the graphic.

Aiding Interpretation of Numbers:

- Display a grid on request.
- Permit the viewer to click on a data point to display actual values.
- Show numeric values automatically for each point or bar.
- Permit the viewer to zoom in on an area of the graphic.
- Permit the user to change the scale values.

Statistical graphics take many forms. There are curves and line graphs, surface charts, scatter plots, bar graphs, histograms, segmented or stacked bars, and pie charts.

Curve and Line Graphs:

- Display data curves or lines that must be compared in a **single graph**.
- Display no more than **four** or **five curves** in a single graph.
- Identify each curve or line with an **adjacent label** whenever possible.
- If a legend must be included, order the legend to match the spatial ordering of the lines.
- For tightly packed curves or lines, provide data differentiation with a line-coding technique, such as different colors or different line composition types.
- Highlight curves or lines representing important or critical data.
- When comparing actual to projected data:
 - Use solid curves or lines for actual data.
 - Use broken curves or lines for projected data.

- Display a reference index if the displayed data must be compared to a standard or critical value.
- Display differences between two data sets as a curve or line itself.

Curves and line graphs can be used to show relationships between sets of data defined by two continuous variables. They are especially useful showing data changes overtime, being superior to other graphic methods for speed and accuracy in determining data trends. With a curve, the data relations are summarized by a smoothed line. With a line, straight line segments connect the data plots.

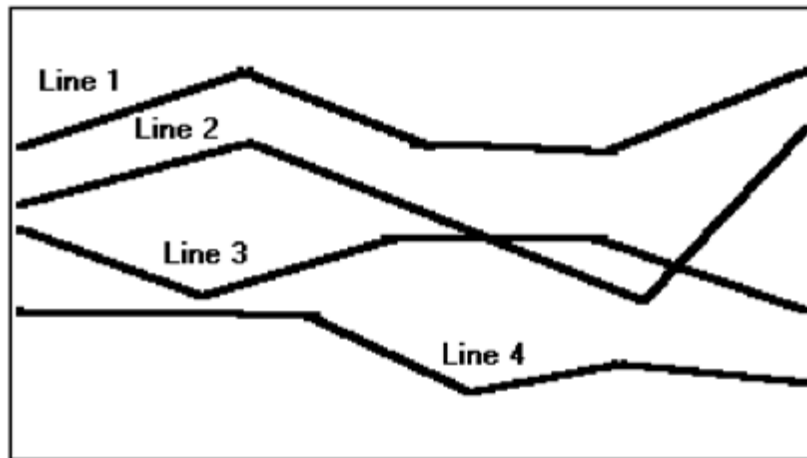


Fig: A line graph

Surface Charts: Order the data categories so that:

- The least variable is at the bottom, and the most variable at the top.
- The largest is at the bottom and the smallest at the top.
 - Use different texture or shading coding schemes to differentiate the areas below each curve or line.
 - Incorporate labels within the bands of data. If the data being depicted by a curve or line represents all the parts of a whole, consider developing

Surface chart : In this kind of graph, the curves or lines are stacked above one another to indicate

Ordering. In ordering the data categories, place the least variable at the bottom and the most variable at the top. Irregularities in the bottom curve or line will affect those above it. This makes it difficult for viewer to determine whether the irregularity in the upper curves reflect real data differences or is the result of this style of graph.

Coding schemes. Use different texture or shading coding schemes. Ensure that the coding scheme chosen for each area is visually distinguishable from all the others. Place darker shades or colors toward the bottom.

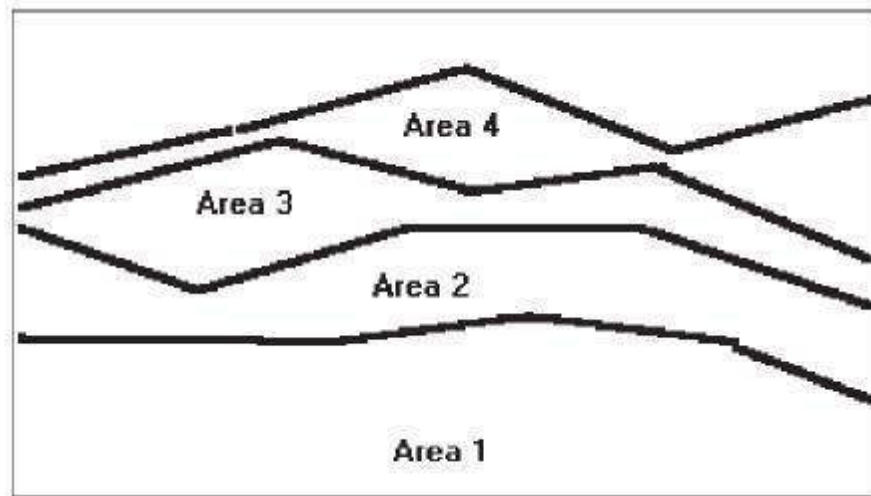


Fig: A surface chart.

Labels. Labels with a left-to-right reading orientation should be included within textured or shaded bands, if possible. Legends showing individual percentages, or cumulative percentages, should only be incorporated where space constraints exist within the bands.

Scatterplots:

- Limit use to two-dimensional displays of data.
- Maintain consistent scale size intervals.
- Provide distinguishable, equal-sized plot points.
- If there is more than one set of data on the plot, use different symbols for each data set's points.
- Visually distinguish points of particular significance through a highlighting technique.

Scatter plots can be used to show relationships among individual data points in a two-dimensional array.

A point is displayed on the plot where the X-axis and Y-axis variables intersect.

Correlations and trends on scatter plots can be indicated by the superimposition of curves (thus combining the scatter plot with another kind of graphic display).

Two dimensions. Limit scatter plots to two dimensions. Three-dimensional scatter plots, while possible, do not yield clear, unambiguous displays.

Consistent intervals. Maintain consistent scale size intervals. Inconsistent spacing size between scale ticks on the two axes will distort the displayed data.

Distinguishable plots. Construct the plot points of distinguishable, equal-sized circles, squares, rectangles, or diamonds. These symbols may be filled in or empty.

Color may also be used to designate the points. Keep in mind that, when using color, different colors can.

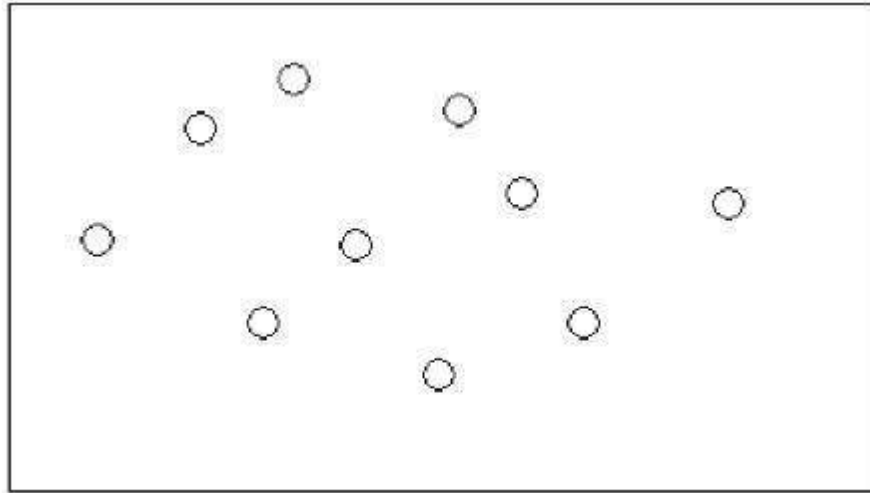


Fig: A scatterplot

Significant points. Visually distinguish significant points. Points of particular significance on scatter plots can be made distinctive through highlighting techniques such as the use of high intensity, different colors, or different shapes.

Bar Graphs:

- Orient bars consistently, either horizontally or vertically.
- Use vertical bars when the item being counted is of greatest interest.
- Use horizontal bars:
 - When the data labels are long.
 - To highlight the information rather than the count.
- Use a meaningful organizing principle.
 - If none exists, arrange the bars so that the length of bars is in ascending or descending order.
- Make the spacing between bars equal to one-half the width of the bars or less.
 - If groupings of bars are presented, leave space between the groupings only.
- If different kinds of bars must be easily distinguished, provide differentiation through a coding technique.
 - If possible, use a pattern or color that reinforces the data.
- Highlight bars representing important or critical data.
- Provide a consistent ordering for related groups of bars.
- Display a reference index if displayed data must be compared to a standard or critical value.
- Identify each bar with an adjacent label.
 - Place labels below, or to the left of, the baseline.
- When a great many pieces of data must be compared, consider using histograms or step charts.

Bar graphs can be used to show a few differences between separate entities or to show differences in variable at a few discrete intervals. A bar graph consists of a series of bars extending from a common origin or base line or they may extend between separately plotted high and low points, as shown below, having only one axis. Bar graphs may be arrayed horizontally or vertically. Vertical bar graphs are sometimes called *column charts*.

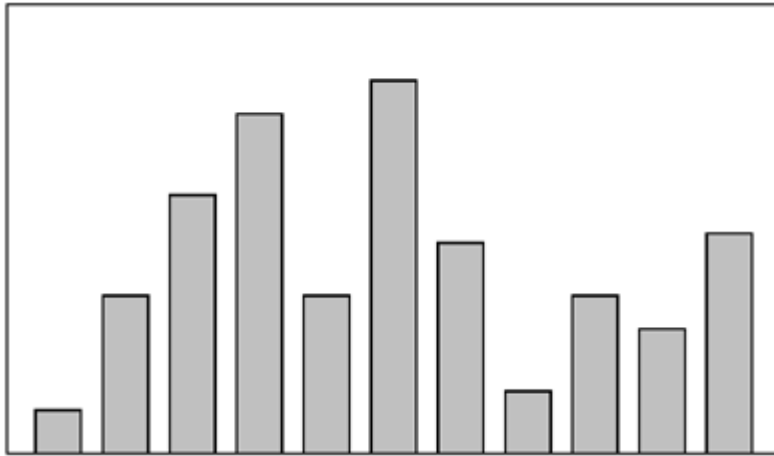


Figure : A bar graph with a common origin point.

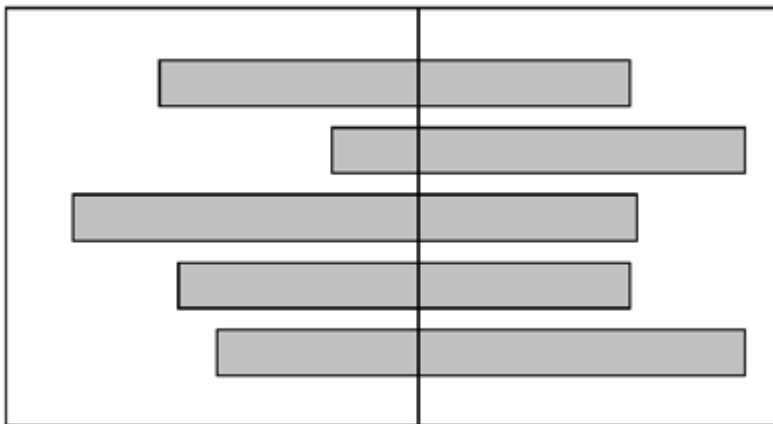


Figure: A bar graph with separately plotted high and low points.

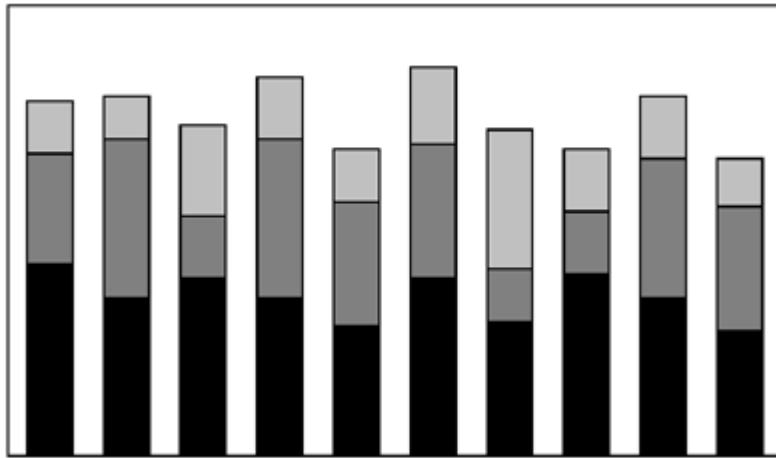


Figure: A histogram or step chart.

Segmented or Stacked Bars: Order the data categories in the same sequence.

■ Order the data categories so that:

- The least variable is at the bottom.
- The most variable is at the top.
- Limit the number of segments to those that are large enough to be seen and labeled.
- Use different texture or coding schemes to differentiate the areas within each bar.
- Clearly associate labels with bars or segments.
- Place segment labels to the right on a vertical chart or above on a horizontal chart. If both the total measure of a value and its component portions are of interest, consider using *segmented or stacked bars*. These bars are similar to bar graphs except that the bar is segmented into two or more pieces reflecting the component values. In this way they are similar to surface graphs and pie charts. Design guidelines are similar to stacked bars, except for the following:



Pie chart

- They must add up to 100 percent.
- Use five segments or fewer.
- Each segment should take up at least 5 percent (18 degrees) of the circle.
- Place the largest segment starting at 12:00.
- Directly label each segment in the normal reading orientation.

If leaders for labels in small segments are necessary, orient them in as few angles as possible.

- Include numbers with segment labels to indicate percentages of absolute values.
- Texture- or color-coding selected for segments should not emphasize one segment over another (unless it is intended).
- Highlight segments requiring particular emphasis through a contrasting display technique or by “exploding” it.
- Never tilt a pie.



Figure : A pie chart

Pie charts, a circle broken up into pie-shaped pieces, can be used to show an apportionment of a total into its component parts, as illustrated in Figure 3.79. Bar graphs, however, usually permit more accurate estimates of proportions. Experts caution against the use of pie charts because:

They provide no means of absolute measurement.

They cannot represent totals greater than 100 percent.

They can only represent a fixed point in time.

Human estimation of relationships is more accurate with linear than with angular representations.

Choosing a Graph Type:

- Determine what kind of information is most important for the viewer to extract.

- Choose the type of graph best suited for presenting that kind of information.

The types of graphics just described have rarely been experimentally studied to determine their most effective use.

Flow Charts:

- Displayed steps should be designed to:

- Follow some logical order.

- Minimize path link.

- Orient the chart following common flowchart reading conventions such as left-to right and top-to-bottom.

- Follow common flowchart coding conventions to distinguish elements.

- Use arrows in conventional ways to indicate directional relationships.

- Highlight elements requiring particular attention through a contrasting display technique.

- Require only one decision at each step.

- Be consistent in all option ordering and wording.

If the data to be displayed flows in a complex, yet sequential, process, consider using *flowchart* to schematically represent it. Flowcharts can also be used to aid problem solving in which a solution can be reached by answering a series of questions. They are not useful when trade-offs must be made.

Technological Considerations in Interface Design:

Interface design is also affected by the physical characteristics of the display device itself and the characteristics of the interfaces controlling software.

Graphical Systems

■ Screen design must be compatible with the capabilities of the system, including:

- System power.
- Screen size.
- Screen resolution.
- Display colors.
- Other display features.

■ Screen design must be compatible with the capabilities of the:

- System platform being used.
- Development and implementation tools being used.
- Platform style guide being used.

Graphical system design must be compatible with the system's power, screen size, screen resolution, and displayable colors, fonts and other features. Designs for Web systems must also take into consideration the characteristics of the browsers being used and the bandwidth of the communication medium. The

Other Display Features

The design must be compatible with the system platform and any development and implementation tools being used. The design may also take into consideration any available platform style guide. Finally, the design must effectively utilize the various available display features or attributes.

Platform Compatibility

The design must be compatible with the windowing platform being used—Apple Computer's Macintosh, Microsoft Windows or any other.

Development and Implementation Tool Compatibility

More than half of software code is now devoted to user interface design. To use a very old cliché, the tail is now beginning to wag the dog. Available tools include toolkits, interface builders, and user interface management systems.

A toolkit is a library of controls or widgets such as menus, buttons, and scroll bars. Toolkits have programmatic interface and must be used by programmers. They are usually for a specific windowing platform. Examples of toolkits include those for Motif, OpenLook, and the Macintosh.

An **interface builder** is a graphical tool that helps a programmer create dialog boxes, menus, and other controls. It provides a palette to select and position controls, and to set properties. Interface builders are limited to use in laying out the static parts of the interface. They cannot handle the parts of the interface that involve graphical objects moving around.

A *user interface management system* (UIMS) extends the features of a builder by also providing assistance with creating and managing the insides of windows. Examples include HyperCard and Visual Basic

Style Guide Compatibility: A thrust for commonality in graphical system application design has emerged as providers have finally come to realize that design consistency is a virtue that has been ignored too long.

To achieve this consistency in interface design, most providers' have developed style guidelines for system developers. These guidelines specify the appearance and behavior of the user interface. They describe the windows, menus, and various controls available, including what they look like and how they work. They also provide some guidance on when to use the various components.

Web Systems

- Understand the current level of Web technology.
- Design for system configuration used by most users.
- Refrain from haphazard use of leading-edge technology.

Technological advances. Monitors with small screens must coexist with large screens. Color must coexist with monochrome displays. High-resolution displays must coexist with those of low resolution. High-speed information transmission must coexist with low speed. New browsers that contain and support many different and desirable features must coexist with old browsers that support little.

Browsers

■ **Compatibility:** Make the Web site accessible to all users' browsers & Use browser defaults as much as possible.

■ **Monitor size and resolution:** Design within the boundaries of an image-safe area for all browsers.

— Present images at a resolution appropriate for all users' monitors.

■ **Fonts:** Use fonts that can be displayed on a variety of browsers.

■ **Colors:** Use colors that succeed on a variety of browsers and platforms.

A palette of 216 colors.

■ **Bandwidth:** Design for the most commonly used bandwidth.

A 56-kbps modem is most common for home users.

■ **Versions :** Create multiple versions that support multiple browsers.

Always provide a text-only version & Make use of browser sniffers.

Other Web Considerations :

■ **Downloading:** Provide fast page download times, no more than 8 to 10 seconds per page.

Minimize the use of design techniques that cause longer download times.

Long pages, Large chunky headings, Numerous or large graphics and images.

Animation, Excessive amount of color, Excess use of frames.

— Provide enough information to the user so that whether or not to request a download can be determined, including:

Program or document description.

Type of download.

Size of download.

Download version.

Estimated loading time.

Special operating requirements.

- Currency: Keep Web site information current.
- Page printing:
 - Provide a means to print, Groups of related pages, Individual pages, Sections of pages.
- Maintainability: Ensure easy Web site maintainability.

UNIT 4:

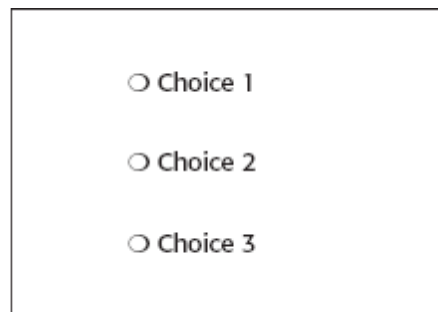
Windows

Develop System Menus and Navigation Schemes

Structures of Menus

Single Menu

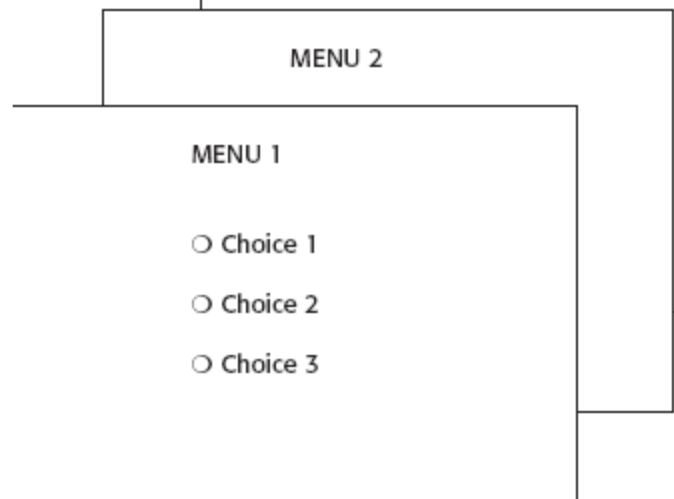
- In this simplest form of menu, a single screen or window is presented to seek the user's input or request an action to be performed



- A single menu may be iterative if it requires data to be entered into it and this data input is subject to a validity check that fails. The menu will then be represented to the user with a message requesting reentry of valid data.

Sequential Linear Menus

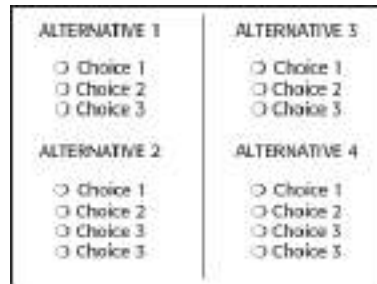
- Sequential linear menus are presented on a series of screens possessing only one path.
- The menu screens are presented in a preset order, and, generally, their objective is for specifying parameters or for entering data.



- Sequential path menus have several shortcomings. A long sequence may become tedious as menu after menu is presented.

Simultaneous Menus

- Instead of being presented on separate screens, all menu options are available simultaneously.



- Problems with simultaneous menus are that for large collections of menu alternatives screen clutter can easily occur, and screen paging or scrolling may still be necessary to view all the choices.
- Presenting many menu dependencies and relationships on a screen, especially if poorly indicated, can also be very confusing

Hierarchical Menus

- A hierarchical structure results in an increasing refinement of choice as menus are stepped through, for example, from options, to suboptions, from categories to subcategories, from pages to sections to subsections, and so on
- A hierarchical structure can best be represented as an inverse tree, leading to more and more branches as one moves downward through it.
- Common examples of hierarchical design today are found in menu bars with their associated pull-downs



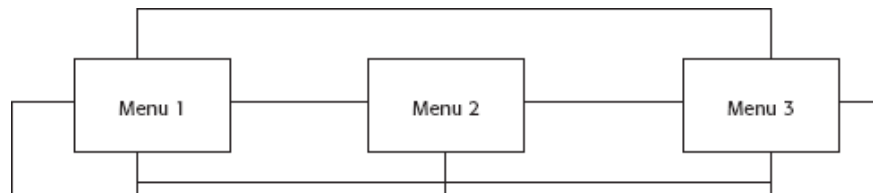
- A disadvantage of a hierarchical scheme is that the defined branching order may not fit the users conception of the task flow.
- If users are not familiar with the hierarchical menu, or are unable to predict what suboptions lie below
- a particular choice, they may go down wrong paths and find it necessary to go back up the tree to change a choice, or perhaps even return to the top-level menu

Connected Menus

- Connected menus are networks of menus all interconnected in some manner.

Movement through a structure of menus is not restricted to a hierarchical tree, but is permitted between most or all menus in the network.

- A connected menu system may be cyclical, with movement permitted in either direction between menus, or acyclical, with movement permitted in only one direction. These menus also vary in connectivity, the extent to which menus are linked by multiple paths.



- The biggest advantage of a connected menu network is that it gives the user full control over the navigation flow. Its disadvantage is its complexity,

Event-Trapping Menus

- Event Trapping menus provide an ever-present background of control over the F

Functions of Menus

- a menu can be used to perform several functions, to navigate to a new menu, to execute an action or procedure, to display information, or to input data or parameters

Navigation to a New Menu

- Each user selection causes another menu in a hierarchical menu tree to be displayed.
- The purpose of each selection is to steer the user toward an objective or goal.
- Selection errors may lead the user down wrong paths, and cost time and, perhaps, aggravation, but these errors are nondestructive and usually undoable.

Execute an Action or Procedure

- A user selection directs the computer to implement an action or perform a procedure.
- The action may be something like opening or closing a file, copying text, or sending a message.
- Accidental selection of critical irreversible actions must be prevented in interface design.

Displaying Information

- ☐ The main purpose of selecting a menu choice may simply be to display information.
- ☐ The user may be searching for specific information in a database or browsing the Web. The content material and the user's interests will determine the paths followed.
- ☐ The user's focus is primarily on the information desired and less on the selection function. Wrong turns in the process will again cost time and perhaps aggravation, but these errors are nondestructive and usually undoable.

Data or Parameter Input

- ☐ Each selection specifies a piece of input data for the system or provides a parameter value. Data or values may be input on a single menu or spread over a hierarchy of menus.

Content of Menus

- ☐ A menu consists of four elements, its context, its title, its choice descriptions, and its completion instructions.

Menu Context

- ☐ A menu's context provides information to keep the user oriented.
- ☐ Feedback is necessary that tells users where they are in a process, what their past choices were, and possibly how much farther they still have to navigate
- ☐ Verbal linkage, spatial linkage, or both may be used to provide navigation feedback.
- ☐ Verbal linkage involves providing, on the current menu screen, a listing of choices made on previous menus that have led to this position. It also involves assuring the user that the displayed menu is the menu desired
- ☐ Spatial linkage can be accomplished by graphic methods. Each succeeding menu screen can be displayed overlapping the previous menu screen so a succession of choices can be seen in a single view.

Menu Title

- ☐ A menu's title provides the context for the current set of choices. The title must reflect the choice selected on the previously displayed menu.

Choice Descriptions

- ☐ Choice descriptions are the alternatives available to the user.
- ☐ These descriptions can range from a mnemonic, numeric, or alphabetized listing of choices to single words or phrases to full sentences or more.

Completion Instructions

- ☐ Completion instructions tell users how to indicate their choices
- ☐ Explicit instructions may be needed for first time or casual users of a system.

Experienced users will find overly verbose instructions unnecessary.

- ☐ The needs of all system users, and the nature of the system, must again be considered in creating this kind of on-screen guidance.

Formatting of Menus

- ☐ What follows is a series of guidelines for formatting menus.

Consistency

- ☐ Provide consistency with the user's expectations.
- ☐ Provide consistency in menu:
 - Formatting, including organization, presentation, and choice ordering.
 - Phrasing, including titles, choice descriptions, and instructions.
 - Choice selection methods.
 - Navigation schemes.

Display

- ☐ If continual or frequent references to menu options are necessary, permanently display the menu in an area of the screen that will not obscure other screen data.
- ☐ If only occasional references to menu options are necessary, the menu may be presented on demand.
 - Critical options should be continuously displayed, however.

Presentation

- ☐ Ensure that a menu and its choices are obvious to the user by presenting them with a unique and consistent structure, location, and/or display technique.
- ☐ Ensure that other system components do not possess the same visual qualities as menu choices.

Organization

- ☐ Provide a general or main menu.
- ☐ Display:
 - All relevant alternatives.
 - Only relevant alternatives.
 - Delete or gray-out inactive choices.
- ☐ Match the menu structure to the structure of the task.
 - Organization should reflect the most efficient sequence of steps to accomplish a person's most frequent or most likely goals.
- ☐ Minimize number of menu levels within limits of clarity.
 - For Web sites, restrict it to two levels (requiring two mouse clicks) for fastest performance.
- ☐ Be conservative in the number of menu choices presented on a screen:
 - Without logical groupings of elements, limit choices to 4 to 8.
 - With logical groupings of elements, limit choices to 18 to 24.

- ☐ Provide decreasing direction menus, if sensible.
- ☐ Never require menus to be scrolled.
- ☐ Provide users with an easy way to restructure a menu according to how work is accomplished.
- ☐ In general, the more choices contained on a menu (greater breadth), the less will be its depth; the fewer choices on a menu (less breadth), the greater will be its depth.
- ☐ The advantages of a menu system with greater breadth and less depth are:
 - Fewer steps and shorter time to reach one's objective.
 - Fewer opportunities to wander down wrong paths.
 - Easier learning by allowing the user to see relationships of menu items.
- ☐ A broad menu's disadvantages are:
 - A more crowded menu that may reduce the clarity of the wording of choices.
 - Increased likelihood of confusing similar choices because they are seen together.
- ☐ The advantages of greater depth are:
 - Less crowding on the menu.
 - Fewer choices to be scanned.
 - Easier hiding of inappropriate choices.
 - Less likelihood of confusing similar choices since there is less likelihood that they will be seen together.
- ☐ Greater depth disadvantages are:
 - More steps and longer time to reach one's objective.
 - More difficulties in learning since relationships between elements cannot always be seen.
 - More difficulties in predicting what lies below, resulting in increased likelihood of going down wrong paths or getting lost.
 - Higher error rates.

Complexity

- ☐ Provide both simple and complex menus.
- ☐ Simple: a minimal set of actions and menus.
- ☐ Complex: a complete set of actions and menus.

Item Arrangement

- ☐ Align alternatives or choices into single columns whenever possible.
 - Orient for top-to-bottom reading.
 - Left-justify descriptions.
- ☐ If a horizontal orientation of descriptions must be maintained:
 - Organize for left-to-right reading.

Ordering

- ☐ Order lists of choices by their natural order, or
- ☐ For lists associated with numbers, use numeric order.

- ☐ For textual lists with a small number of options (seven or less), order by:
 - Sequence of occurrence.
 - Frequency of occurrence.
 - Importance.
 - Semantic similarity.
- ☐ Use alphabetic order for:
 - Long lists (eight or more options).
 - Short lists with no obvious pattern or frequency.
- ☐ Separate potentially destructive actions from frequently chosen items.
- ☐ If option usage changes, do not reorder menus.
- ☐ Maintain a consistent ordering of options on all related menus.
 - For variable-length menus, maintain consistent relative positions.
 - For fixed-length menus, maintain consistent absolute positions.
- ☐ A meaningful ordering is necessary to:
 - Facilitate search for an item.
 - Provide information about the structure and relationships among items.
 - Provide compatibility with the user's mental model of the item structure.
 - Enhance the user's ability to anticipate a choice's location.

Groupings

- ☐ Create groupings of items that are logical, distinctive, meaningful, and mutually exclusive.
- ☐ Categorize them in such a way as to:
 - Maximize the similarity of items within a category.
 - Minimize the similarity of items across categories.
- ☐ Present no more than six or seven groupings on a screen.
- ☐ Order categorized groupings in a meaningful way.
- ☐ If meaningful categories cannot be developed and more than eight options must be displayed on a screen, create arbitrary visual groupings that:
 - Consist of about four or five but never more than seven options.
 - Are of equal size.
- ☐ Separate groupings created through either:
 - Wider spacing, or
 - A thin ruled line.
- ☐ Provide immediate access to critical or frequently chosen items.

Line Separators

- ☐ Separate vertically arrayed groupings with subtle solid lines.
- ☐ Separate vertically arrayed subgroupings with subtle dotted or dashed lines.
- ☐ For subgroupings within a category:
 - Left-justify the lines under the first letter of the columnized choice descriptions.
 - Right-justify the lines under the last character of the longest choice description.
- ☐ For independent groupings:
 - Extend the line to the left and right menu borders.

Phrasing the Menu

- ☐ A menu must communicate to the user information about:
 - The nature and purpose of the menu itself.
 - The nature and purpose of each presented choice.
 - How the proper choice or choices may be selected.

Menu Titles

- ☐ Main menu:
 - Create a short, simple, clear, and distinctive title, describing the purpose of the entire series of choices.
- ☐ Submenus:
 - Submenu titles must be worded exactly the same as the menu choice previously selected to display them.
- ☐ General:
 - Locate the title at the top of the listing of choices.
 - Spell out the title fully using either an:
 - Uppercase font.
 - Mixed-case font in the headline style.
 - Superfluous titles may be omitted.

Menu Choice Descriptions

- ☐ Create meaningful choice descriptions that are familiar, fully spelled out, concise, and distinctive.
- ☐ Descriptions may be single words, compound words, or multiple words or phrases.
 - Exception: Menu bar items should be a single word (if possible).
- ☐ Place the keyword first, usually a verb.
- ☐ Use the headline style, capitalizing the first letter of each significant word in the choice description.
- ☐ Use task-oriented not data-oriented wording.
- ☐ Use parallel construction.
- ☐ A menu choice must never have the same wording as its menu title.
- ☐ Identical choices on different menus should be worded identically.
- ☐ Choices should not be numbered.
 - Exception: If the listing is numeric in nature, graphic, or a list of varying items, it may be numbered.
- ☐ If menu options will be used in conjunction with a command language, the capitalization and syntax of the choices should be consistent with the command language.
- ☐ Word choices as commands to the computer.

Menu Instructions

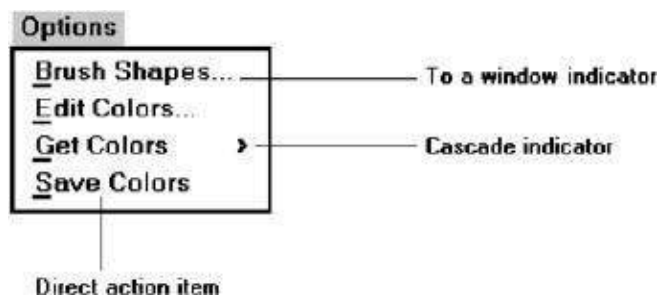
- ☐ For novice or inexperienced users, provide menu completion instructions.
 - Place the instructions in a position just preceding the part, or parts, of the menu to which they apply.
 - Left-justify the instruction and indent the related menu choice

descriptions a minimum of three spaces to the right.

- Leave a space line, if possible, between the instructions and the related menu choice descriptions.
- Present instructions in a mixed-case font in sentence style.
- ☐ For expert users, make these instructions easy to ignore by:
 - Presenting them in a consistent location.
 - Displaying them in a unique type style and/or color.

Intent Indicators

- ☐ Cascade indicator:
 - To indicate that selection of an item will lead to a submenu, place a triangle or right-pointing solid arrow following the choice.
 - A cascade indicator must designate every cascaded menu.
- ☐ To a window indicator:
 - For choices that result in displaying a window to collect more information, place an ellipsis (. . .) immediately following the choice.
 - Exceptions—do not use when an action:
 - Causes a warning window to be displayed.
 - May or may not lead to a window.
- ☐ Direct action items:
 - For choices that directly perform an action, no special indicator should be placed on the menu.



Keyboard Equivalents

- ☐ To facilitate keyboard selection of a menu choice, each menu item should be assigned a keyboard equivalent mnemonic.
- ☐ The mnemonic should be the first character of the menu item's description.
 - If duplication exists in first characters, use another character in the duplicated item's description.
 - Preferably choose the first succeeding consonant.
- ☐ Designate the mnemonic character by underlining it.
- ☐ Use industry-standard keyboard access equivalents when they exist.

Keyboard Accelerators

- ☐ For frequently used items, provide a keyboard accelerator to facilitate keyboard selection.

- ☐ The accelerator may be one function key or a combination of keys.
 - Function key shortcuts are easier to learn than modifier plus letter shortcuts.
- ☐ Pressing no more than two keys simultaneously is preferred.
 - Do not exceed three simultaneous keystrokes.
- ☐ Use a plus (+) sign to indicate that two or more keys must be pressed at the same time.
- ☐ Accelerators should have some associative value to the item.
- ☐ Identify the keys by their actual key top engraving.
- ☐ If keyboard terminology differences exist, use:
 - The most common keyboard terminology.
 - Terminology contained on the newest PCs.
- ☐ Separate the accelerator from the item description by three spaces.
- ☐ Right-align the key descriptions.
- ☐ Do not use accelerators for:
 - Menu items that have cascaded menus.
 - Pop-up menus.
- ☐ Use industry-standard keyboard accelerators

Style	
<u>N</u> ormal	
B old	Ctrl+B
<i>I</i> talic	Ctrl+I
<u>U</u> nderline	Ctrl+U
<u>O</u> utline	
<u>S</u> hadow	

Selecting Menu Choices

Initial Cursor Positioning

- ☐ If one option has a significantly higher probability of selection, position the cursor at that option.
- ☐ If repeating the previously selected option has the highest probability of occurrence, position the cursor at this option.
- ☐ If no option has a significantly higher probability of selection, position the cursor at the first option.

Choice Selection

- ☐ Pointers:
 - Select the choice by directly pointing at it with a mechanical device such as a mouse or trackball pointer, or light pen, or pointing with one's finger.
 - Visually indicate:
 - Which options can be selected.
 - When the option is directly under the pointer and can be selected.
 - Visually distinguish single- and multiple-choice menu alternatives.
 - If pointing with a mechanical device is the selection method used:
 - The selectable target area should be at least twice the size of the active

area of the pointing device or displayed pointer. In no case should it be less than 6 millimeters square.

- Adequate separation must be provided between adjacent target areas.

— If finger pointing is the selection method used:

- The touch area must be a minimum of 20 to 30 millimeters square.
- The touch area must encompass the entire caption plus one character around it.

☐ **Keyboard:**

— If moving the cursor to a menu choice:

- The up and down arrow keys should move the cursor up or down vertically oriented menu options.
- The left and right cursor keys should move the cursor left or right between horizontally oriented menu options.

— If keying a choice identifier value within an entry field:

- Locate the entry field at the bottom of the last choice in the array of choices.
- Uppercase, lowercase, and mixed -case typed entries should all be acceptable.

☐ **Selection/execution:**

— Provide separate actions for selecting and executing menu options.

— Indicate the selected choice through either:

- Highlighting it with a distinctive display technique.
- Modifying the shape of the cursor.

— Permit unselecting choice before execution.

- If a menu is multiple choice, permit all options to be selected before execution.

☐ **Combining techniques:**

— Permit alternative selection techniques, to provide flexibility.

Defaults

- ☐ Provide a default whenever possible.
- ☐ Display as bold text.

Unavailable Choices

- ☐ Unavailable choices should be dimmed or -grayed out.¶
- ☐ Do not add or remove items from a menu unless the user takes explicit action to add or remove them through the application.

Mark Toggles or Settings

- Purpose:
 - Use to designate that an item or feature is active or inactive over a relatively long period of time.
 - Use to provide a reminder that an item or feature is active or inactive.
- Guidelines:
 - Position the indicator directly to the left of the option.
 - For situations where several nonexclusive choices may be selected, consider including one alternative that deselects all the items and reverts the state to the -normal condition.

Regular	F5
✓ Bold	Ctrl+B
✓ Italic	Ctrl+I
Underline	Ctrl+U
Superscript	
Subscript	
Reduce Font	
Enlarge Font	
Fonts...	

Figure 4.11 Mark toggles.

Toggled Menu Items

- Purpose:
 - Use to designate two opposite commands that are accessed frequently.
 - Use when the menu item displayed will clearly indicate that the opposite condition currently exists.
- Guidelines:
 - Provide a meaningful, fully spelled-out description of the action.
 - Begin with a verb that unambiguously represents the outcome of the command.
 - Use mixed-case letters, with the first letter of each word capitalized.

Kinds of Graphical Menus

- The best kind of menu to use in each situation depends on several factors. The following must be considered:
 - The number of items to be presented in the menu.
 - How often the menu is used.
 - How often the menu contents may change.

Menu Bar

- ☐ Proper usage:
 - To identify and provide access to common and frequently used application actions that takes place in a wide variety of different windows.
 - A menu bar choice by itself should not initiate an action.
- ☐ The advantages of menu bars are that they:
 - Are always visible, reminding the user of their existence.
 - Are easy to browse through.
 - Are easy to locate consistently on the screen.
 - Usually do not obscure the screen working area.
 - Usually are not obscured by windows and dialog boxes.
 - Allow for use of keyboard equivalents.
- ☐ The disadvantages of menu bars are that:
 - They consume a full row of screen space.
 - They require looking away from the main working area to find.
 - They require moving pointer from the main working area to select.
 - The menu options are smaller than full-size buttons, slowing selection time.
 - Their horizontal orientation is less efficient for scanning.
 - Their horizontal orientation limits number of choices that can be displayed.

Display

- ☐ All primary windows must have a menu bar.
- ☐ All menu bars must have an associated pull-down menu containing at least two choices.
- ☐ Do not allow the user to turn off the display of the menu bar.
- ☐ If all the items in its associated pull-down menu are disabled, then disable the menu bar item.
 - Display the disabled item in a visually subdued manner.
 - However, the disabled pull-down menu must always be capable of being pulled down so that the choices may be seen.

Location

- ☐ Position choices horizontally over the entire row at the top of the screen, just below the screen title.
- ☐ A large number of choices may necessitate display over two rows.

Title

- ☐ The window title will be the menu bar title.

Item Descriptions

- ☐ The menu item descriptions must clearly reflect the kinds of choices available in the associated pull-down menus.

- ☐ Menu item descriptions will be the –titles‖ for pull-down menus associated with them.
- ☐ Use mixed-case letters to describe choices.
- ☐ Use single-word choices whenever possible.
- ☐ Do not display choices that are never available to the user.

Organization

- ☐ Follow standard platform ordering schemes where they exist.
 - Place application-specific choices where they fit best.
- ☐ Order choices left-to-right with:
 - Most frequent choices to the left.
 - Related information grouped together.
- ☐ Choices found on more than one menu bar should be consistently positioned.
- ☐ Left-justify choices within the line.
- ☐ When choices can be logically grouped, provide visual logical groupings, if possible.
- ☐ Help, when included, should be located at the right side of the bar.

Layout

- ☐ Indent the first choice one space from the left margin.
- ☐ Leave at least three spaces between each of the succeeding choices (except for Help which will be right-justified).
- ☐ Leave one space between the final choice and the right margin.

Separation

- ☐ Separate the bar from the remainder of the screen by:
 - A different background, or
 - Solid lines above and below.

Other Components

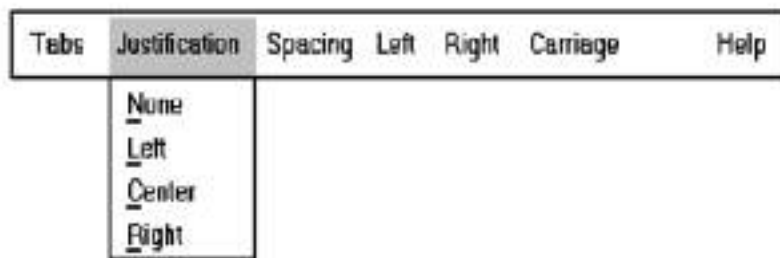
- ☐ Keyboard equivalent mnemonics should be included on menu bars.
- ☐ Keyboard accelerators, to a window indicators, and cascade indicators need not be included.

Selection Indication

- ☐ Keyboard cursor:
 - Use a reverse video, or reverse color, selection cursor to surround the choice.
 - Cover the entire choice, including one blank space before and after the choice word.
- ☐ Pointer:
 - Use reverse video, or reverse color, to highlight the selected choice.

Pull-Down Menu

- ☐ Proper usage:
 - To initiate frequently used application actions that take place on a wide variety of different windows.
 - A small number of items.
 - Items best represented textually.
 - Items whose content rarely changes.
- ☐ The advantages of pull-down menus are:
 - The menu bar cues a reminder of their existence.
 - They may be located relatively consistently on the screen.
 - No window space is consumed when they are not used.
 - They are easy to browse through.
 - Their vertical orientation is most efficient for scanning.
 - Their vertical orientation is most efficient for grouping.
 - Their vertical orientation permits more choices to be displayed.
 - They allow for display of both keyboard equivalents and accelerators.
- ☐ The disadvantages of pull-down menus are:
 - They require searching and selecting from another menu before seeing options.
 - They require looking away from main working area to read.
 - They require moving the pointer out of working area to select (unless using keyboard equivalents).
 - The items are smaller than full-size buttons, slowing selection time.
 - They may obscure the screen working area.



Display

- ☐ Display all possible alternatives.
- ☐ Gray-out or dim items that cannot be chosen due to the current state of an application.

Location

- ☐ Position the pull-down directly below the selected menu bar choice.

Size

- ☐ Must contain a minimum of two choices.

- ☐ Restrict to no more than 5 to 10 choices, preferably 8 or less.

Title

- ☐ Not necessary on a pull-down menu. The title will be the name of the menu bar item chosen.

Item Descriptions

- ☐ Use mixed-case, headline-style words to describe choices.
 - If the choices can be displayed graphically, for example, as fill-in patterns, shades, or colors, textual descriptions are not necessary.
- ☐ Do not:
 - Identify a menu item by the same wording as its menu title.
 - Change the meaning of menu items through use of the Shift key.
 - Use scrolling in pull-downs.
 - Place instructions in pull-downs.

Organization

- ☐ Follow standard platform ordering schemes when they exist.
 - Place application-specific choices where they fit best.
- ☐ Place frequent or critical items at the top.
- ☐ Separate destructive choices from other choices.
- ☐ Align choices into columns, with:
 - Most frequent choices toward the top.
 - Related choices grouped together.
 - Choices found on more than one pull-down consistently positioned.
- ☐ Left-align choice descriptions.
- ☐ Multicolumn menus are not desirable. If necessary, organize top-to-bottom, then left-to-right.

Layout

- ☐ Leave the menu bar choice leading to the pull-down highlighted in the selected manner (reverse video or reverse color).
- ☐ Physically, the pull-down menu must be wide enough to accommodate the longest menu item description and its cascade or accelerator indicator.
- ☐ Align the first character of the pull-down descriptions under the second character of the applicable menu bar choice.
- ☐ Horizontally, separate the pull-down choice descriptions from the pull-down borders by two spaces on the left side and at least two spaces on the right side.
 - The left-side border will align with the left side of the highlighted menu bar choice.
 - The right-side border should extend, at minimum, to the right side of its highlighted menu bar choice.
 - Pull-downs for choices on the far right side of the menu bar, or long pull-down descriptions, may require alignment to the left of their menu bar choice to maintain visibility and clarity.

Groupings

- Provide groupings of related pull-down choices:
 - Incorporate a solid line between major groupings.
 - Incorporate a dotted or dashed line between subgroups.
 - Left-justify the lines under the first letter of the columnized choice descriptions.
 - Right-justify the lines under the last character of the longest choice description.
 - Display the solid line in the same color as the choice descriptions.

Mark Toggles or Settings

- If a menu item establishes or changes the attributes of data or properties of the interface mark the pull-down choice or choices whose state is current or active -on.¶
 - For nonexclusive items, display a check mark to the left of the item description.
 - If the two states of a setting are not obvious opposites, a pair of alternating menu item descriptions should be used to indicate the two states.
 - For exclusive choices, precede the choice with a contrasting symbol such as a diamond or circle.

Pull-Downs Leading to Another Pull-Down

- If a pull-down choice leads to another pull-down, provide a cascade indicator as follows:
 - Place an arrow or right-pointing triangle after the choice description.
 - Align the triangles to the right side of the pull-down.
 - Display the triangle in the same color as the choice descriptions.

Pull-Downs Leading to a Window

- For pull-down choices leading to a window:
 - Place an ellipsis (three dots) after the choice description.
 - Do not separate the dots from the description by a space.
 - Display the ellipsis in the same color as the choice descriptions.

Keyboard Equivalents and Accelerators

- Provide unique mnemonic codes by which choices may be selected through the typewriter keyboard.

- Indicate the mnemonic code by underlining the proper character.
- ☐ Provide key accelerators for choice selection.
 - Identify the keys by their actual key-top engravings.
 - Use a plus (+) sign to indicate that two or more keys must be pressed at the same time.
 - Enclose the key names within parentheses ().
 - Right-align the key names, beginning at least three spaces to the right of the longest choice description.
 - Display the key alternatives in the same color as the choice descriptions.

Separation

- ☐ Separate the pull-down from the remainder of the screen, but visually relate it to the menu bar by:
 - Using a background color the same as the menu bar.
 - Displaying choice descriptions in the same color as the menu bar.
 - Incorporating a solid-line border completely around the pull-down in the same color as the choice descriptions.
- ☐ A drop shadow (a heavier shaded line along two borders that meet) may also be included.

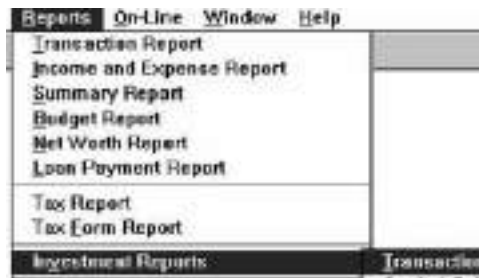
Selection Cursor

- ☐ Use a reverse video, or reverse color, selection cursor the same color as the menu bar to surround the choice.
- ☐ Create a consistently sized cursor as wide as the pull-down menu.

Cascading Menus

- ☐ Proper usage:
 - To reduce the number of choices presented together for selection (reduce menu breadth).
 - When a menu specifies many alternatives and the alternatives can be grouped in meaningful related sets on a lower-level menu.
 - When a choice leads to a short, fixed list of single-choice properties.
 - When there are several fixed sets of related options.
 - To simplify a menu.
 - Avoid using for frequent, repetitive commands.
- ☐ The advantages of cascading menus are that:
 - The top-level menus are simplified because some choices are hidden.
 - More first-letter mnemonics are available because menus possess fewer alternatives.
 - High-level command browsing is easier because subtopics are hidden.
- ☐ The disadvantages of cascading menus are:
 - Access to submenu items requires more steps.
 - Access to submenu items requires a change in pointer movement direction.

- Exhaustive browsing is more difficult; some alternatives remain hidden as pull downs become visible.



Cascade Indicator

- ☐ Place an arrow or right-pointing triangle to the right of each menu choice description leading to a cascade menu.
- ☐ Separate the indicator from the choice description by one space.
- ☐ Display the indicator in the same color as the choice descriptions.

Location

- ☐ Position the first choice in the cascading menu immediately to the right of the selected choice.
- ☐ Leave the choice leading to the cascading menu highlighted.

Levels

- ☐ Do not exceed three menu levels (two cascades).
— Only one cascading menu is preferred.

Title

- ☐ Not necessary on the cascading menu.
— The title will be the name of the higher-level menu item chosen.

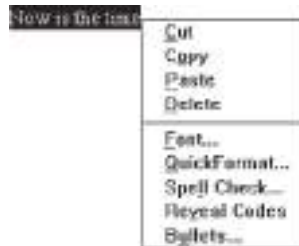
Other Guidelines

- ☐ Follow the organization, content, layout, separation, and selection cursor guidelines for the kind of menu from which the menu cascades.

Pop-up Menus

- ☐ Use to present alternatives or choices within the context of the task.
- ☐ The advantages of pop-up menus are:
 - They appear in the working area.
 - They do not use window space when not displayed.
 - No pointer movement is needed if selected by button.

- Their vertical orientation is most efficient scanning.
- Their vertical orientation most efficient for grouping.
- Their vertical orientation allows more choices to be displayed.
- They may be able to remain showing (-pinned) when used frequently.
- They allow for display of both keyboard equivalents and accelerators.
- The disadvantages of pop-up menus are:
 - Their existence must be learned and remembered.
 - Means for selecting them must be learned and remembered.
 - They require a special action to see the menu (mouse click).
 - Items are smaller than full-size buttons, slowing selection time.
 - They may obscure the screen working area.
 - Their display locations may not be consistent.



Display

- Provide a pop-up menu for common, frequent, contextual actions.
 - If the pointer is positioned over an object possessing more than one quality (for example, both text and graphics), at minimum present actions common to all object qualities.
- Items that cannot be chosen due to the current state of an application should not be displayed.
- Continue to display a pop-up until:
 - A choice is selected.
 - An action outside the pop-up is initiated.
 - The user removes the pop-up.

Location

- Position the pop-up:
 - Centered and to the right of the object from which it was requested.
 - Close enough to the pointer so that the pointer can be easily moved onto the menu.
 - But not so close that the pointer is positioned on an item, possibly leading to accidental selection.
- If the pointer is positioned in such a manner that the pop-up would appear offscreen or clipped, position the menu:
 - As close as possible to the object, but not covering the object.
 - So that it appears fully on the screen.

Size

- ☐ Restrict the pop-up to no more than 5 to 10 choices, preferably 8 or less.

Title

- ☐ Not necessary on a pop-up menu.
- ☐ If included, clearly describe the menu's purpose.
- ☐ Locate in a centered position at the top.
- ☐ Display in uppercase or mixed-case letters.
- ☐ Separate it from the menu items by a line extending from the left menu border to the right border.

Other Guidelines

- ☐ Arrange logically organized and grouped choices into columns.
- ☐ If items are also contained in pull-down menus, organize pop-up menus in the same manner.
- ☐ Left-align choice descriptions.
- ☐ Use mixed-case headline-style words to describe choices.
- ☐ Separate groups with a solid line the length of the longest choice description.
- ☐ If the choice leads to a pop-up window, place an ellipsis after the choice description.
- ☐ To separate the pop-up from the screen background:
 - Use a contrasting, but complementary background.
 - Incorporate a solid line border around the pull-down.

Tear-off Menus

- ☐ It may also be called a pushpin, detachable, or roll-up menu. Its purpose is to present alternatives or choices to the screen user that are needed infrequently at some times
- ☐ Follow all relevant guidelines for pull-down menus.
- ☐ Advantages/disadvantages. No space is consumed on the screen when the menu is not needed. When needed, it can remain continuously displayed. It does require extra steps to retrieve, and it may obscure the screen working area.

Iconic Menus

- ☐ Use to remind users of the functions, commands, attributes, or application choices available.
- ☐ Create icons that:
 - Help enhance recognition and hasten option selection.
 - Are concrete and meaningful.
 - Clearly represent choices.
 -



Advantages/disadvantages.

- ☐ Pictures help facilitate memory of applications, and their larger size increases speed of selection. Pictures do, however, consume considerably more screen space than text, and they are difficult to organize for scanning efficiency.
- ☐ To create meaningful icons requires special skills and an extended amount of time. Iconic menus should be used to designate applications or special functions within an application.
- ☐ Icons must be meaningful and clear. They should help enhance recognition and hasten option selection.

Pie Menus

- ☐ Consider using for:
 - Mouse-driven selections, with one- or two-level hierarchies, short lists, and choices conducive to the format.

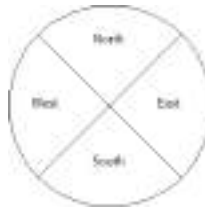


Table 4.4 Menu Proper Usage Summary

Menu Bar	To identify and provide access to: <ul style="list-style-type: none"> • Common and frequently used application actions. • Actions that take place in a wide variety of different windows.
Pull-Down Menu	For frequently used application actions that take place in a wide variety of different windows: <ul style="list-style-type: none"> • A small number of items (5–10). • Items rarely changing in content.
Cascading Menu	To simplify a higher-level menu. To provide easier browsing of a higher-level menu. For mutually exclusive choices. Restrict to 1–2 cascades.
Pop-Up Menu	For: <ul style="list-style-type: none"> • Frequent users. • Frequently used contextual commands. • A small number of items (5–10). • Items rarely changing in content. • Items that require a small amount of screen space.
Tear-Off Menu	For items: <ul style="list-style-type: none"> • Sometimes frequently selected. • Sometimes infrequently selected. • Small in number (5–10). • Rarely changing in content.
Iconic Menu	To designate applications available. To designate special functions within an application.

Default Menu

Items File

A standard element, the File menu provides all the commands needed to open, create, and save files. Some standard File functions are:

New Open Close Save Save As Print Preview Print Exit

Edit

A standard element, the Edit menu provides commands that affect the state of selected objects. Some standard Edit functions are:

Undo Cut Copy Paste Select All Find Replace

View

An optional element, the View menu provides commands that affect the perspective, details, and appearance of the application. They affect the view, not the data itself. The view functions are application-specific and include the following:

Toolbars Status Bar Magnify Zoom In Zoom Out Grid Points

Window

The Window menu, an optional element, provides commands to manipulate entire windows. Included are items such as:

New Window Arrange All Hide Show

Help

The Help menu, a standard element, provides Help commands, including:

Contents Search for Help on How to Use Help About (Application)

Functions Not Represented by Default Items

Labels

- ☐ General:
 - Provide a label for each command.
 - Use labels that indicate:
 - The purpose of the command, or
 - The result of what happens when the command is selected.
 - Use familiar, short, clear, concise words.
 - Use distinctive wording.
 - Use mixed case, with the first letter capitalized.
 - Begin commands with verbs or adjectives, not nouns.
 - Preferably, use only one word.
 - If multiple words are required for clarity, capitalize the first letter of each significant word.
 - Do not use sentences as labels.
 - Provide an ellipsis (. . .) to indicate that another window will result from selection of a command.
 - Do not use the ellipsis when the following window is a confirmation or warning.
- ☐ Dynamic labels:
 - As contexts change, dynamically change the label wording to make its meaning clearer in the new context.
 - For example, after a cut operation, Undo may be changed to Undo Cut.

Disabled Commands

- ☐ When a command is not available, indicate its disabled status by displaying it grayed out or subdued.
- ☐ If selection of a disabled command is attempted, provide a message in the information area that the -Help|| function will explain why it is disabled.

Navigation and Selection

- ☐ General:

- Permit multiple methods for selecting commands.
- ☐ Keyboard equivalents:
 - Assign a mnemonic for each command.
 - A mnemonic should be as meaningful as possible. Use:
 - The first letter of the command, or if duplications exist,
 - The first letter of another word in the command, or
 - Another significant consonant in the command.
 - For standard commands, use mnemonics provided by the tool set.
- ☐ Keyboard accelerators:
 - Assign keyboard accelerators for frequently used commands.
 - For standard commands, use keyboard accelerators provided by the tool set.

Windows and controls

- ☐ To understand the purpose and usage of different kinds of windows for respective tasks.
- ☐ To identify proper input devices for implementing to the user based on their characteristics
- ☐ To identify proper screen based controls for implementing to the user based on their characteristics

Select the Proper Kinds of Windows

- ☐ A window is an area of the screen, usually rectangular in shape, defined by a border that contains a particular view of some area of the computer or some portion of a person's dialog with the computer.
- ☐ It can be moved and rendered independently on the screen.

Window Characteristics

- ☐ A window is seen to possess the following characteristics:
 - A name or title, allowing it to be identified.
 - A size in height and width (which can vary).
 - A state, accessible or active, or not accessible. (Only active windows can have their contents altered.)
 - Visibility—the portion that can be seen. (A window may be partially or fully hidden behind another window, or the information within a window may extend beyond the window's display area.)
 - A location, relative to the display boundary.
 - Presentation, that is, its arrangement in relation to other windows. It may be tiled, overlapping, or cascading.
 - Management capabilities, methods for manipulation of the window on the screen.
 - Its highlight, that is, the part that is selected.
 - The function, task, or application to which it is dedicated.

The Attraction of Windows

- ☐ While all the advantages and disadvantages of windows are still not completely understood, windows do seem to be useful in the following ways.
- ☐ **Presentation of Different Levels of Information:** A document table of contents can be presented in a window. A chapter or topic selected from this window can be simultaneously displayed in more detail in an adjoining window.
- ☐ **Presentation of Multiple Kinds of Information:** Variable information needed to complete a task can be displayed simultaneously in adjacent windows. For example in one window billing can be done and in one window stock

Maintenance can be done at the same time using windows. Significant windows could remain displayed so that details may be modified as needed prior

- ☐ **Sequential Presentation of Levels or Kinds of Information:** Steps to accomplish a task can be sequentially presented through windows. Key windows may remain displayed, but others appear and disappear as necessary. This sequential preparation is especially useful if the information-collection process leads down various paths.
- ☐ **Access to Different Sources of Information:** Independent sources of information may have to be accessed at the same time. Independent sources of information may have to be accessed at the same time
- ☐ **Combining Multiple Sources of Information:** Text from several documents may have to be reviewed and combined into one. Pertinent information is selected from one window and copied into another.
- ☐ **Performing More Than One Task:** While waiting for a long, complex procedure to finish, another can be performed. Tasks of higher priority can interrupt less important ones and then the interrupted tasks can be preceded.
- ☐ **Reminding:** It can be used to provide remainder through messages or popup or menus.
- ☐ **Monitoring:** Data in one window can be modified and its effect on data in another window can be studied.
- ☐ **Multiple Representations of the Same Task:** the same task can be represented in two different ways in two windows. For example a report can be given as table in one window and as a chart in another window.

Constraints in Window System Design

- ☐ Historically, system developers have been much more interested in solving hardware problems than in user considerations.
- ☐ This lack of guidelines makes it difficult to develop acceptable and agreeable

- window standards.
- The result is that developers of new systems create another new variation each time they design a product, and users must cope with a new interface each time they encounter a new windowing system.

Hardware Limitations

- Either seeing all the contents of one window is preferable to seeing small parts of many windows or the operational and visual complexity of multiple windows is not wanted.
- Poor screen resolution and graphics capability may also deter effective use of windows by not permitting sharp and realistic drawings and shapes

Human Limitations

- ☐ These window management operations are placed on top of other system operations, and window management can become an end in itself. This can severely detract from the task at hand.
- ☐ The results suggest that advantages for windows do exist, but they can be negated by excessive window manipulation requirements.
- ☐ It is also suggested that to be truly effective, window manipulation must occur implicitly as a result of user task actions, not as a result of explicit window management actions by the user.

Other Limitations

- ☐ Other possible window problems include the necessity for window borders to consume valuable screen space, and that small windows providing access to large amounts of information can lead to excessive, bothersome scrolling

Components of a Window

Frame

- ☐ A window will have a frame or border, usually rectangular in shape, to define its boundaries and distinguish it from other windows.
- ☐ While a border need not be rectangular, this shape is a preferred shape for most people.

Title Bar

- ☐ The title bar is the top edge of the window, inside its border and extending its entire width.
- ☐ This title bar is also referred to by some platforms as the *caption*, *caption bar*, or *title area*.
- ☐ The title bar contains a descriptive title identifying the purpose or content of the window.

Title bar Icon

- ☐ Located at the left corner of the title bar in a primary window, this button is used in Windows to retrieve a pull-down menu of commands that apply to the object in the window.
- ☐ It is 16 X 16 version of the icon of the object being viewed.

Window Sizing Buttons

- ☐ Located at the right corner of the title bar, these buttons are used to manipulate the size of a window.

- The leftmost button, the *minimize* button— inscribed with a short horizontal line toward the bottom of the button—is used to reduce a window to its minimum size, usually an icon. It also hides all associated windows.
- The *maximize* button—typically inscribed with a large box—enlarges a window to its maximum size, usually the entire screen. When a screen is maximized, the *restore* button replaces the maximize button, since the window can no longer be increased in size.
- When these buttons are displayed, use the following guidelines:
 - When a window does not support a command, do not display its command button.
 - The *Close* button always appears as the rightmost button. Leave a gap between it and any other buttons.
 - The *Minimize* button always precedes the *Maximize* button.
 - The *Restore* button always replaces the *Maximize* button or the *Minimize* button when that command is carried out.

What's This? Button

- The *What's This?* Button, which appears on secondary windows and dialog boxes, is used to invoke the What's This?
- Windows command to provide contextual Help about objects displayed within a secondary window.

Menu Bar

- A menu bar is used to organize and provide access to actions. It is located horizontally at the top of the window, just below the title bar.
- A menu bar contains a list of topics or items that, when selected, are displayed on a pull-down menu beneath the choice.

Status Bar

- Information of use to the user can be displayed in a designated screen area or areas. They may be located at the top of the screen in some platforms and called a *status area*, or at the screen's bottom.
- Microsoft recommends the bottom location and refers to this area as the *status bar*. It is also referred to by other platforms as a *message area* or *message bar*.

Scroll Bars

- When all display information cannot be presented in a window, the additional information must be found and made visible.

- ☐ This is accomplished by scrolling the display's contents through use of a scroll bar.
- ☐ A scroll bar is an elongated rectangular container consisting of a scroll area or shaft, a slider box or elevator, and arrows or anchors at each end.
- ☐ For vertical scrolling, the scroll bar is positioned at the far right side of the work

Split Box

- ☐ A window can be split into two or more pieces or panes by manipulating a *split box* located above a vertical scroll bar or to the left of a horizontal scroll bar.
- ☐ A split box is sometimes referred to as a *split bar*.
- ☐ A window can be split into two or more separate viewing areas that are called *panes*

Toolbar

- ☐ Toolbars are permanently displayed panels or arrays of choices or commands that must be accessed quickly. They are sometimes called *command bars*.
- ☐ Toolbars are designed to provide quick access to specific commands or options. Specialized toolbars are sometimes referred to as *ribbons*, *toolboxes*, *rulers*, or *palettes*.

Command Area

- ☐ In situations where it is useful for a command to be typed into a screen, a command area can be provided.
- ☐ The desired location of the command area is at the bottom of the window.

Size Grip

- ☐ A size grip is a Microsoft Windows special handle included in a window to permit it to be resized.
- ☐ When the grip is dragged the window resizes, following the same conventions as the sizing border. Three angled parallel lines in the lower-right corner of a window designate the size grip.

Work Area

- ☐ The work area is the portion of the screen where the user performs tasks.
- ☐ It is the open area inside the window's border and contains relevant peripheral screen components such as the menu bar, scroll bars, or message bars.
- ☐ The work area may also be referred to as the *client area*.

Table 5.1 Microsoft Windows Components

COMPONENT	WINDOWS CONTAINING COMPONENT		
	PRIMARY	SECONDARY	DIALOG BOX
<i>Frame or Border</i> • Boundary to define shape. • If sizable, contains control points for resizing.	X	X	X
<i>Title Bar Text</i> • Name of object being viewed in window. • Control point for moving window.	X	X	X
<i>Title Bar Icon</i> • Small version of icon for object being viewed. • Access point for commands that apply to the object.	X		
<i>Title Bar Buttons</i> • Shortcuts to specific commands.	X	X	X
<i>Close</i>	X	X	X
<i>Minimize/Maximize/Restore</i>	X		
<i>What's This?</i> – Displays context-sensitive Help about any object displayed on window.		X	X
<i>Menu Bar</i> • Provides basic and common application commands.	X		
<i>Status Bar</i> • An area used to display status information about what is displayed in window.	X		
<i>Scroll Bar</i> • Standard control to support scrolling.	X		
<i>Size Grip</i> • Control to resize window, located at right side of status bar.	X		

Window Presentation Styles

- ☐ The presentation style of a window refers to its spatial relationship to other windows.
- ☐ There are two basic styles, commonly called tiled or overlapping.

Tiled Windows

- ☐ Tiled windows derive their name from common floor or wall tile. Tiled windows appear in one plane on the screen and expand or contract to fill up the display surface, as needed.
- ☐ Most systems provide two-dimensional tiled windows, adjustable in both height and width.



□ advantages:

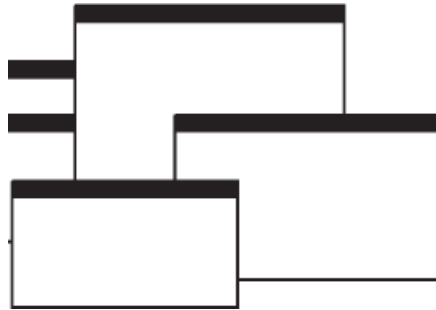
- The system usually allocates and positions windows for the user, eliminating the necessity to make positioning decisions.
- Open windows are always visible, eliminating the possibility of them being lost and forgotten.
- Every window is always completely visible, eliminating the possibility of information being hidden.
- They are perceived as fewer complexes than overlapping windows, possibly because there are fewer management operations or they seem less -magical.¶
- They are easier, according to studies, for novice or inexperienced people to learn and use.
- They yield better user performance for tasks where the data requires little window manipulation to complete the task.

□ Disadvantages

- Only a limited number can be displayed in the screen area available.
- As windows are opened or closed, existing windows change in size. This can be annoying.
- As windows change in size or position, the movement can be disconcerting.
- As the number of displayed windows increases, each window can get very tiny.
- The changes in sizes and locations made by the system are difficult to predict.
- The configuration of windows provided by the system may not meet the user's needs.
- They are perceived as crowded and more visually complex because window borders are flush against one another, and they fill up the whole screen. Crowding is accentuated if borders contain scroll bars or control icons. Viewer attention may be drawn to the border, not the data.
- They permit less user control because the system actively manages the windows.

Overlapping Windows

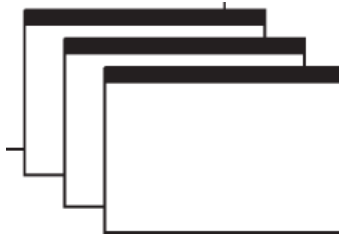
- ☐ Overlapping windows may be placed on top of one another like papers on a desk.
- ☐ They possess a three-dimensional quality, appearing to lie on different planes.



- ☐ Advantages:
 - Visually, their look is three-dimensional, resembling the desktop that is familiar to the user.
 - Greater control allows the user to organize the windows to meet his or her needs.
 - Windows can maintain larger sizes.
 - Windows can maintain consistent sizes.
 - Windows can maintain consistent positions.
 - Screen space conservation is not a problem, because windows can be placed on top of one another.
 - There is less pressure to close or delete windows no longer needed.
 - The possibility exists for less visual crowding and complexity. Larger borders can be maintained around window information, and the window is more clearly set off against its background. Windows can also be expanded to fill the entire display.
 - They yield better user performance for tasks where the data requires much window manipulation to complete the task.
- ☐ Disadvantages
 - They are operationally much more complex than tiled windows. More control functions require greater user attention and manipulation.
 - Information in windows can be obscured behind other windows.
 - Windows themselves can be lost behind other windows and be presumed not to exist.
 - That overlapping windows represent a three-dimensional space is not always realized by the user.
 - Control freedom increases the possibility for greater visual complexity and crowding. Too many windows, or improper offsetting, can be visually overwhelming.

Cascading Windows

- ☐ A special type of overlapping window has the windows automatically arranged in a regular progression.
- ☐ Each window is slightly offset from others, as illustrated in Figure



- ☐ Advantages
 - No window is ever completely hidden.
 - Bringing any window to the front is easier.
 - It provides simplicity in visual presentation and cleanness.

Picking a Presentation Style

- ☐ Use tiled windows for:
 - Single-task activities.
 - Data that needs to be seen simultaneously.
 - Tasks requiring little window manipulation.
 - Novice or inexperienced users.
- ☐ Use overlapping windows for:
 - Switching between tasks.
 - Tasks necessitating a greater amount of window manipulation.
 - Expert or experienced users.
 - Unpredictable display contents.

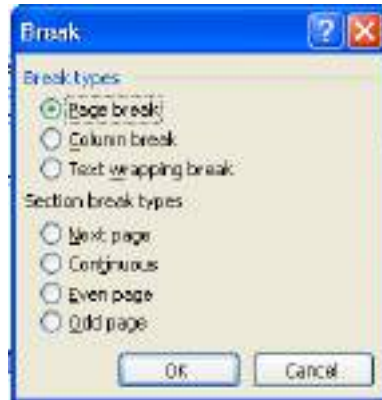
Types of Windows

Primary Window



- Proper usage:
 - Should represent an independent function or application.
 - Use to present constantly used window components and controls.
 - Menu bar items that are:
 - Used frequently.
 - Used by most, or all, primary or secondary windows.
 - Controls used by dependent windows.
 - Use for presenting information that is continually updated.
 - For example, date and time.
 - Use for providing context for dependent windows to be created.
 - Do not:
 - Divide an independent function into two or more primary windows.
 - Present unrelated functions in one primary window.
- It has also been variously referred to as the *application* window or the *main* window. In addition, it may be referred to as the *parent* window if one or more *child* windows exist

Secondary Windows



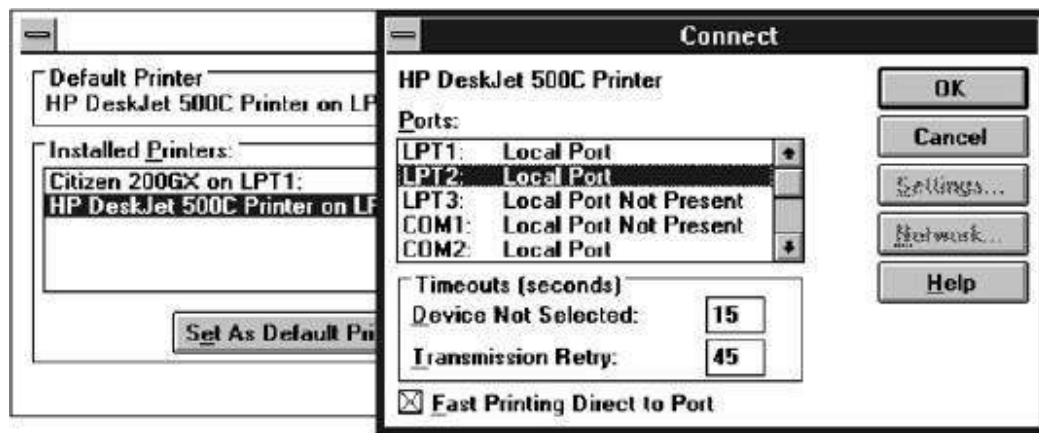
- Proper usage:
 - For performing subordinate, supplemental, or ancillary actions that are:
 - Extended or more complex in nature.
 - Related to objects in the primary window.
 - For presenting frequently or occasionally used window components.
- Important guidelines:
 - Should typically not appear as an entry on the taskbar.
 - A secondary window should not be larger than 263 dialog units x 263 dialog units.
- A *dependent* secondary window is one common type. It can only be displayed from a command on the interface of its primary window. It is typically associated with a single data object, and appears on top of the active window when requested. It is movable, and scrollable.
- An *independent* secondary window can be opened independently of a primary window—for example, a property sheet displayed when the user clicks the Properties command on the menu of a desktop icon.

Modal and Modeless

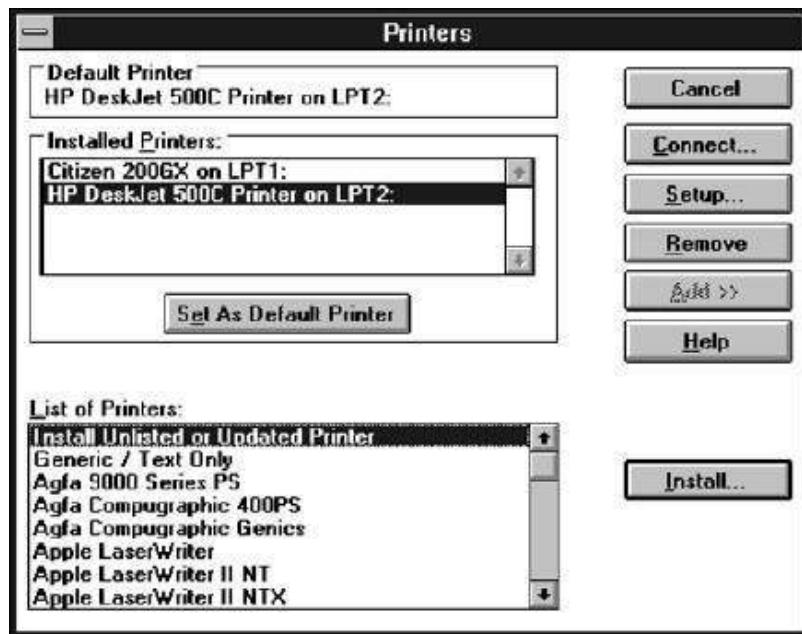
- Modal:
 - Use when interaction with any other window must not be permitted.
 - Use for:
 - Presenting information.
 - For example, messages (sometimes called a message box).
 - Receiving user input.
 - For example, data or information (sometimes called a prompt box).
 - Asking questions.
 - For example, data, information, or directions (sometimes called a question box).
 - Use carefully because it constrains what the user can do.
- Modeless:
 - Use when interaction with other windows must be permitted.
 - Use when interaction with other windows must be repeated.

Cascading and Unfolding

- Cascading:
 - Purpose:
 - To provide advanced options at a lower level in a complex dialog.
 - Guidelines:
 - Provide a command button leading to the next dialog box with a -To a Window indicator, an ellipsis (. . .).
 - Present the additional dialog box in cascaded form.
 - Provide no more than two cascades in a given path.
 - Do not cover previous critical information.
 - Title Bar.
 - Relevant displayed information.
 - If independent, close the secondary window from which it was opened.
- Unfolding:
 - Purpose:
 - To provide advanced options at the same level in a complex dialog.
 - Guidelines:
 - Provide a command button with an expanding dialog symbol (>>).
 - Expand to right or downward.

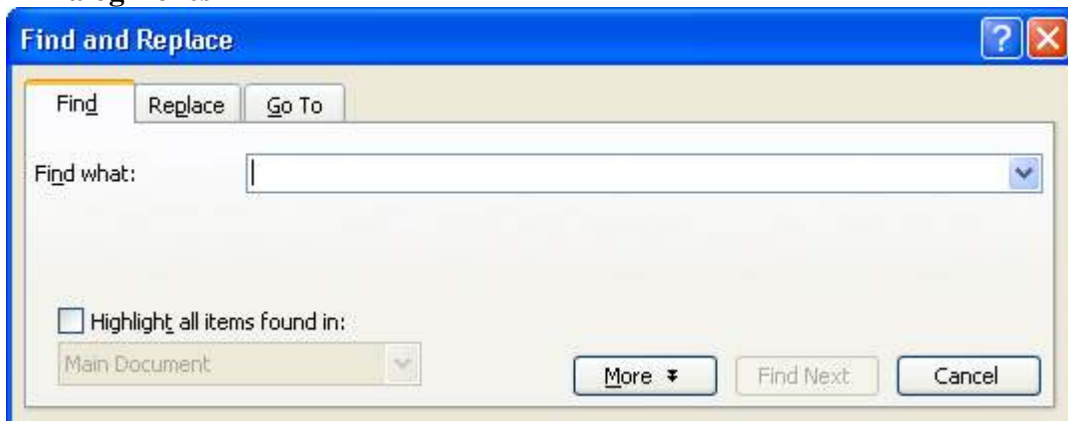


Cascaded Window



Unfolded Window

Dialog Boxes

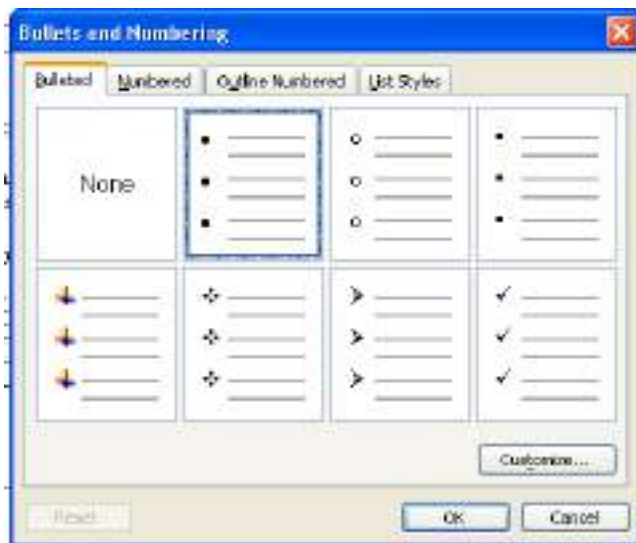


- ☐ Use for presenting brief messages.
- ☐ Use for requesting specific, transient actions.
- ☐ Use for performing actions that:
 - Take a short time to complete.
 - Are not frequently changed.
- ☐ Command buttons to include:
 - OK.
 - Cancel.
 - Others as necessary.

Property Sheets and Property Inspectors

Secondary windows provide two other techniques for displaying properties, *property sheets* and *property inspectors*.

Property Sheets



- ☐ Use for presenting the complete set of properties for an object.
- ☐ Categorize and group within property pages, as necessary.
 - Use tabbed property pages for grouping peer-related property sets.

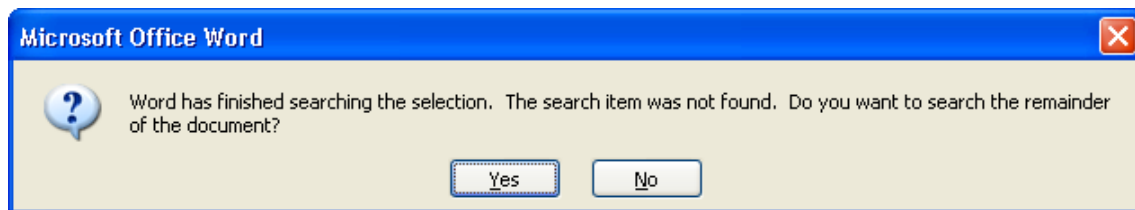
- The recommended sizes for property sheets are:
 - 252 DLUs wide x 218 DLUs high
 - 227 DLUs wide x 215 DLUs high
 - 212 DLUs wide x 188 DLUs high
- Command buttons to include:
 - OK.
 - Cancel.
 - Apply.
 - Reset.
 - Others as necessary.
- For single property sheets, place the commands on the sheet.
- For tabbed property pages, place the commands outside the tabbed pages.

Property Inspectors



- Use for displaying only the most common or frequently accessed objects properties.
- Make changes dynamically.

Message Boxes



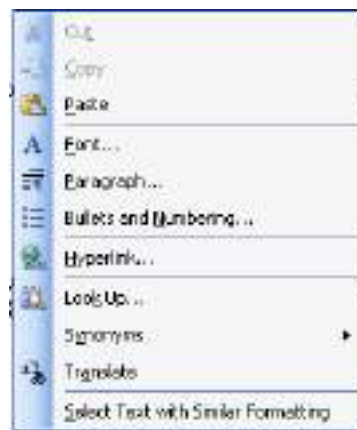
- Use for displaying a message about a particular situation or condition.
- Command buttons to include:
 - OK.
 - Cancel.
 - Help.
 - Yes and No.
 - Stop.
 - Buttons to correct the action that caused the message box to be displayed.
- Enable the title bar close box only if the message includes a cancel button.
- Designate the most frequent or least destructive option as the default command

Palette Windows



- Use to present a set of controls.
- Design as resizable.
 - Alternately, design them as fixed in size.

Pop-up Windows



- Use pop-up windows to display:
 - Additional information when an abbreviated form of the information is the main presentation.
 - Textual labels for graphical controls.
 - Context-sensitive Help information

Window Management

Microsoft Windows also provides several window management schemes, a *single document interface*, a *multiple-document interface*, *workbooks*, and *projects*.

Single-Document Interface

- Description:
 - A single primary window with a set of secondary windows.
- Proper usage:
 - Where object and window have a simple, one-to-one relationship.
 - Where the object's primary presentation or use is as a single unit.
 - To support alternate views with a control that allows the view to be changed.
 - To support simultaneous views by splitting the window into panes.
- Advantages:

- Most common usage.
- Window manipulation is easier and less confusing.
- Data-centered approach.
- Disadvantage:
 - Information is displayed or edited in separate windows.

Multiple-Document Interface

- Description:
 - A technique for managing a set of windows where documents are opened into windows.
 - Contains:
 - A single primary window, called the parent.
 - A set of related document or child windows, each also essentially a primary window.
 - Each child window is constrained to appear only within the parent window.
 - The child windows share the parent window's operational elements.
 - The parent window's elements can be dynamically changed to reflect the requirements of the active child window.
- Proper usage:
 - To present multiple occurrences of an object.
 - To compare data within two or more windows.
 - To present multiple parts of an application.
 - Best suited for viewing homogeneous object types.
 - To clearly segregate the objects and their windows used in a task.
- Advantages:
 - The child windows share the parent window's interface components (menus, toolbars, and status bars), making it a very space-efficient interface.
 - Useful for managing a set of objects.
 - Provides a grouping and focus for a set of activities within the larger environment of the desktop.
- Disadvantages:
 - Reinforces an application as the primary focus.
 - Containment for secondary windows within child windows does not exist, obscuring window relationships and possibly creating confusion.
 - Because the parent window does not actually contain objects, context cannot always be maintained on closing and opening.
 - The relationship between files and their windows is abstract, making an MDI application more challenging for beginning users to learn.
 - Confining child windows to the parent window can be inconvenient or inappropriate for some tasks.
 - The nested nature of child windows may make it difficult for the user to distinguish a child window in a parent window from a primary window that is a peer with the parent window but is positioned on top.

Workbooks

- Description:

- A window or task management technique that consists of a set of views organized like a tabbed notebook.
- It is based upon the metaphor of a book or notebook.
- Views of objects are presented as sections within the workbook's primary windows; child windows do not exist.
- Each section represents a view of data.
- Tabs can be included and used to navigate between sections.
- Otherwise, its characteristics and behavior are similar to those of the multiple document interface with all child windows maximized.
- Proper usage:
 - To manage a set of views of an object.
 - To optimize quick navigation of multiple views.
 - For content where the order of the sections is significant.
- Advantages:
 - Provides a grouping and focus for a set of activities within the larger environment of the desktop.
 - Conserves screen real estate.
 - Provides the greater simplicity of the single-document window interface.
 - Provides greater simplicity by eliminating child window management.
 - Preserves some management capabilities of the multiple-document interface.
- Disadvantage:
 - Cannot present simultaneous views.

Projects

- Description:
 - A technique that consists of a container: a project window holding a set of objects.
 - The objects being held within the project window can be opened in primary windows that are peers with the project window.
 - Visual containment of the peer windows within the project window is not necessary.
 - Each opened peer window must possess its own menu bar and other interface elements.
 - Each opened peer window can have its own entry on the task bar.
 - When a project window is closed, all the peer windows of objects also close.
 - When the project window is opened, the peer windows of the contained objects are restored to their former positions.
 - Peer windows of a project may be restored without the project window itself being restored.
- Proper usage:
 - To manage a set of objects that do not necessarily need to be contained.
 - When child windows are not to be constrained.
- Advantages:
 - Provides a grouping and focus for a set of activities within the larger environment of the desktop.
 - Preserves some management capabilities of the multiple document interface.
 - Provides the greatest flexibility in the placement and arrangement of windows.

- Disadvantage:
 - Increased complexity due to difficulty in differentiating peer primary windows of the project from windows of other applications.

Organizing Window Functions

Window Organization

- Organize windows to support user tasks.
- Support the most common tasks in the most efficient sequence of steps.
- Use primary windows to:
 - Begin an interaction and provide a top-level context for dependent windows.
 - Perform a major interaction.
- Use secondary windows to:
 - Extend the interaction.
 - Obtain or display supplemental information related to the primary window.
- Use dialog boxes for:
 - Infrequently used or needed information.
 - -Nice-to-know information.

Number of Windows

- Minimize the number of windows needed to accomplish an objective.
- The general rule:
 - Minimize the number of windows used to accomplish an objective.
 - Use a single window whenever possible. Consider, however, the user's task.
 - Don't clutter up a single window with rarely used information when it can be placed on a second, infrequently used, window.

Window Operations

Active Window

- A window should be made active with as few steps as possible.
- Visually differentiate the active window from other windows.

General Guidelines

- Design easy to use and learn windowing operations.
 - Direct manipulation seems to be a faster and more intuitive interaction style than indirect manipulation for many windowing operations.
- Minimize the number of window operations necessary to achieve a desired effect.
- Make navigating between windows particularly easy and efficient to do.
- Make the setting up of windows particularly easy to remember.
- In overlapping systems, provide powerful commands for arranging windows on the screen in user-tailorable configurations.

Opening a Window

- Provide an iconic representation or textual list of available windows.
 - If opening with an expansion of an icon, animate the icon expansion.
- When opening a window:
 - Position the opening window in the most forward plane of the screen.
 - Adapt the window to the size and shape of the monitor on which it will be presented.
 - Designate it as the active window.
 - Set it off against a neutral background.
 - Ensure that its title bar is visible.
- When a primary window is opened or restored, position it on top.
 - Restore all secondary windows to the states that existed when the primary window was closed.
- When a dependent secondary window is opened, position it on top of its associated primary window.
 - Position a secondary window with peer windows on top of its peers.
 - Present layered or cascaded windows with any related peer secondary windows.
- When a dependent secondary window is activated, its primary window and related peer windows should also be positioned at the top.
- If more than one object is selected and opened, display each object in a separate window.
- Designate the last window selected as the active window.
- Display a window in the same state as when it was last accessed.
 - If the task, however, requires a particular sequence of windows, use a fixed or consistent presentation sequence.
- With tiled windows, provide an easy way to resize and move newly opened windows.

Sizing Windows

- Provide large-enough windows to:
 - Present all relevant and expected information for the task.
 - Avoid hiding important information.
 - Avoid crowding or visual confusion.
 - Minimize the need for scrolling.
 - But use less than the full size of the entire screen.
- If a window is too large, determine:
 - Is all the information needed?
 - Is all the information related?
- Otherwise, make the window as small as possible.
 - Optimum window sizes:
 - For text, about 12 lines.
 - For alphanumeric information, about seven lines.
- Larger windows seem to have these advantages:
 - They permit displaying of more information.

- They facilitate learning: Data relationships and groupings are more obvious.
- Less window manipulation requirements exist.
- Breadth is preferred to depth (based on menu research).
- More efficient data validation and data correction can be performed.
- Disadvantages include:
 - Longer pointer movements are required.
 - Windows are more crowded.
 - More visual scanning is required.
 - Other windows more easily obscure parts of the window.
 - It is not as easy to hide inappropriate data.

Window Placement

- Considerations:
 - In placing a window on the display, consider:
 - The use of the window.
 - The overall display dimensions.
 - The reason for the window's appearance.
- General:
 - Position the window so it is entirely visible.
 - If the window is being restored, place the window where it last appeared.
 - If the window is new, and a location has not yet been established, place it:
 - At the point of the viewer's attention, usually the location of the pointer or cursor.
 - In a position convenient to navigate to.
 - So that it is not obscuring important or related underlying window information.
 - For multiple windows, give each additional window its own unique and discernible location.
 - A cascading presentation is recommended.
 - In a multiple-monitor configuration, display the secondary window on the same monitor as its primary window.
 - If none of the above location considerations apply, then:
 - Horizontally center a secondary window within its primary window just below the title bar, menu bar, and any docked toolbars.
 - If the user then moves the window, display it at this new location the next time the user opens the window.
 - Adjust it as necessary to the current display configuration.
 - Do not let the user move a window to a position where it cannot be easily repositioned.
- Dialog boxes:
 - If the dialog box relates to the entire system, center it on screen.
 - Keep key information on the underlying screen visible.
 - If one dialog box calls another, make the new one movable whenever possible.

Window Separation

- Crisply, clearly, and pleasingly demarcate a window from the background of the screen on which it appears.
 - Provide a surrounding solid line border for the window.
 - Provide a window background that sets the window off well against the overall screen background.
 - Consider incorporating a drop shadow beneath the window.

Moving a Window

- Permit the user to change the position of all windows.
- Change the pointer shape to indicate that the move selection is successful.
- Move the entire window as the pointer moves.
 - If it is impossible to move the entire window, move the window outline while leaving the window displayed in its original position.
- Permit the moving of a window without its being active.

Resizing a Window

- Permit the user to change the size of primary windows.
 - Unless the information displayed in the window is fixed or cannot be scaled to provide more information.
- Change the pointer shape to indicate that the resizing selection is successful.
- The simplest operation is to anchor the upper-left corner and resize from the lower right corner.
 - Also permit resizing from any point on the window.
- Show the changing window as the pointer moves.
 - If it is impossible to show the entire window being resized, show the window's outline while leaving the window displayed in its original position.
- When window size changes and content remains the same:
 - Change image size proportionally as window size changes.
- If resizing creates a window or image too small for easy use, do one of the following:
 - Clip (truncate) information arranged in some logical structure or layout when minimum size is attained, or
 - When no layout considerations exist, format (restructure) information as size is reduced, or
 - Remove less useful information (if it can be determined), or
 - When minimum size is attained, replace information with a message that indicates that the minimum size has been reached and that the window must be enlarged to continue working.
- Permit resizing a window without its being active.

Other Operations

Permit primary windows to be maximized, minimized, and restored.

Window Shuffling

Window shuffling must be easy to accomplish.

Keyboard Control/Mouse less Operation

- Window actions should be capable of being performed through the keyboard as well as with a mouse.
- Keyboard alternatives should be designated through use of mnemonic codes as much as possible.
- Keyboard designations should be capable of being modified by the user.

Closing a Window

- Close a window when:
 - The user requests that it be closed.
 - The user performs the action required in the window.
 - The window has no further relevance.
- If a primary window is closed, also close all of its secondary windows.
- When a window is closed, save its current state, including size and position, for use when the window is opened again.

Select the Proper Device-Based Controls

Device-based controls, often called input devices, are the mechanisms through which people communicate their desires to the system.

Characteristics of Device-Based Controls

Several specific tasks are performed using graphical systems.

- To point at an object on the screen.
- To select the object or identify it as the focus of attention.
- To drag an object across the screen.
- To draw something free form on the screen.
- To track or follow a moving object.
- To orient or position an object.
- To enter or manipulate data or information.

Direct and Indirect Devices

- *Direct* devices are operated on the screen itself. Examples include the light pen, the finger, and voice.
- *Indirect* devices are operated in a location other than the screen, most often on the desktop.

Trackball

- Description:
 - A spherical object (ball) that rotates freely in all directions in its socket.

- Direction and speed is tracked and translated into cursor movement.
- Advantages:
 - Direct relationship between hand and pointer movement in terms of direction and speed.
 - Does not obscure vision of screen.
 - Does not require additional desk space (if mounted on keyboard).
- Disadvantages:
 - Movement is indirect, in a plane different from the screen.
 - No direct relationship exists between hand and pointer movement in terms of distance.
 - Requires a degree of eye-hand coordination.
 - Requires hand to be removed from keyboard keys.
 - Requires different hand movements.
 - Requires hand to be removed from keyboard (if not mounted on keyboard).
 - Requires additional desk space (if not mounted on keyboard).
 - May be difficult to control.
 - May be fatiguing to use over extended time.

Joystick

- Description:
 - A stick or bat-shaped device anchored at the bottom.
 - Variable in size, smaller ones being operated by fingers, larger ones requiring the whole hand.
 - Variable in cursor direction movement method, force joysticks respond to pressure, movable ones respond to movement.
 - Variable in degree of movement allowed, from horizontal-vertical only to continuous.
- Advantages:
 - Direct relationship between hand and pointer movement in terms of direction.
 - Does not obscure vision of screen.
 - Does not require additional desk space (if mounted on keyboard).
- Disadvantages:
 - Movement indirect, in plane different from screen.
 - Indirect relationship between hand and pointer in terms of speed and distance.
 - Requires a degree of eye-hand coordination.
 - Requires hand to be removed from keyboard keys.
 - Requires different hand movements to use.
 - Requires hand to be removed from keyboard (if not mounted on keyboard).
 - Requires additional desk space (if not mounted on keyboard).
 - May be fatiguing to use over extended time.
 - May be slow and inaccurate.

Graphic Tablet

- Description:
 - Pressure-, heat-, light-, or light-blockage-sensitive horizontal surfaces that lie on the desktop or keyboard.

- May be operated with fingers, light pen, or objects like a stylus or pencil.
- Pointer imitates movements on tablet.
- Advantages:
 - Direct relationship between touch movements and pointer movements in terms of direction, distance, and speed.
 - More comfortable horizontal operating plane.
 - Does not obscure vision of screen.
- Disadvantages:
 - Movement is indirect, in a plane different from screen.
 - Requires hand to be removed from keyboard.
 - Requires hand to be removed from keyboard keys.
 - Requires different hand movements to use.
 - Requires additional desk space.
- Finger may be too large for accuracy with small objects

Touch Screen

- Description:
 - A special surface on the screen sensitive to finger or stylus touch.
- Advantages:
 - Direct relationship between hand and pointer location in terms of direction, distance, and speed.
 - Movement is direct, in the same plane as screen.
 - Requires no additional desk space.
 - Stands up well in high-use environments.
- Disadvantages:
 - Finger may obscure part of screen.
 - Finger may be too large for accuracy with small objects.
 - Requires moving the hand far from the keyboard to use.
 - Very fatiguing to use for extended period of time.
 - May soil or damage the screen.
- Design Guidelines:
 - Screen objects should be at least $3/4"$ \square \square \square $3/4"$ \square in size.
 - Object separation should be at least $1/8"$.
 - Provide visual feedback in response to activation. Auditory feedback may also be appropriate.
 - When the consequences are destructive, require confirmation after selection to eliminate inadvertent selection.
 - Provide an instructional invitation to begin using.

Light Pen

- Description:
 - A special surface on a screen sensitive to the touch of a special stylus or pen.
- Advantages:
 - Direct relationship between hand and pointer movement in terms of direction,

- distance, and speed.
 - Movement is direct, in the same plane as screen.
 - Requires minimal additional desk space.
 - Stands up well in high-use environments.
 - More accurate than finger touching.
- Disadvantages:
 - Hand may obscure part of screen.
 - Requires picking it up to use.
 - Requires moving the hand far from the keyboard to use.
 - Very fatiguing to use for extended period of time.

Voice

- Description:
 - Automatic speech recognition by the computer.
- Advantages:
 - Simple and direct.
 - Useful for people who cannot use a keyboard.
 - Useful when the user's hands are occupied.
- Disadvantages:
 - High error rates due to difficulties in:
 - Recognizing boundaries between spoken words.
 - Blurred word boundaries due to normal speech patterns.
 - Slower throughput than with typing.
 - Difficult to use in noisy environments.
 - Impractical to use in quiet environments.

Mouse

- Description:
 - A rectangular or dome-shaped, movable, desktop control containing from one to three buttons used to manipulate objects and information on the screen.
 - Movement of screen pointer mimics the mouse movement.
- Advantages:
 - Direct relationship between hand and pointer movement in terms of direction, distance, and speed.
 - Permits a comfortable hand resting position
 - Selection mechanisms are included on mouse.
 - Does not obscure vision of the screen.
- Disadvantages:
 - Movement is indirect, in a plane different from screen.
 - Requires hand to be removed from keyboard.
 - Requires additional desk space.
 - May require long movement distances.
 - Requires a degree of eye-hand coordination.
- ***Mouse Usage Guidelines***
 - Provide a -hot zone|| around small or thin objects that mouse positioning.
 - Never use double-clicks or double-drags as the only means operations.

- Do not use mouse plus keystroke combinations.
- Do not require a person to point at a moving target.

Keyboard

- Description:
 - Standard typewriter keyboard and cursor movement keys.
- Advantages:
 - Familiar.
 - Accurate.
 - Does not take up additional desk space.
 - Very useful for:
 - Entering text and alphanumeric data.
 - Inserting in text and alphanumeric data.
 - Keyed shortcuts—accelerators.
 - Keyboard mnemonics—equivalents.
 - Advantageous for:
 - Performing actions when less than three mouse buttons exist.
 - Use with very large screens.
 - Touch typists.
- Disadvantages:
 - Slow for non-touch-typists.
 - Slower than other devices in pointing.
 - Requires discrete actions to operate.
 - No direct relationship between finger or hand movement on the keys and cursor movement on screen in terms of speed and distance.
- **Keyboard Guidelines**
 - Provide keyboard accelerators.
 - Assign single keys for frequently performed, small-scale tasks.
 - Use standard platform accelerators.
 - Assign Shift-key combinations for actions that extend or are complementary to the actions of the key or key combination used without the Shift-key.
 - Assign Ctrl-key combinations for:
 - Infrequent actions.
 - Tasks that represent larger-scale versions of the task assigned to the unmodified key.
 - Provide keyboard equivalents.
 - Use standard platform equivalents.
 - Use the first letter of the item description.
 - If first letter conflicts exist, use:
 - Another distinctive consonant in the item description.
 - A vowel in the item description.
 - Provide window navigation through use of keyboard keys.

Selecting the Proper Device-Based Controls

- Consider the characteristics of the task.
 - Provide keyboards for tasks involving:

- Heavy text entry and manipulation.
- Movement through structured arrays consisting of a few discrete objects.
- Provide an alternative pointing device for graphical or drawing tasks.
- The following are some suggested best uses:
 - Mouse—pointing, selecting, drawing, and dragging.
 - Joystick—selecting and tracking.
 - Trackball—pointing, selecting and tracking.
 - Touch screen—pointing and selecting.
 - Graphic tablet—pointing, selecting, drawing, and dragging.
- Provide touch screens under the following conditions:
 - The opportunity for training is minimal.
 - Targets are large, discrete, and spread out.
 - Frequency of use is low.
 - Desk space is at a premium.
 - Little or no text input requirement exists.
- Consider user characteristics and preferences.
 - Provide keyboards for touch typists.
- Consider the characteristics of the environment.
- Consider the characteristics of the hardware.
- Consider the characteristics of the device in relation to the application.
- Provide flexibility.
- Minimize eye and hand movements between devices.

Keyboard versus Mouse

Speed is obviously one reason. An experienced typist, through kinesthetic memory, has memorized the location of keyboard keys. The keying process becomes exceptionally fast and well learned. The mouse is slower,

Control Research

- A survey of the research literature comparing and evaluating different devices yields the following summarization concerning tasks involving pointing and dragging:
 - The fastest tools for pointing at stationary targets on screens are the devices that permit direct pointing: the touch screen and light pen. This is most likely due to their high level of eye-hand coordination and because they use an action familiar to people.
 - In terms of positioning speed and accuracy for stationary targets, the indirect pointing devices—the mouse, trackball, and graphic tablet, do not differ greatly from one another. The joystick is the slowest, although it is as accurate as the others. Of most importance in selecting one of these devices will be its fit to the user's task and working environment.
 - A separate confirmation action that must follow pointer positioning increases pointing accuracy but reduces speed. The mouse offers a very effective design configuration for tasks requiring this confirmation.

- For tracking small, slowly moving targets, the mouse, trackball, and graphic tablet are preferred to the touch screen and light pen because the latter may obscure the user's view of the target.
- Another common manipulation task is dragging an object across the screen. Using a mouse, graphic tablet, and trackball for this task, as well as pointing, was studied by MacKenzie, Sellen, and Buxton (1991). They report the following:
 - The graphic tablet yielded best performance during pointing.
 - The mouse yielded best performance during dragging.
 - The trackball was a poor performer for both pointing and dragging, and it had a very high error rate in dragging.

Pointer Guidelines

The pointer:

- Should be visible at all times.
- Should contrast well with its background.
- Should maintain its size across all screen locations and during movement.
- The hotspot should be easy to locate and see.
- Location should not warp (change position).

The user should always position the pointer.

The shape of a pointer:

- Should clearly indicate its purpose and meaning.
- Should be constructed of already defined shapes.
- Should not be used for any other purpose other than its already defined meaning.
- Do not create new shapes for already defined standard functions.

Use only as many shapes as necessary to inform the user about current location and status. Too many shapes can confuse a person.

Be conservative in making changes as the pointer moves across the screen.

- Provide a short -time-out before making noncritical changes on the screen.

Animation should not:

- Distract.
- Restrict one's ability to interact.

Choose the Proper Screen-Based Controls

- Screen-based controls, often simply called *controls* and sometimes called *widgets*, are the elements of a screen that constitute its body.
- By definition, they are graphic objects that represent the properties or operations of other objects. A control may:
 - Permit the entry or selection of a particular value.
 - Permit the changing or editing of a particular value.
 - Display only a particular piece of text, value, or graphic.
 - Cause a command to be performed.
 - Possess a contextual pop-up window.
- Three extremely important principles regarding controls should be noted:
 - A control must:
Look the way it works.

Work the way it looks.

- A control must be used exactly as its design intended.
- A control must be presented in a standard manner.
- The look of a control should make it obvious that it is a control. Its design characteristics should signal –enterability‖ or –clickability.‖ Microsoft Windows, for example, presents the following simple rules:
 - Raised elements can be pressed.
 - Recessed elements cannot be pressed.
 - Elements on a flat white background can be opened, edited, or moved.

Operable Controls

- Operable controls are those that permit the entry, selection, changing, or editing of a particular value, or cause a command to be performed.
- Classes include buttons, text entry/read-only, selection, combination entry/selection, and other specialized controls.

Buttons

- Description:
 - A square or rectangular-shaped control with a label inside that indicates action to be accomplished.
 - The label may consist of text, graphics, or both.
- Purpose:
 - To start actions.
 - To change properties.
 - To display a pop-up menu.
- Advantages:
 - Always visible, reminding one of the choices available.
 - Convenient.
 - Can be logically organized in the work area.
 - Can provide meaningful descriptions of the actions that will be performed.
 - Larger size generally provides faster selection target.
 - Can possess 3-D appearance:
 - Adds an aesthetically pleasing style to the screen.
 - Provides visual feedback through button movement when activated.
 - May permit use of keyboard equivalents and accelerators.
 - Faster than using a two-step menu bar/pull-down sequence.
- Disadvantages:
 - Consumes screen space.
 - Size limits the number that may be displayed.
 - Requires looking away from main working area to activate.
 - Requires moving the pointer to select.
- Proper usage:
 - Use for frequently used actions that are specific to a window.
 - To cause something to happen immediately.
 - To display another window.

- To display a menu of options.
- To set a mode or property value.
- A button comes in three styles.



Command buttons.



Toolbar buttons without labels.



Symbol button

Command Buttons

Command button guidelines include the following.

Usage

- For windows with a menu bar:
 - Use to provide fast access to frequently used or critical commands.
- For windows without a menu bar:
 - Use to provide access to all necessary commands.

Structure

- Provide a rectangular shape with the label inscribed within it.
- Give the button a raised appearance.
- Maintain consistency in style throughout an application.

Labels

- Use standard button labels when available.
- Provide meaningful descriptions of the actions that will be performed.
- Use single-word labels whenever possible.
 - Use two-three words for clarity, if necessary.
- Use mixed-case letters with the first letter of each significant label word capitalized.
- Display labels:
 - In the regular system font.
 - In the same size font.

- Do not number labels.
 - Center the label within the button borders, leaving at least two pixels between the text and the button border.
 - Provide consistency in button labeling across all screens.

Size

- Provide as large a button as feasible.
- Maintain consistent button heights and widths.
- Exception: Buttons containing excessively long labels may be wider.

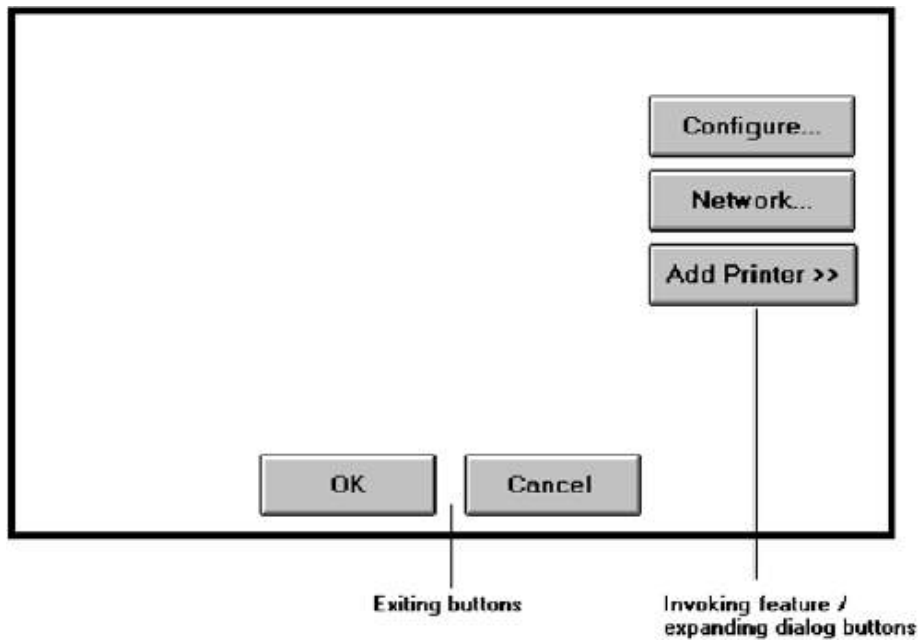


Number

- Restrict the number of buttons on a window to six or fewer.

Location and Layout

- Maintain consistency in button location between windows.
- Never simply "fill" buttons in available space.
- If buttons are for exiting the dialog:
 - Position them centered and aligned horizontally at the bottom.
- If buttons are used for invoking a dialog feature or expanding the dialog:
 - Position them centered and aligned vertically on the right side.
- If a button has a contingent relationship to another control:
 - Position it adjacent to the related control.
- If a button has a contingent relationship to a group of controls:
 - Position it at the bottom or to right of related controls.
- If, due to space constraints, exiting and expanding/invoking feature buttons must be placed together:
 - If at the bottom, place exiting buttons to the right, separating the groupings by one button's width.
 - If along the right side, place exiting buttons at the bottom, separating the groupings by one button's height.
- For exiting and expanding/invoking feature buttons, do not:
 - Align with the other screen controls.
 - Present displayed within a line border.
- Provide equal and adequate spacing between adjacent buttons.
- Provide adequate spacing between buttons and the screen body controls.

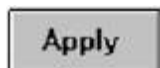


Organization

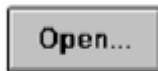
- Organize standard buttons in the manner recommended by the platform being used.
- For other buttons, organize them in common and customary grouping schemes.
 - For buttons ordered left to right, place those for most frequent actions to the left.
 - For buttons ordered top to bottom, place those for most frequent actions at the top.
- Keep related buttons grouped together.
- Separate potentially destructive buttons from frequently chosen selections.
- Buttons found on more than one window should be consistently positioned.
- The order should never change.
- For mutually exclusive actions, use two buttons; do not dynamically change the text.
- Windows recommends the following:
 - An affirmative action to the left (or above).
 - The default first.
 - OK and Cancel next to each other.
 - Help last, if supported.

Intent Indicators

- When a button causes an action to be immediately performed, no intent indicator is necessary.



- When a button leads to a cascading dialog, include an ellipsis (...) after the label.



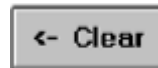
- When a button leads to a menu, include a triangle pointing in the direction the menu will appear after the label.



- When a button leads to an expanding dialog, include a double arrow (>>) with the label.



- When a button has a contingent relationship to another control that must be indicated, include a single arrow (->) pointing at the control.



Expansion Buttons

- Gray them out after expansion.
- Provide a contraction button, if necessary.
 - Locate it beneath, or to right of, the expansion button.
 - Gray it out when not applicable.

Defaults

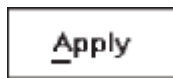
- Intent:
 - When a window is first displayed, provide a default action, if practical.
- Selection:
 - A default should be the most likely action:
 - A confirmation.
 - An application of the activity being performed.
 - A positive action such as OK, unless the result is catastrophic.
 - If a destructive action is performed (such as a deletion), the default should be Cancel.
- Presentation:
 - Indicate the default action by displaying the button with a bold or double border.
- Procedures:
 - The default can be changed as the user interacts with the window.
 - When the user navigates to a button, it can temporarily become the default.
 - Use the Enter key to activate a default button.
 - If another control requires use of the Enter key, temporarily disable the default while the focus is on the other control.
 - Permit double-clicking on a single selection control in a window to also carry out the default command.

Unavailable Choices

- Temporarily unavailable choices should be dimmed or grayed out.

Keyboard Equivalents and Accelerators

- Equivalents:
 - Assign a keyboard equivalent mnemonic to each button to facilitate keyboard selection.
 - The mnemonic should be the first character of the button's label.
 - If duplication exists in first characters, for duplicate items, use another character in the label.
 - Preferably, choose the first succeeding consonant.
 - Designate the mnemonic character by underlining it.
 - Maintain the same mnemonic on all identical buttons on other screens.



- Accelerators:
 - Assign a keyboard accelerator to each button to facilitate keyboard selection.

Scrolling

- If a window can be scrolled, do not scroll the command buttons.
 - Exception: if the screen cannot scroll independently of the buttons.
- Use buttons to move between multipage forms, not scroll bars.
 - Label buttons Next and Previous.

Button Activation

Pointing:

- Highlight the button in some visually distinctive manner when the pointer is resting on it and the button is available for selection.

Activation:

- Call attention to the button in another visually distinctive manner when it has been activated or pressed.
- If a button can be pressed continuously, permit the user to hold the mouse button down and repeat the action.

Toolbars

- *Toolbars* are compilations of commands, actions, or functions, usually graphical in structure but sometimes textual, grouped together for speedy access.
- Toolbars may also be called *button bars*, *control bars*, or *access bars*. Specialized toolbars may also be referred to as *ribbons*, *toolboxes*, or *palettes*. Toolbars may also appear in palette windows.

Usage

- To provide easy and fast access to most frequently used commands or options across multiple screens.
- To invoke a sub application within an application.
- To use in place of certain menu items.

Structure

- ☐ Images:
 - Provide buttons of equal size.
 - Create a meaningful and unique icon.
 - Design them using icon design guidelines.
 - Center the image within the button.
 - Give the button a raised appearance.
 - Ensure that toolbar images are discernible from Web page graphical images.
- ☐ Text:
 - Create a meaningful label, adhering to label guidelines for command buttons.
 - Create toolbar buttons of equal size, following the size guidelines recently described.
- ☐ Consistency:
 - Use the same icon throughout an application and between applications.

Size

- ☐ Button:
 - 24 (w) by 22 (h) pixels, including border.
 - 32 (w) by 30 (h) pixels, including border.
 - Larger buttons can be used on high-resolution displays.
- ☐ Label:
 - 16 (w) by 16 (h) pixels.
 - 14 (w) by 24 (h) pixels.
- ☐ Default:
 - Provide the smaller size as the default size with a user option to change it.
- ☐ Image:
 - Center the image in the button.

Organization

- ☐ Order the buttons based on common and customary grouping schemes.
 - For buttons ordered left to right, place those for the most frequently used actions to the left.
 - For buttons ordered top to bottom, place those for the most frequently used actions at the top.
- ☐ Keep related buttons grouped together.
- ☐ Separate potentially destructive buttons from frequently chosen selections.
- ☐ Permit user reconfiguration of button organization.

Location

- ☐ Position main features and functions bar horizontally across top of window just below menu bar.
- ☐ Position subtask and sub features bars along sides of window.
- ☐ Permit the location of the bar to be changed by the user.
- ☐ Permit display of the bar to be turned on or off by the user.
 - Also provide access through standard menus.

Active Items

- ☐ Make only currently available toolbar items available.
- ☐ Temporarily not available items may be displayed grayed out.

Customization

- ☐ Permit toolbars to be turned off by the user.
- ☐ Allow the customizing of toolbars.
 - Provide a default, however.

Keyboard Equivalents and Accelerators

- ☐ Equivalents:
 - Assign keyboard equivalents to facilitate keyboard selection.
 - Maintain the same mnemonic on all identical buttons on all screens.
- ☐ Accelerators:
 - Assign a keyboard accelerator to facilitate keyboard selection.

Button Activation

- ☐ Pointing:
 - Highlight the button in some visually distinctive manner when the pointer is resting on it and the button is available for selection.
- ☐ Activation:
 - Call attention to the button in another visually distinctive manner when it has been activated or pressed.

Text Entry/Read-Only Controls

- ☐ A Text Entry/Read-Only control contains text that is exclusively entered or modified through the keyboard.
- ☐ It may also contain entered text being presented for reading or display purposes only.

Text Boxes

- ☐ Description:
 - A control, usually rectangular in shape, in which:

- Text may be entered or edited.
 - Text may be displayed for read-only purposes.
- Usually possesses a caption describing the kind of information contained within it.
- An outline field border:
 - Is included for enterable/editable text boxes.
 - Is not included for read-only text boxes.
- Two types exist:
 - Single line.
 - Multiple line.
- When first displayed, the box may be blank or contain an initial value.
- ☐ Purpose:
 - To permit the display, entering, or editing of textual information.
 - To display read-only information.
- ☐ Advantages:
 - Very flexible.
 - Familiar.
 - Consumes little screen space.
- ☐ Disadvantages:
 - Requires use of typewriter keyboard.
 - Requires user to remember what must be keyed.
- ☐ Proper usage:
 - Most useful for data that is:
 - Unlimited in scope.
 - Difficult to categorize.
 - Of a variety of different lengths.
 - When using a selection list is not possible.

Types of text box

- ☐ Two types of *text boxes* exist. One consists of a rectangular box into which information is typed. It may also be referred to as an *edit* control.
- ☐ The second is also rectangular in shape but contains text displayed purely for read-only purposes. The former type has historically been referred to as an *entry field*, the latter as an *inquiry* or *display field*.

Entry/Modification:

Display/Read Only: Information

Two forms of Text Box

Single-Line and Multiple-Line Text Boxes

- ☐ Single line:
 - Description:
 - A control consisting of no more than one line of text.
 - Purpose:

- To make textual entries when the information can be contained within one line of the screen.
- Typical uses:
 - Typing the name of a file to save.
 - Typing the path of a file to copy.
 - Typing variable data on a form.
 - Typing a command.
- Multiple line:
 - Description:
 - A control consisting of a multiline rectangular box for multiple lines of text.
 - Purpose:
 - To type, edit, and read passages of text.
 - Typical uses:
 - Creating or reading an electronic mail message.
 - Displaying and editing text files.

Captions

- Structure and size:
 - Provide a descriptive caption to identify the kind of information to be typed, or contained within, the text box.
 - Use a mixed-case font.
 - Display the caption in normal intensity or in a color of moderate brightness.
- Formatting:
 - Single fields:
 - Position the field caption to the left of the text box.
 - Place a colon (:) immediately following the caption.
 - Separate the colon from the text box by one space.

Composition:

- Alternately, the caption may be placed above the text box.
 - Place a colon (:) immediately following the caption.
 - Position above the upper-left corner of the box, flush with the left edge.
 - Multiple occurrence fields:

Composition:

- For entry/modification text boxes:
 - Position the caption left-justified one line above the column of entry fields.

Offices:

- For display/read-only boxes:

— If the data field is long and fixed-length, or the displayed data is about the same length, center the caption above the displayed text box data.

Date:

07/17/94
07/21/94
01/26/95
08/21/95
11/18/96

— If the data displayed is alphanumeric, short, or quite variable in length, left-justify the caption above the displayed text box data.

Location:

Alice Springs
Kakadu National Park
Traralgon
Wagga Wagga
Whyalla

— If the data field is numeric and variable in length, right-justify the caption above the displayed text box data.

Balances:

12,642,123.05
53.98
355,125.44
199.13
612.01

Fields

☐ Structure:

— Identify entry/modification text boxes with a line border or reverse polarity rectangular box.

- To visually indicate that it is an enterable field, present the box in a recessed manner.
- Present display/read-only text boxes on the window background.

— Break up long text boxes through incorporation of slashes (/), dashes (-), spaces, or other common delimiters.

Date:

Telephone:

Date: / /

Telephone: () -

- Size:
 - Size to indicate the approximate length of the field.
 - Text boxes for fixed-length data must be large enough to contain the entire entry.
 - Text boxes for variable-length data must be large enough to contain the majority of the entries.
 - Where entries may be larger than the entry field, scrolling must be provided to permit keying into, or viewing, the entire field.
 - Employ word wrapping for continuous text in multiple-line text boxes.
- Highlighting:
 - Call attention to text box data through a highlighting technique.
 - Higher intensity.
 - If color is used, choose one that both complements the screen background and contrasts well with it.
- Unavailable fields:
 - Gray-out temporarily unavailable text boxes.
- Fonts:
 - To support multiple fonts, use a *Rich-Text Box*.

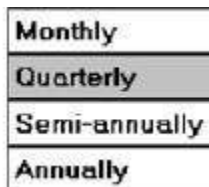
Selection Controls

- A selection control presents on the screen all the possible alternatives, conditions, or choices that may exist for an entity, property, or value.
- The relevant item or items are selected from those displayed.
- Selection controls include radio buttons, check boxes, list boxes, drop-down/pop-up list boxes, and palettes.

Radio Buttons

- Description:
 - A two-part control consisting of the following:
 - Small circles, diamonds, or rectangles.
 - Choice descriptions.
 - When a choice is selected:
 - The option is highlighted.
 - Any existing choice is automatically unhighlighted and deselected.
- Purpose:
 - To set one item from a small set of mutually exclusive options (2 to 8).
- Advantages:

- Easy-to-access choices.
- Easy-to-compare choices.
- Preferred by users.
- ☐ Disadvantages:
 - Consume screen space.
 - Limited number of choices.
- ☐ Proper usage:
 - For setting attributes, properties, or values.
 - For mutually exclusive choices (that is, only one can be selected).
 - Where adequate screen space is available.
 - Most useful for data and choices that are:
 - Discrete.
 - Small and fixed in number.
 - Not easily remembered.
 - In need of a textual description to meaningfully describe the alternatives.
 - Most easily understood when the alternatives can be seen together and compared to one another.
 - Never changed in content.
 - Do not use:
 - For commands.
 - Singly to indicate the presence or absence of a state.



Choice Descriptions

- ☐ Provide meaningful, fully spelled-out choice descriptions clearly describing the values or effects set by the radio buttons.
- ☐ Display in a single line of text.
- ☐ Display using mixed-case letters, using the sentence style.
- ☐ Position descriptions to the right of the button. Separate them by at least one space from the button.
- ☐ When a choice is conditionally unavailable for selection, display the choice description grayed out or dimmed.
- ☐ Include a none choice if it adds clarity.

Size

- ☐ Show a minimum of two choices, a maximum of eight.

Defaults

- ☐ When the control possesses a state or affect that has been predetermined to have a higher probability of selection than the others, designate it as the default and display its button filled in.
- ☐ When the control includes choices whose states cannot be predetermined, display all the buttons without setting a dot, or in the *indeterminate* state.
- ☐ When a multiple selection includes choices whose states vary, display the buttons in another unique manner, or in the *mixed value* state.

Structure

- ☐ A columnar orientation is the preferred manner of presentation.
- ☐ Left-align the buttons and choice descriptions.
- ☐ If vertical space on the screen is limited, orient the buttons horizontally.
- ☐ Provide adequate separation between choices so that the buttons are associated with the proper description.
 - A distance equal to three spaces is usually sufficient.
- ☐ Enclose the buttons in a border to visually strengthen the relationship they possess.

☐ Red
☐ Yellow
☐ Green
☐ Blue

☐ Green ☐ Blue ☐ Yellow ☐ Red

Plan Choice:
☐ Limited
☐ Basic
☐ Superior
☐ Premium

Plan Choice:
☐ Limited
☐ Basic
☐ Superior
☐ Premium

Plan Choice:
☐ Limited
☐ Basic
☐ Superior
☐ Premium

Still Better

Plan Choice:
☐ Limited
☐ Basic
☐ Superior
☐ Premium

Plan Choice:
☐ Limited
☐ Basic
☐ Superior
☐ Premium

Best

Organization

- ☐ Arrange selections in expected order or follow other patterns such as frequency of occurrence, sequence of use, or importance.
 - For selections arrayed top to bottom, begin ordering at the top.
 - For selections arrayed left to right, begin ordering at the left.
- ☐ If, under certain conditions, a choice is not available, display it subdued or less brightly than the available choices.

Related Control

- ☐ Position any control related to a radio button immediately to the right of the choice description.
- ☐ If the radio button choice description also acts as the label for the control that follows it, end the label with an arrow (>).

☒ Responsible Person >

☐ No Responsible Party

Captions

- ☐ Structure:
 - Provide a caption for each radio button control.

- Exception: In screens containing only one radio button control, the screen title may serve as the caption.

□ Display:

- Fully spelled out.
- In mixed-case letters, capitalizing the first letter of all significant words.

□ Columnar orientation:

- With a control border, position the caption:
 - Upper-left-justified within the border.

Color

☐ Red

☐ Yellow

☒ Green

☐ Blue

- Alternately, the caption may be located to the left of the topmost choice description.

- Without an enclosing control border, position the caption:

- Left-justified above the choice descriptions, separated by one space line.

Color:

☒ Red

☐ Yellow

☐ Green

☐ Blue

- Alternately, the caption may be located to the left of the topmost choice description.

Color: ☐ Red

☐ Yellow

☒ Green

☐ Blue

□ Horizontal orientation:

- Position the caption to the left of the choice descriptions.

Color: ☐ Green ☐ Blue ☐ Yellow ☐ Red

- Alternately, with an enclosing control border, left-justified within the border.

Color

☐ Green ☐ Blue ☐ Yellow ☒ Red

- Be consistent in caption style and orientation within a screen.

Keyboard Equivalents

- Assign a keyboard mnemonic to each choice description.



- ☐ Designate the mnemonic by underlining the applicable letter in the choice description.

Selection Method and Indication

- ☐ Pointing:
 - The selection target area should be as large as possible.
 - Include the button and the choice description text.
 - Highlight the selection choice in some visually distinctive way when the cursor's resting on it and the choice is available for selection.
 - This cursor should be as long as the longest choice description plus one space at each end. Do not place the cursor over the small button.



- ☐ Activation:
 - When a choice is selected, distinguish it visually from the unselected choices.
 - A radio button should be filled in with a solid dark dot or made to look depressed or higher through use of a shadow.
 - When a choice is selected, any other selected choice must be deselected.
- ☐ Defaults:
 - If a radio button control is displayed that contains a choice previously selected or a default choice, display the selected choice as set in the control

Check Boxes

- ☐ Description:
 - A two-part control consisting of a square box and choice description.
 - Each option acts as a switch and can be either -on|| or -off.||
 - When an option is selected (on), a mark such as an -X|| or -check|| appears within the square box, or the box is highlighted in some other manner.
 - Otherwise the square box is unselected or empty (off).
 - Each box can be:
 - Switched on or off independently.
 - Used alone or grouped in sets.
- ☐ Purpose:
 - To set one or more options as either on or off.
- ☐ Advantages
 - Easy-to-access choices.
 - Easy-to-compare choices.
 - Preferred by users.
- ☐ Disadvantages:

- Consume screen space.
- Limited number of choices.
- Single check boxes difficult to align with other screen controls.
- ☐ Proper usage:
 - For setting attributes, properties, or values.
 - For nonexclusive choices (that is, more than one can be selected).
 - Where adequate screen space is available.
 - Most useful for data and choices that are:
 - Discrete.
 - Small and fixed in number.
 - Not easily remembered.
 - In need of a textual description to describe meaningfully.
 - Most easily understood when the alternatives can be seen together and compared to one another.
 - Never changed in content.
 - Can be used to affect other controls.
 - Use only when both states of a choice are clearly opposite and unambiguous.



Choice Descriptions

- ☐ Provide meaningful, fully spelled-out choice descriptions clearly describing the values or effects set by the check boxes.
- ☐ Display them in a single line of text.
- ☐ Display them using mixed-case letters in sentence style.
- ☐ Position descriptions to the right of the check box. Separate by at least one space from the box.
- ☐ When a choice is unavailable for selection under a certain condition, display the choice description visually dimmed.

Size

- ☐ Show a minimum of one choice, a maximum of eight.

Defaults

- ☐ When the control possesses a state or affect that has been preset, designate it as the default and display its check box marked.
- ☐ When a multiple selection includes choices whose states vary, display the buttons in another unique manner, or the *mixed value* state.

Structure

- ☐ Provide groupings of related check boxes.
- ☐ A columnar orientation is the preferred manner of presentation for multiple related check boxes.
- ☐ Left-align the check boxes and choice descriptions.
- ☐ If vertical space on the screen is limited, orient the boxes horizontally.
- ☐ Provide adequate separation between boxes so that the buttons are associated with the proper description.
 - A distance equal to three spaces is usually sufficient.
- ☐ Enclose the boxes in a border to visually strengthen the relationship they possess.

Organization

- ☐ Arrange selections in logical order or follow other patterns such as frequency of occurrence, sequence of use, or importance.
 - For selections arrayed top to bottom, begin ordering at the top.
 - For selections arrayed left to right, begin ordering at the left.
- ☐ If, under certain conditions, a choice is not available, display it subdued or less brightly than the available choices.

Related Control

- ☐ Position any control related to a check box immediately to the right of the choice description.
 - If a the check box choice description also acts as the label for the control that follows it , end the label with an arrow (>).

Captions and Keyboard Equivalents

Same as Radio Button

Selection Method and Indication

- ☐ Pointing:
 - The selection target area should be as large as possible.
 - Include the check box and the choice description text.
 - Highlight the selection choice in some visually distinctive way when the cursor's resting on it and the choice is available for selection.
 - This cursor should be as long as the longest choice description plus one space at each end. Do not place the cursor over the check box.

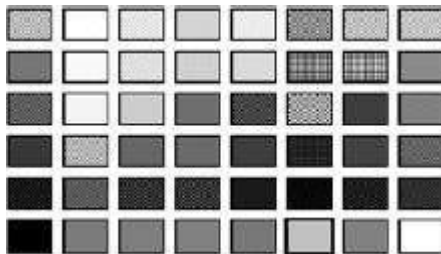
- Activation:
 - When a choice is selected, distinguish it visually from the non-selected choices.
 - A check box should be filled in or made to look depressed or higher through use of a shadow.
- Defaults:
 - If a check box is displayed that contains a choice previously selected or default choice, display the selected choice as set in the control.
- Select/deselect all:
 - Do not use *Select All* and *Deselect All* check boxes.
- Mixed-value state:
 - When a check box represents a value, and a multiple selection encompasses multiple value occurrences set in both the on and off state, display the check box in a *mixed value* state.



- Fill the check box with another easily differentiable symbol or pattern.
- Toggle the check box as follows:
 - Selection 1: Set the associated value for all elements. Fill the check box with an -X or -check.
 - Selection 2: Unset the value for all associated elements. Blank-out the check box.
 - Selection 3: Return all elements to their original state. Fill the check box with the mixed value symbol or pattern.

Palettes

- Description:
 - A control consisting of a series of graphical alternatives. The choices themselves are descriptive, being composed of colors, patterns, or images.
 - In addition to being a standard screen control, a palette may also be presented on a pull-down or pop-up menu or a toolbar.



- Purpose:
 - To set one of a series of mutually exclusive options presented graphically or pictorially.
- Advantages:
 - Pictures aid comprehension.

- 0Easy-to-compare choices.
- Usually consume less screen space than textual equivalents.
- Disadvantages:
 - A limited number of choices can be displayed.
 - Difficult to organize for scanning efficiency.
 - Requires skill and time to design meaningful and attractive graphical representations.
- Proper usage:
 - For setting attributes, properties, or values.
 - For mutually exclusive choices (that is, only one can be selected).
 - Where adequate screen space is available.
 - Most useful for data and choices that are:
 - Discrete.
 - Frequently selected.
 - Limited in number.
 - Variable in number.
 - Not easily remembered.
 - Most easily understood when the alternatives may be seen together and compared to one another.
 - Most meaningfully represented pictorially or by example.
 - Can be clearly represented pictorially.
 - Rarely changed in content.
 - Do not use:
 - Where the alternatives cannot be meaningfully and clearly represented pictorially.
 - Where words are clearer than images.
 - Where the choices are going to change.

Graphical Representations

- Provide meaningful, accurate, and clear illustrations or representations of choices.
- Create images large enough to:
 - Clearly illustrate the available alternatives.
 - Permit ease in pointing and selecting.
- Create images of equal size.
- Always test illustrations before implementing them.

Size

- Present all available alternatives within the limits imposed by:
 - The size of the graphical representations.
 - The screen display's capabilities.

Layout

- Create boxes large enough to:
 - Effectively illustrate the available alternatives.
 - Permit ease in pointing and selecting.

- ☐ Create boxes of equal size.
- ☐ Position the boxes adjacent to, or butted up against, one another.
- ☐ A columnar orientation is the preferred manner.
- ☐ If vertical space on the screen is limited, orient the choices horizontally.

Organization

- ☐ Arrange palettes in expected or normal order.
 - For palettes arrayed top to bottom, begin ordering at the top.
 - For palettes arrayed left to right, begin ordering at the left.
- ☐ If an expected or normal order does not exist, arrange choices by frequency of occurrence, sequence of use, importance, or alphabetically (if textual).
- ☐ If, under certain conditions, a choice is not available, display it subdued or less brightly than the other choices.

Captions

- ☐ Provide a caption for each palette.
 - On screens containing only one palette, the screen title may serve as the caption.
- ☐ Display the caption fully spelled out using mixed-case letters.
- ☐ Columnar orientation:
 - The field caption may be positioned left-aligned above the palette.

Shade:



— Alternately, the caption may be positioned to the left of the topmost alternative.

Shade:



- ☐ Horizontal orientation:
 - The field caption may be positioned above the palette.

Shade:



— Alternately, the caption may be positioned to the left of the alternatives.

Shade:



Selection Method and Indication

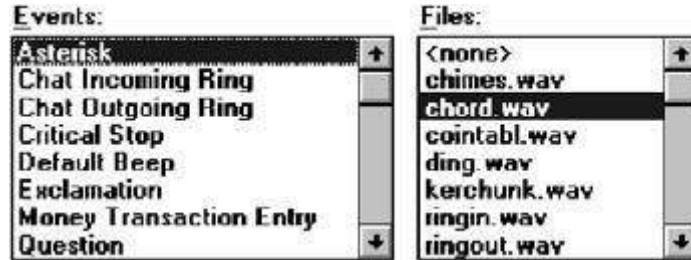
- ☐ Pointing:
 - Highlight the choice in some visually distinctive way when the pointer or cursor is resting on it and the choice is available for selection.
- ☐ Activation:

- When a choice is selected, distinguish it visually from the unselected choices by highlighting it in a manner different from when it is pointed at, or by placing a bold border around it.
- Defaults:
 - If a palette is displayed with a choice previously selected or a default choice, display the currently active choice in the manner used when it was selected.

List Boxes

- Description:
 - A permanently displayed box-shaped control containing a list of attributes or objects from which:
 - A single selection is made (mutually exclusive), or
 - Multiple selections are made (non-mutually-exclusive).
 - The choice may be text, pictorial representations, or graphics.
 - Selections are made by using a mouse to point and click.
 - Capable of being scrolled to view large lists of choices.
 - No text entry field exists in which to type text.
 - A list box may be associated with a *summary list box* control, which allows the selected choice to be displayed or an item added to the list.
- Purpose:
 - To display a collection of items containing:
 - Mutually exclusive options.
 - Non-mutually-exclusive options.
- Advantages:
 - Unlimited number of choices.
 - Reminds users of available options.
 - Box always visible.
- Disadvantages:
 - Consumes screen space.
 - Often requires an action (scrolling) to see all list choices.
 - The list content may change, making it hard to find items.
 - The list may be ordered in an unpredictable way, making it hard to find items.
- Proper usage:
 - For selecting values or setting attributes.
 - For choices that are:
 - Mutually exclusive (only one can be selected).
 - Non-mutually-exclusive (one or more may be selected).
 - Where screen space is available.
 - For data and choices that are:
 - Best represented textually.
 - Not frequently selected.
 - Not well known, easily learned, or remembered.
 - Ordered in an unpredictable fashion.
 - Frequently changed.
 - Large in number.
 - Fixed or variable in list length.

— hen screen space or layout considerations make radio buttons or check boxes impractical.



List Box General Guidelines

Selection Descriptions

- ☐ Clearly and meaningfully describe the choices available. Spell them out as fully as possible.
 - Graphical representations must clearly represent the options.
- ☐ Present in mixed case, using the sentence style structure.
- ☐ Left-align into columns.

List Size

- ☐ Not actual limit in size.
- ☐ Present all available alternatives.
- ☐ Require no more than 40 page-downs to search a list.
 - If more are required, provide a method for using search criteria or scoping the options.

Box Size

- ☐ Must be long enough to display 6 to 8 choices without requiring scrolling.
 - Exceptions:
 - If screen space constraints exist, the box may be reduced in size to display at least three items.
 - If it is the major control within a window, the box may be larger.
 - If more items are available than are visible in the box, provide vertical scrolling to display all items.
- ☐ Must be wide enough to display the longest possible choice.



- When box cannot be made wide enough to display the longest entry:
 - Make it wide enough to permit entries to be distinguishable, or,
 - Break the long entries with an ellipsis (...) in the middle, or,
 - Provide horizontal scrolling.

Organization

- ☐ Order in a logical and meaningful way to permit easy browsing.
 - Consider using separate controls to enable the user to change the sort order or filter items displayed in the list.
- ☐ If a particular choice is not available in the current context, omit it from the list.
 - Exception: If it is important that the existence and unavailability of a particular list item be communicated, display the choice dimmed or grayed out instead of deleting it.

Layout and Separation

- ☐ Enclose the choices in a box with a solid border.
 - The border should be the same color as the choice descriptions.
- ☐ Leave one blank character position between the choice descriptions and the left border.
- ☐ Leave one blank character position between the longest choice description in the list and the right border, if possible.

Captions

- ☐ Use mixed-case letters.
- ☐ The preferred position of the control caption is above the upper-left corner of the list box.



- ☐ Alternately, the caption may be located to the left of the topmost choice description.



- ☐ Be consistent in caption style and orientation within a screen, and related screens.

Disabling

- ☐ When a list box is disabled, display its caption and show its entries as grayed out or dimmed.

Selection Method and Indication

- ☐ Pointing:
 - Highlight the selection choice in some visually distinctive way when the pointer or cursor is resting on it and the choice is available for selection.
- ☐ Selection:
 - Use a reverse video or reverse color bar to surround the choice description when it is selected.
 - The cursor should be as wide as the box itself.

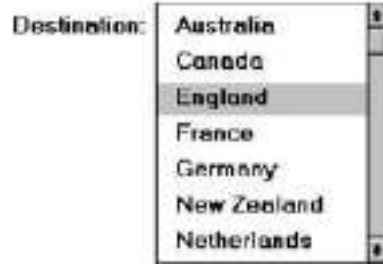


- Mark the selected choice in a distinguishing way.
- ☐ Activation:
 - Require the pressing of a command button when an item, or items, is selected.

Single-Selection List Boxes

- ☐ Purpose:
 - To permit selection of only one item from a large listing.
- ☐ Design guidelines:
 - Related text box
 - If presented with an associated text box control:
 - Position the list box below and as close as possible to the text box.
 - The list box caption should be worded similarly to the text box caption.

Destination:



— If the related text box and the list box are very close in proximity, the caption may be omitted from the list box.



— Use the same background color for the text box as is used in the list box.

☐ Defaults:

- When the list box is first displayed:

- Present the currently active choice highlighted or marked with a circle or diamond to the left of the entry.

- If a choice has not been previously selected, provide a default choice and display it in the same manner that is used in selecting it.

- If the list represents mixed values for a multiple selection, do not highlight an entry.

☐ Other:

- Follow other relevant list box guidelines.

Extended and Multiple-Selection List Boxes

☐ Purpose:

- To permit selection of more than one item in a long listing.

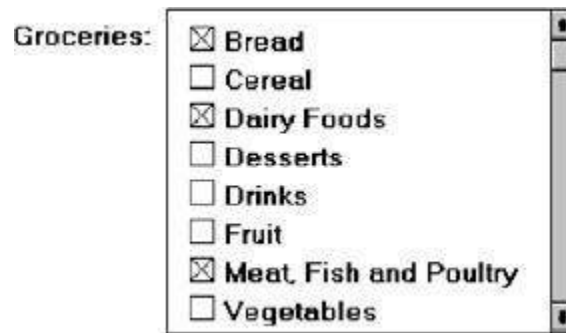
- Extended list box: Optimized for individual item or range selection.

- Multiple-selection list box: Optimized for independent item selection.

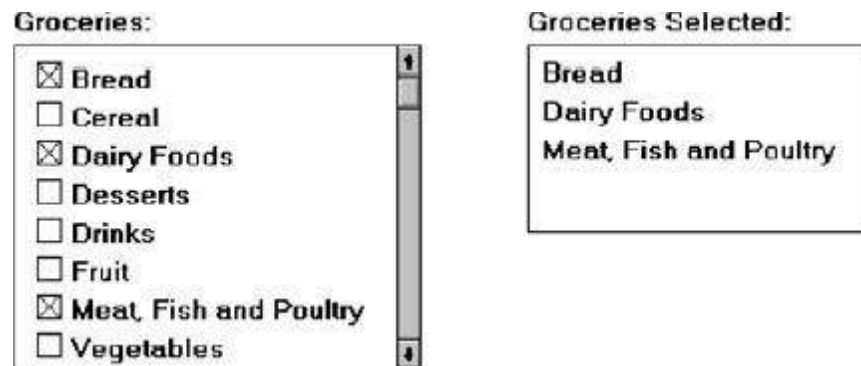
☐ Design guidelines:

- Selection indication:

- Mark the selected choice with an X or check mark to the left of the entry.



- Consider providing a *summary list box*.
- Position it to the right of the list box.
- Use the same colors for the summary list box as are used in the list box.



- Provide command buttons to *Add* (one item) or *Add All* (items) to the summary list box, and *Remove* (one item) or *Remove All* (items) from the summary list box.
- Consider providing a display-only text control indicating how many choices have been selected.
- Position it justified upper-right above the list box.



- Select all and Deselect All buttons
- Provide command buttons to accomplish fast *Select All* and *Deselect All* actions, when these actions must be frequently or quickly performed.
- Defaults:
 - When the list box is first displayed:
 - Display the currently active choices highlighted.
 - Mark with an X or check mark to the left of the entry.

- If the list represents mixed values for a multiple selection, do not highlight an entry.
- Other:
 - Follow other relevant list box guidelines.

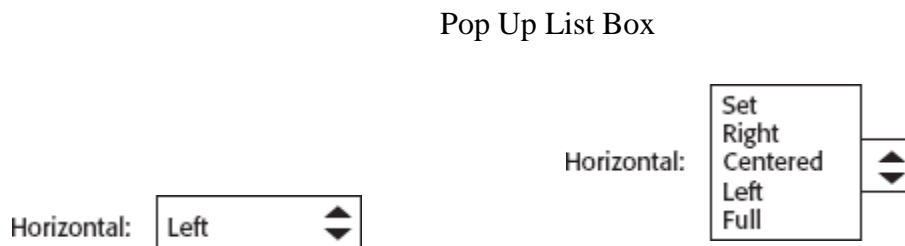
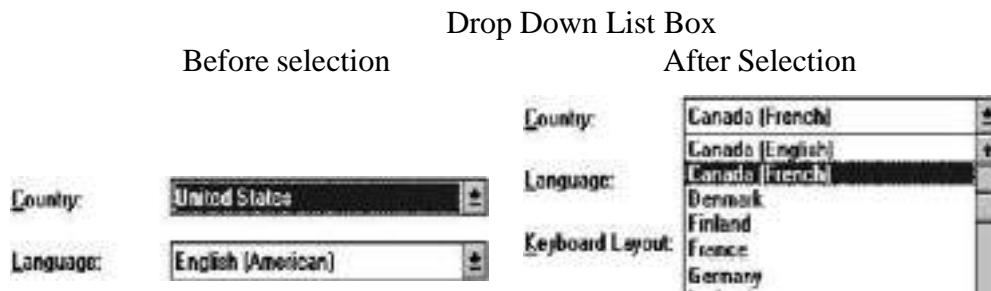
List View Controls

- Description:
 - A special extended-selection list box that displays a collection of items, consisting of an icon and a label.
 - The contents can be displayed in four different views:
 - Large Icon: Items appear as a full-sized icon with a label below.
 - Small Icon: Items appear as a small icon with label to the right.
 - List: Items appear as a small icon with label to the right.
 - Arrayed in a columnar, sorted layout.
 - Report: Items appear as a line in a multicolumn format.
 - Leftmost column includes icon and its label.
 - Subsequent columns include application-specific information.
- Purpose and usage:
 - Where the representation of objects as icons is appropriate.
 - To represent items with multiple columns of information.

Drop-down/Pop-up List Boxes

- Description
 - A single rectangular control that shows one item with a small button to the right side.
 - The button provides a visual cue that an associated selection box is available but hidden.
 - When the button is selected, a larger associated box appears, containing a list of choices from which one may be selected.
 - Selections are made by using the mouse to point and click.
 - Text may not be typed into the control.
- Purpose:
 - To select one item from a large list of mutually exclusive options when screen space is limited.
- Advantages:
 - Unlimited number of choices.
 - Reminds users of available options.
 - Conserves screen space.
- Disadvantages:
 - Requires an extra action to display the list of choices.
 - When displayed, all choices may not always be visible, requiring scrolling.
 - The list may be ordered in an unpredictable way, making it hard to find items.
- Proper usage:
 - For selecting values or setting attributes.
 - For choices that are mutually exclusive (only one can be selected).
 - Where screen space is limited.

- For data and choices that are:
 - Best represented textually.
 - Infrequently selected.
 - Not well known, easily learned, or remembered.
 - Ordered in a unpredictable fashion.
 - Large in number.
 - Variable or fixed in list length.
- Use drop-down/pop-up lists when:
 - Screen space or layout considerations make radio buttons or single-selection list boxes impractical.
 - The first, or displayed, item will be selected most of the time.
- Do not use a drop-down list if it important that all options be seen together.



Prompt Button

- ☐ Provide a visual cue that a box is hidden by including a downward pointing arrow, or other meaningful image, to the right side of the selection field.
 - Position the button directly against, or within, the selection field.



Selection Descriptions

- ☐ Clearly and meaningfully describe the choices available. Spell them out as fully as possible.
 - Graphical representations must clearly represent the options.
 - Left-align them in columns.
 - Display the descriptions using mixed-case letters.

List Size

- ☐ Not limited in size.
- ☐ Present all available alternatives.

Box Size

- ☐ Long enough to display 6 to 8 choices without scrolling.
 - If more than eight choices are available, provide vertical scrolling to display all items.
- ☐ Wide enough to display the longest possible choice.
- ☐ When a box cannot be made wide enough to display the longest entry:
 - Make it wide enough to permit entries to be distinguishable, or,
 - Break long entries with ellipses (...) in the middle, or,
 - Provide horizontal scrolling.

Organization

- ☐ Order in a logical and meaningful way to permit easy browsing.
- ☐ If a particular choice is not available in the current context, omit it from the list.
 - Exception: If it is important that the existence and unavailability of a particular list item be communicated, display the choice dimmed or grayed out instead of deleting it.

Layout and Separation

- ☐ Enclose the choices in a box composed of a solid line border.
 - The border should be the same color as the choice descriptions.
 - Leave one blank character position between the choices and the left border.
 - Leave one blank character position between the longest choice description in the list and the right border, if possible.

Captions

- ☐ Display using mixed-case letters.
- ☐ Position the caption to the left of the box.
 - Alternately, it may be positioned left-justified above the box.

Defaults

- ☐ When the drop-down/pop-up listing is first presented, display the currently set value.
- ☐ If a choice has not been previously selected, provide a default choice.

Disabling

- ☐ When a drop-down/pop-up list box is disabled, display its caption and entries as disabled or dimmed.

Selection Method and Indication

- **Pointing:**
 - Highlight the selection choice in some visually distinctive way when the pointer or cursor is resting on it and the choice is available for selection.
- **Activation:**
 - Close the drop-down/pop-up list box when an item is selected.

Combination Entry/Selection Controls

- It is possible for a control to possess the characteristics of both a text field and a selection field.
- The types of combination entry/selection fields are spin boxes, attached combination boxes, and drop-down/pop-up combination boxes.

Spin Boxes

- **Description:**
 - A single-line field followed by two small, vertically arranged buttons.
 - The top button has an arrow pointing up.
 - The bottom button has an arrow pointing down.
 - Selection/entry is made by:
 - Using the mouse to point at one of the directional buttons and clicking. Items will change by one unit or step with each click.
 - Keying a value directly into the field itself.
- **Purpose:**
 - To make a selection by either scrolling through a small set of meaningful predefined choices or typing text.
- **Advantages:**
 - Consumes little screen space.
 - Flexible, permitting selection or typed entry.
- **Disadvantages:**
 - Difficult to compare choices.
 - Can be awkward to operate.
 - Useful only for certain kinds of data.
- **Proper usage:**
 - For setting attributes, properties, or values.
 - For mutually exclusive choices (only one can be selected).
 - When the task requires the option of either key entry or selection from a list.
 - When the user prefers the option of either key entry or selection from a list.
 - Where screen space is limited.
 - Most useful for data and choices that are:
 - Discrete.
 - Infrequently selected.
 - Well known, easily learned or remembered, and meaningful.
 - Ordered in a predictable, customary, or consecutive fashion.
 - Infrequently changed.
 - Small in number.
 - Fixed or variable in list length.

List Size

- ☐ Keep the list of items relatively short.
- ☐ To reduce the size of potentially long lists, break the listing into subcomponents, if possible.

List Organization

- ☐ Order the list in the customary, consecutive, or expected order of the information contained within it.
 - Ensure that the user can always anticipate the next (not-yet-visible) choice.
- ☐ When first displayed, present a default choice in the box.

Other Spin Box Guidelines

- ☐ Box size:
 - The spin box should be wide enough to display the longest entry or choice.
- ☐ Caption:
 - Display it using mixed-case letters.
 - Position the caption to the left of the box.
 - Alternately, it may be positioned left-justified above the box.
- ☐ Entry and selection methods:
 - Permit completion by:
 - Typing directly into the box.
 - Scrolling and selecting with a mouse.
 - Scrolling and selecting with the up/down arrow keys.
 - For alphabetical values:
 - Move down the order using the down arrow.
 - Move up the order using the up arrow.
 - For numeric values or magnitudes:
 - Show a larger value using the up arrow.
 - Show a smaller value using the down arrow.

Combo Boxes

- ☐ Description:
 - A single rectangular text box entry field, beneath which is a larger rectangular list box (resembling a drop-down list box) displaying a list of options.
 - The text box permits a choice to be keyed within it.
 - The larger box contains a list of mutually exclusive choices from which one may be selected for placement in the entry field.

- Selections are made by using a mouse to point and click.
- As text is typed into the text box, the list scrolls to the nearest match.
- When an item in the list box is selected, it is placed into the text box, replacing the existing content.
- Information keyed may not necessarily have to match the list items.
- Purpose:
 - To allow either typed entry in a text box or selection from a list of options in a permanently displayed list box attached to the text box.
- Advantages:
 - Unlimited number of entries and choices.
 - Reminds users of available options.
 - Flexible, permitting selection or typed entry.
 - Entries not necessarily restricted to items selectable from list box.
 - List box always visible.
- Disadvantages:
 - Consumes some screen space.
 - All list box choices not always visible, requiring scrolling.
 - Users may have difficulty recalling sufficient information to type entry, making text box unusable.
 - The list may be ordered in an unpredictable way, making it hard to find items.
- Proper usage:
 - For entering or selecting objects or values or setting attributes.
 - For information that is mutually exclusive (only one can be entered or selected).
 - When users may find it practical to, or prefer to, type information rather than selecting it from a list.
 - When users can recall and type information faster than selecting it from a list.
 - When it is useful to provide the users a reminder of the choices available.
 - Where data must be entered that is not contained in the selection list.
 - Where screen space is available.
 - For data and choices that are:
 - Best represented textually.
 - Somewhat familiar or known.
 - Ordered in an unpredictable fashion.
 - Frequently changed.
 - Large in number.
 - Variable or fixed in list length.

Combo Box Guidelines

For the text box entry field, see –Text Box/Single Line guidelines. For the list box, see –Drop-down/Pop-up List Box guidelines.

Drop-down/Pop-up Combo Boxes

- Description:
 - A single rectangular text box with a small button to the side and an associated hidden list of options.
 - The button provides a visual cue that an associated selection box is available but hidden.
 - When requested, a larger associated rectangular box appears, containing a scrollable list of choices from which one is selected.
 - Selections are made by using the mouse to point and click.
 - Information may also be keyed into the field.
 - As text is typed into the text box, the list scrolls to the nearest match.
 - When an item in the list box is selected, it is placed into the text box, replacing the existing content.
 - The information keyed does not necessarily have to match list items.
 - Combines the capabilities of both a text box and a drop-down/pop-up list box.
- Purpose:
 - To allow either typed entry or selection from a list of options in a list box that may be closed and retrieved as needed.
- Advantages:
 - Unlimited number of entries and choices.
 - Reminds users of available options.
 - Flexible, permitting selection or typed entry.
 - Entries not restricted to items selectable from list box.
 - Conserves screen space.
- Disadvantages:
 - Requires an extra step to display the list of choices.
 - When displayed, all box choices may not always be visible, requiring scrolling.
 - User may have difficulty in recalling what to type.
 - The list content may change, making it hard to find items.
 - The list may be ordered in an unpredictable way, making it hard to find items.
- Proper usage:
 - For entering or selecting objects or values or setting attributes.
 - For information that is mutually exclusive (only one can be entered or selected).
 - When users may find it practical to, or prefer to, type information rather than selecting it from a list.
 - When users can recall and type information faster than selecting from a list.
 - When it is useful to provide the users with an occasional reminder of the choices available.
 - Where data must be entered that is not contained in the selection list.
 - Where screen space is limited.
 - For data and choices that are:
 - Best represented textually.

- Somewhat familiar or known.
- Ordered in an unpredictable fashion.
- Frequently changed.
- Large in number.
- Variable or fixed in list length.



Prompt Button

- ☐ Provide a visual cue that a list box is hidden by including a downward-pointing arrow to the right of the text box.
- ☐ Separate the button from the text box by a small space.



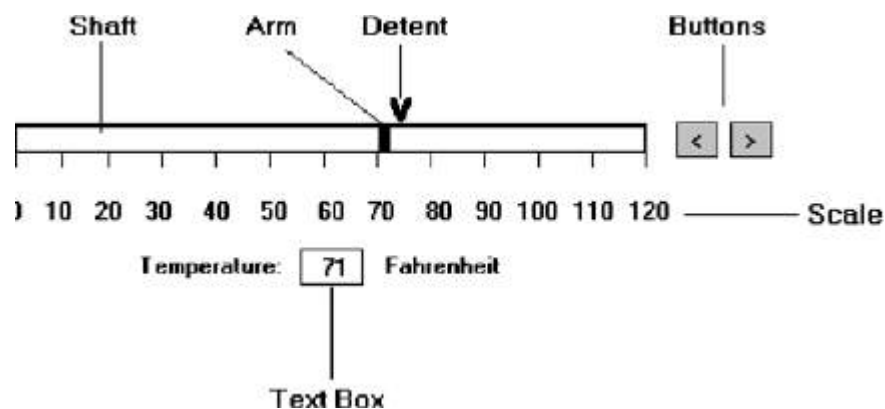
Other Guidelines

For the text box entry field, see the –Text Box/Single Line guidelines. For the box and selection components, see the –Drop-down/Pop-up List Box guidelines.

Slider

- ☐ Description:
 - A scale exhibiting degrees of a quality on a continuum.
 - Includes the following:
 - A shaft or bar.
 - A range of values with appropriate labels.
 - An arm indicating relative setting through its location on the shaft.
 - Optionally, a pair of buttons to permit incremental movement of the slider arm.
 - Optionally, a text box for typing or displaying an exact value.
 - Optionally, a detent position for special values.
 - May be oriented vertically or horizontally.
 - Selected by using the mouse to:
 - Drag a slider across the scale until the desired value is reached.
 - Point at the buttons at one end of the scale and clicking to change the value.
 - Keying a value in the associated text box.
- ☐ Purpose:
 - To make a setting when a continuous qualitative adjustment is acceptable, it is useful to see the current value relative to the range of possible values.

- Advantages:
 - Spatial representation of relative setting.
 - Visually distinctive.
- Disadvantages:
 - Not as precise as an alphanumeric indication.
 - Consumes screen space.
 - Usually more complex than other controls.
- Proper usage:
 - To set an attribute.
 - For mutually exclusive choices.
 - When an object has a limited range of possible settings.
 - When the range of values is continuous.
 - When graduations are relatively fine.
 - When the choices can increase or decrease in some well-known, predictable, and easily understood way.
 - When a spatial representation enhances comprehension and interpretation.
 - When using a slider provides sufficient accuracy.



General

- Use standard sliders whenever available.

Caption and Labels

- Caption:
 - Provide meaningful, clear, and consistent captions.
 - Display them using mixed-case letters.
 - Position the caption to the left of the box.
 - Alternately, it may be positioned left-justified above the slider.
- Labels:
 - Provide meaningful and descriptive labels to aid in interpreting the scale.

Scale

- Show a complete range of choices.

- ☐ Mark the low, intermediate, and high ends of the scale.
- ☐ Provide scale interval markings, where possible.
- ☐ Provide consistent increments.
- ☐ Permit the user to change the units of measure.
- ☐ If the precise value of a quantity represented is important, display the value set in an adjacent text box.

Slider Arm

- ☐ If the user cannot change the value shown in a slider, do not display a slider arm.

Slider Buttons

- ☐ Provide slider buttons to permit movement by the smallest increment.
- ☐ If the user cannot change the value shown in a slider, do not display slider buttons.

Detents

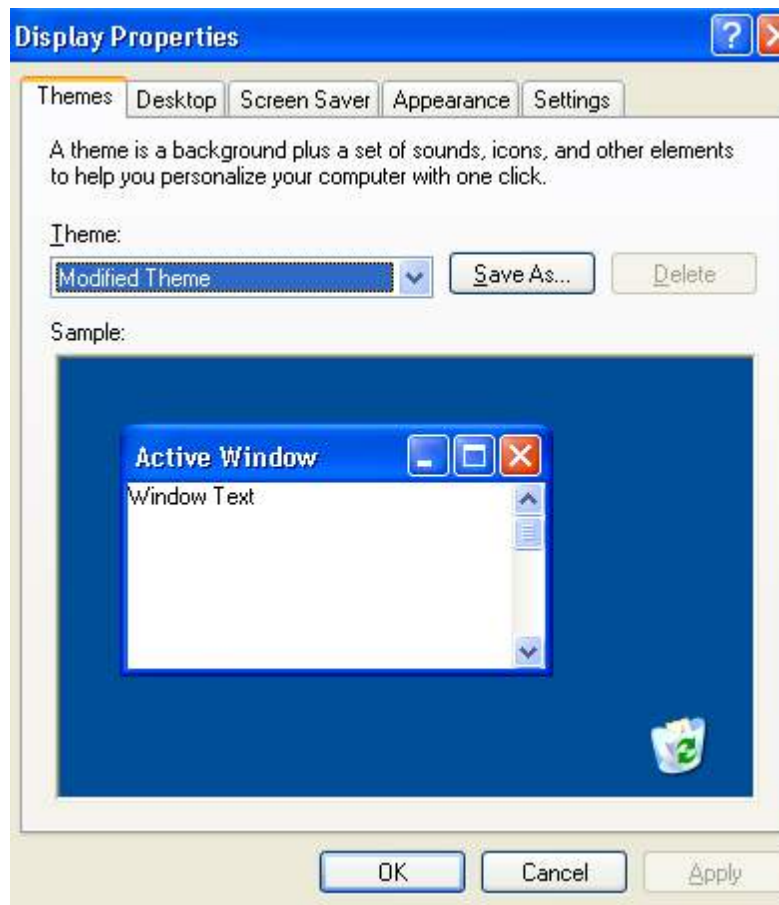
- ☐ Provide detents to set values that have special meaning.
- ☐ Permit the user to change the detent value.

Proportions

- ☐ To indicate the proportion of a value being displayed, fill the slider shaft in some visually distinctive way.
 - Fill horizontal sliders from left to right.
 - Fill vertical sliders from bottom to top.

Tabs

- ☐ Description:
 - A window containing tabbed dividers that create pages or sections.
 - Navigation is permitted between the pages or sections.
- ☐ Purpose:
 - To present information that can be logically organized into pages or sections within the same window.
- ☐ Advantages:
 - Resembles their paper-based cousins.
 - Visually distinctive.
 - Effectively organize repetitive, related information.
- ☐ Disadvantages:
 - Visually complex.
- ☐ Proper usage:
 - To present discrete, logically structured, related, information.
 - To present the setting choices that can be applied to an object.
 - When a short tab label can meaningfully describe the tab's contents.
 - When the order of information use varies.



Sections and Pages

- ☐ Place related information within a page or section.
- ☐ Order them meaningfully.
- ☐ Arrange pages so they appear to go deeper, left to right and top to bottom.
- ☐ Provide pages of equal size.

Location, Size, and Labels

- ☐ Place the tabs at the top of the page or section.
- ☐ Provide fixed-width tabs for pages or sections of related information.
- ☐ Provide textual labels.
 - Use system fonts.
 - Keep information brief and the same general length.
 - Nouns are usually better than verbs.
 - Use mixed case, capitalizing each significant word.
 - Assign a keyboard equivalent for keyboard access.
- ☐ Center the labels within the tabs.
- ☐ Restrict tabs to only one row.
- ☐ Arrange tabs so that they appear to go deeper, left to right and top to bottom.

Command Buttons

- ☐ If they affect only a page or section, locate the buttons on the page or section.
- ☐ If they affect the entire tabbed control, locate the buttons outside the tabbed pages

Date-Picker

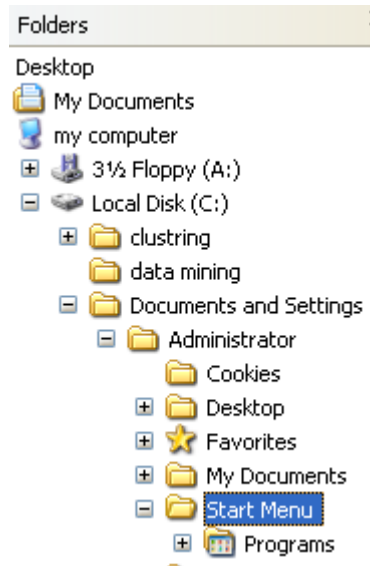
- ☐ Description:
 - A drop-down list box that displays a 1-month calendar in the drop-down list box.
 - The displayed month can be changed through pressing command buttons with left- and right-pointing arrows.
 - The left arrow moves backward through the monthly calendars.
 - The right arrow moves forward through the monthly calendars.
 - A date for the list box can be selected from the drop-down calendar.
- ☐ Purpose:
 - To select a date for inscribing in a drop-down list box.
- ☐ Advantages:
 - Provides a representation of a physical calendar, a meaningful entity.
 - The calendar listing is ordered in a predictable way.
 - Visually distinctive.
- ☐ Disadvantages:
 - Requires an extra step to display the calendar.
 - When displayed, all month choices are not visible, requiring a form of scrolling to access the desired choice.
- ☐ Proper usage:
 - To select and display a single date in close monthly proximity to the default month presented on the drop-down list box.



Tree View

- ☐ Description:
 - A special list box control that displays a set of objects as an indented outline, based on the objects' logical hierarchical relationship.
 - Includes, optionally, buttons that expand and collapse the outline.

- A button inscribed with a plus (+) expands the outline.
- A button inscribed with a minus (-) collapses the outline.
- Elements that can optionally be displayed are:
 - Icons.
 - Graphics, such as a check box.
 - Lines to illustrate hierarchical relationships.
- ☐ Purpose and proper usage:
 - To display a set of objects as an indented outline to illustrate their logical hierarchical relationship.



Scroll Bars

- ☐ Description:
 - An elongated rectangular container consisting of:
 - A scroll area.
 - A slider box or elevator inside.
 - Arrows or anchors at either end.
 - Available, if needed, in primary and secondary windows, some controls, and Web pages.
 - May be oriented vertically or horizontally at the window or page edge.
- ☐ Purpose:
 - To find and view information that takes more space than the allotted display space.
- ☐ Advantages:
 - Permits viewing data of unlimited size.
- ☐ Disadvantages:
 - Consumes screen space.
 - Can be cumbersome to operate.
- ☐ Proper use:
 - When more information is available than the window space for displaying it.
 - Do not use to set values.



Scroll Bar Design Guidelines

- ☐ General:
 - Provide a scroll bar when invisible information must be seen.
- ☐ Scroll area or container:
 - To indicate that scrolling is available, a scroll area or container should be provided.
 - Construct it of a filled-in bar displayed in a technique that visually contrasts with the window and screen body background.
- ☐ Scroll slider box or handle:
 - To indicate the location and amount of information being viewed, provide a slider box or handle.
 - Constructed of a movable and sizable open area of the scroll area, displayed in a technique that contrasts with the scroll area.
 - By its position, spatially indicate the relative location in the file of the information being viewed.
 - By its size, indicate, proportionately, the percentage of the available information in the file being viewed.
- ☐ Scroll directional arrows:
 - To indicate the direction in which scrolling may be performed, directional arrows should be provided.
 - Construct them as arrows in small boxes, with backgrounds that contrast with the scroll area.
- ☐ Selection:
 - When the slider box/handle has been selected, highlight it in some visually distinctive way.
- ☐ Location:
 - Position a vertical (top-to-bottom) scroll bar to the right of the window.
 - Position a horizontal (left-to-right) scroll bar at the bottom of the window.
- ☐ Size:
 - A vertical scroll bar should be the height of the scrollable portion of the window body.
 - A horizontal scroll bar should be at least one-half the width of the scrollable portion of the window body.
- ☐ Current state indication:
 - Whenever the window's size or the position of the information changes, the scroll bar components must also change, reflecting the current state.
 - Include scroll bars in all sizable windows.
 - If no information is currently available by scrolling in a particular direction, the relevant directional arrow should be subdued or grayed out.

Scroll Bar Usage Guidelines

- ☐ Scroll bar style:
 - Stick with standard, proven design styles.

- ☐ Directional preference:
 - Use vertical (top-to-bottom) scrolling.
 - Avoid horizontal (left-to-right) scrolling.

Media Controls

- ☐ For all playable files provide the following controls.
 - Play.
 - Pause/Resume.
 - Stop.
 - Rewind.
 - Fast Forward.
 - Volume.

Custom Controls

- ☐ Implement custom controls with caution.
- ☐ If used, make the look and behavior of custom controls different from that of standard controls.

Presentation Controls

- ☐ Common presentation controls are *static text fields*, *group boxes*, *column headings*, *ToolTips*, *balloon tips*, and *progress indicators*.

Static Text Fields

- ☐ Description:
 - Read-only textual information.
- ☐ Purpose:
 - To identify a control by displaying a control caption.
 - To clarify a screen by providing instructional or prompting information.
 - To present descriptive information.
- ☐ Proper usage:
 - To display a control caption.
 - To display instructional or prompting information.
 - To display descriptive information.

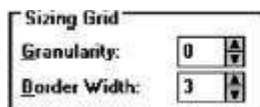
Static Text Field Guidelines

- ☐ Captions:
 - Include a colon (:) as part of the caption.
 - Include a mnemonic for keyboard access.
 - When the associated control is disabled, display it dimmed.
 - Follow all other presented guidelines for caption presentation and layout.

- Instructional or prompting information:
 - Display it in a unique and consistent font style for easy recognition and differentiation.
 - Follow all other presented guidelines for prompting and instructional information.
- Descriptive information:
 - Follow all other guidelines for required screen or control descriptive information.

Group Boxes

- Description:
 - A rectangular frame that surrounds a control or group of controls.
 - An optional caption may be included in the frame's upper-left corner.
- Purpose:
 - To visually relate the elements of a control.
 - To visually relate a group of related controls.
- Proper usage:
 - To provide a border around radio button or check box controls.
 - To provide a border around two or more functionally related controls.
- Guidelines:
 - Label or heading:
 - Typically, use a noun or noun phrase for the label or heading.
 - Provide a brief label or heading, preferably one or two words.
 - Relate label or heading's content to the group box's content.
 - Capitalize the first letter of each significant word.
 - Do not include an ending colon (:).
 - Follow all other guidelines presented for control and section borders.



Column Headings

- Description:
 - Read-only textual information that serves as a heading above columns of text or numbers.
 - Can be divided into two or more parts.
- Purpose:
 - To identify a column of information contained in a table.
- Proper usage:
 - To display a heading above a column of information contained in a table.
- Guidelines:
 - Heading:
 - Provide a brief heading.
 - Can include text and a graphic image.

- Capitalize the first letter of each significant word.
 - Do not include an ending colon (:).
- The width of the column should fit the average size of the column entries.
 - Does not support keyboard access.

Name ▲	Size
diff bwn udf and sp.doc	31 KB
EXAM-700.rar	2,114 KB
EXAM-703.rar	690 KB
Fundamentals of Stored Proc...	195 KB
IBMMAINFRAMES.zip	2,177 KB
Message001.eml	3,062 KB
PROC_LIB.zip	87 KB
triggers.rtf	18 KB
udfs.doc	48 KB

ToolTips

- ☐ Description:
 - A small pop-up window containing descriptive text that appears when a pointer is moved over a control or element either:
 - Not possessing a label.
 - In need of additional descriptive or status information.
- ☐ Purpose:
 - To provide descriptive information about a control or screen element.
- ☐ Advantages:
 - Identifies an otherwise unidentified control.
 - Reduces possible screen clutter caused by control captions and descriptive information.
 - Enables control size to be reduced.
- ☐ Disadvantages:
 - Not obvious, must be discovered.
 - Inadvertent appearance can be distracting.
- ☐ Proper usage:
 - To identify a control that has no caption.
 - To provide additional descriptive or status information about a screen element.

ToolTip Guidelines

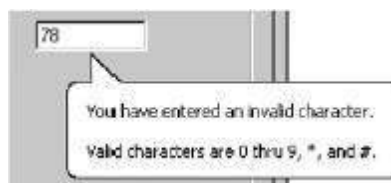
- ☐ Display after a short time-out.
- ☐ For toolbars, provide a brief word as a label.
 - Use mixed case in the headline style of presentation with no ending punctuation.
- ☐ For other elements, provide a brief phrase presenting descriptive or status information.
 - Use mixed case in the sentence style of presentation.
- ☐ Present ToolTips at the lower-right edge of the pointer.
 - Display them fully on the screen.

- For text boxes, display ToolTips centered under the control.
- ☐ Display them in the standard system ToolTip colors.
- ☐ Remove the ToolTip when the control is activated or the pointer is moved away.
- ☐ Don't substitute ToolTips for good design.



Balloon Tips

- ☐ Description:
 - A small pop-up window that contains information in a word balloon.
 - Components can include:
 - Title.
 - Body text.
 - Message Icons.
 - Appear adjacent to the item to which they apply, generally above or to left.
 - Only one tip, the last posted, is visible at any time.
 - Tips are removed after a specified time period.
- ☐ Purpose:
 - To provide additional descriptive or status information about a screen element.
- ☐ Advantages:
 - Provides useful reminder and status information.
- ☐ Disadvantages:
 - If overused they lose their attention-getting value.
 - If overused in situations the user considers not very important, their continual appearance can be aggravating.
- ☐ Proper usage:
 - To display noncritical:
 - Reminder information.
 - Notification information.
 - Do not use tips to display critical information.



Balloon Tip Guidelines

- ☐ General:
 - Use a notification tip to inform the user about state changes.
 - Use a reminder tip for state changes that the user might not usually notice.
 - Point the tip of the balloon to the item it references.

- Do not use them to replace ToolTips.
- Do not overuse balloon tips.
- Content:
 - Restrict them to a length of 100 characters, including title and body text.
 - Title text should:
 - If the tip refers to an icon or other image representing a specific object, include:
 - The object's name, using its normal capitalization.
 - The object's status, using sentence-style presentation without ending punctuation.
 - Be presented in bold.
 - Body text should:
 - Include a description of the situation in one or two brief sentences.
 - Include a brief suggestion for correcting the situation.
 - Be presented using mixed-case in the sentence style.

Progress Indicators

- Description:
 - A rectangular bar that fills as a process is being performed, indicating the percentage of the process that has been completed.
- Purpose:
 - To provide feedback concerning the completion of a lengthy operation.
- Proper usage:
 - To provide an indication of the proportion of a process completed.



Progress Indicator Guidelines

- When filling the indicator:
 - If horizontally arrayed, fill it from left to right.
 - If vertically arrayed, fill it from bottom to top.
- Fill it with a color or a shade of gray.
- Include descriptive text for the process, as necessary.
- Place text outside of the control.

Sample Box

- Description:

- A box illustrating what will show up on the screen based upon the parameter or parameters selected.
- May include text, graphics, or both.
- ☐ Purpose:
 - To provide a representation of actual screen content based upon the parameter or parameters selected.
- ☐ Guidelines:
 - Include a brief label.
 - Use mixed case in the headline style.
 - Locate it adjacent to the controls upon which it is dependent.



Scrolling Tickers

- ☐ Description:
 - Text that scrolls horizontally through a container window.
- ☐ Advantages:
 - Consume less screen space than full text.
- ☐ Disadvantages:
 - Hard to read.
 - Time-consuming to interpret.
 - Distracting.
- ☐ Guideline:
 - Do not use.

Selecting the Proper Controls

- ☐ The proper control will enable a person to make needed selections, entries, and changes quickly, efficiently, and with fewer mistakes. Improper selection most often leads to the opposite result.

Entry versus Selection—A Comparison

- ☐ Studies looked at the advantages and disadvantages of using either entry fields or selection fields for data collection.
- ☐ Entry involved keying text; selection was performed by pointing at a choice through the keyboard using the cursor control keys (not a mouse).
- ☐ The information compared was of three kinds: dates, text, and data. The first conclusion:

Choosing a Type of Control

- ☐ For familiar, meaningful data choose the technique that, in theory, requires the fewest number of keystrokes to complete.
- ☐ If the data is unfamiliar or prone to typing errors, choose a selection technique

Aided versus Unaided Entry

- ☐ Provide aided entry whenever possible.
 - Absorb any extra and unnecessary keystrokes.
 - Provide an auditory signal that auto completion has been performed.

Comparison of GUI Controls

DIRECT MANIPULATION

1. Drag and Drop On
 - The items are arrayed horizontally. An item is dragged to a new location above another item and released. The item in that position moves to the old location of the arriving item.
2. Drag and Drop Between
 - The items are arrayed horizontally. An item is dragged to a new location between two other items and released. The items are readjusted into new positions, including, when necessary, automatic wrap-around for items located at the end of the line.

SELECTION

3. Icons
 - The items are arrayed horizontally. Icons are positioned between each pair of items. Selecting an icon switches the positions of each adjacent item.
4. Radio Buttons
 - The items are presented in a matrix, item name along the left side, item position numbers across the top. Radio buttons in the matrix are selected to represent each item's position.
5. Menus (Drop-down List Boxes)
 - Items are positioned horizontally. A drop-down listing is activated, and the item for that location selected.

ENTRY

6. One Entry Area
 - A single text entry field is provided. A one-character mnemonic (F,N,S,D) is provided for each choice. The mnemonics are keyed in the order in which the items are to be arrayed.
7. Four Entry Areas
 - Four text entry fields, labeled with the item names are arranged vertically. A number (1-4) is keyed into each field, indicating the manner in which the items are to be ordered.

Mutually Exclusive Choice Controls

- ☐ For a small set of options (5), a medium set (12), and a large set (30), radio buttons were significantly faster than the other mutually exclusive controls.

- ☐ The medium and large set sizes (12 and 30) are larger than generally recommended for radio buttons (8 or less). The results indicate that radio buttons may effectively be used for these larger quantities

Nonexclusive Choice Controls

- ☐ For a small set of options (5) with two selected choices, a medium set (12) with three selected choices, and a large set (30) with eight selected choices, check boxes were significantly faster than the other nonexclusive controls.

Controls for Selecting a Value within a Range

- ☐ Setting range values included indicating a time, a percentage, or the transmission frequency of a radio station.
- ☐ Controls evaluated were the spin button, text entry field, and the slider.
- ☐ The spin button was the most accurate, and the text entry field fastest and most preferred.
- ☐ General conclusions are:
 - Making all options always visible will enhance performance.
 - Requiring additional actions to make further options visible slows performance.
 - For longer lists, scrolling tends to degrade performance more than the action associated with retrieving a hidden list.

Control Selection Criteria

- ☐ Selection of the proper control, then, depends on several factors. The first is the structure and characteristics of the property or data itself.
- ☐ Other considerations include the nature of the task, the nature of the user, and the limitations of the display screen itself
- ☐ Data considerations include the following:
 - Is the property or data *mutually exclusive* or *nonexclusive*? Does entry/selection require single or multiple items?
 - Is the property or data *discrete* or *continuous*? Discrete data can be meaningfully specified and categorized, while continuous data cannot.
 - Is the property or data *limited* or *unlimited* in scope? If limited, how many items will the data normally not exceed?
 - Is the property or data *fixed* or *variable* in list length? Are there always a fixed number of items, or will it varies?
 - Is the property or data ordered in a *predictable* or *unpredictable* fashion? If predictable, will the user be able to anticipate the next, unseen, item?
 - Can the property or data be *represented pictorially*? Will a picture or graphic be as meaningful as a textual description?
- ☐ Task considerations reflect the nature of the job. Considerations include the following:
 - *How often* is an item *entered* or *selected*?

- *How often* is an item *changed*?
- How *precisely* must the item be entered or selected?
- User considerations reflect the characteristics of the user. Important considerations:
 - How much *training* in control operation will be provided?
 - How *meaningful* or *known* is the property or data to the user?
 - How *easily remembered* or *learned* by the user is the property or data?
 - How *frequently used* will the system be?
 - Is the user an *experienced typist*?
- Display considerations reflect the characteristics of the screen and hardware.
 - How much *screen space* is available to display the various controls?

Choosing a Control Form

When to Permit Text Entry

- Permit text entry if any of the following questions can be answered *Yes*:
 - Is the data unlimited in size and scope?
 - Is the data familiar?
 - Is the data *not* conducive to typing errors?
 - Will typing be faster than choice selection?
 - Is the user an experienced typist?

What Kind of Control to Choose

- Next are two tables providing some control recommendations based upon a control's known advantages, disadvantages, and proper usage characteristics

Best Controls for Certain Tasks and Screen Conditions

TASK	BEST CONTROL	IF SCREEN SPACE CONSTRAINTS EXIST
Mutually Exclusive	Radio Buttons	Drop-down/Pop-up List Box
Not Mutually Exclusive	Check Boxes	Multiple-Selection List Box
Select or Type a Value Text Entry Field	Radio Buttons with "Other"	Drop-down Combo Box
Setting a Value within a Range	Spin Button	Text Box

From Johnsgard et al., 1995

1. IF:	USE:
<ul style="list-style-type: none"> • <i>Mutually exclusive</i> alternatives. • Discrete data. • Best represented verbally. • Very limited in number (2 to 8). 	
<p>AND:</p> <ul style="list-style-type: none"> • Typed entry is never necessary. • Content can never change. • Adequate screen space is available. 	Radio Buttons
<p>OR:</p> <ul style="list-style-type: none"> • Typed entry is never necessary. • Content can never change. • Adequate screen space is not available. 	Drop-down/Pop-up List Box
<p>OR:</p> <ul style="list-style-type: none"> • Typed entry may be necessary. • Content can change. • Adequate screen space is available. 	Combo box
<p>OR:</p> <ul style="list-style-type: none"> • Typed entry may be necessary. • Content can change. • Adequate screen space is not available. 	Drop-down/Pop-up Combo Box
2. IF:	USE:
<ul style="list-style-type: none"> • <i>Mutually exclusive</i> alternatives. • Discrete data. • Best represented verbally. • Potentially large in number (9 or more). 	
<p>AND:</p> <ul style="list-style-type: none"> • Typed entry is never necessary. • Content can never change. • Adequate screen space is available. 	Single-Selection List Box
<p>OR:</p> <ul style="list-style-type: none"> • Typed entry is never necessary. • Content can never change. • Adequate screen space is not available. 	Drop-down/Pop-up List Box
<p>OR:</p> <ul style="list-style-type: none"> • Typed entry may be necessary. • Content can change. • Adequate screen space is available. 	Combo Box
<p>OR:</p> <ul style="list-style-type: none"> • Typed entry may be necessary. • Content can change. • Adequate screen space is not available. 	Drop-down/Pop-up Combo Box

Suggested Uses for Graphical Controls

3. IF:	USE:
<ul style="list-style-type: none"> • <i>Mutually exclusive</i> alternatives. • Discrete data. • Best represented graphically. • Content rarely changes. • Small or large number of items. 	Palette
4. IF:	USE:
<ul style="list-style-type: none"> • <i>Mutually exclusive</i> alternatives. • Not frequently selected. • Content does not change. • Well-known, easily remembered data. • Predictable, consecutive data. • Typed entry sometimes desirable. 	
AND:	
<ul style="list-style-type: none"> • Adequate screen space is not available. 	Spin Box
OR:	
<ul style="list-style-type: none"> • Adequate screen space is available. 	Combo Box
5. IF:	USE:
<ul style="list-style-type: none"> • <i>Mutually exclusive</i> alternatives. • Continuous data with a limited range of settings. • Value increases/decreases in a well-known, predictable way. • Spatial representation enhances comprehension. 	Slider
6. IF:	USE:
<ul style="list-style-type: none"> • <i>Nonexclusive</i> alternatives. • Discrete data. • Best represented verbally. • Typed entry is never necessary. • Content can never change. • Adequate screen space is available. 	
AND:	
<ul style="list-style-type: none"> • Very limited in number (2 to 8). 	Check Boxes
OR:	
<ul style="list-style-type: none"> • Potentially large in number (9 or more). 	Multiple-Selection List Box

IF THE COMMANDS:	USE:
Are standard commands provided by a tool set.	Commands provided by the tool set
Total seven or more, and can be arranged hierarchically into groups.	Menu bar and pull-downs
Total six or fewer, are selected frequently, and affect an entire window.	Buttons in a window
Total seven or more, are selected frequently, and affect an entire window.	Buttons in a toolbar
Are used with other controls, or are complicated commands and need to be simplified.	Buttons in a dialog box
Are sometimes used frequently and are sometimes used infrequently.	Buttons in a dialog box
Are frequently accessed and have only two conditions.	Toggled menu item

Choosing between Buttons and Menus for Commands

- ☐ Determining the proper way to present a command also depends on several factors.
- ☐ The following considerations are involved in choosing the correct command form:
 - Whether or not the command part of a *standard tool set*.
 - The total *number* of commands in the application.
 - The *complexity* of the commands.
 - The *frequency* with which commands are used.
 - Whether or not the command is used in association *with another control*.

Components

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.

Words, Sentences, Messages, and Text

- ☐ Like all aspects of interface design, knowing the user is the first step in choosing the proper words and creating acceptable messages and text.

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.

Sentences and Messages

- Sentences and messages must be:
 - Brief and simple.
 - 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: 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: 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.
 - Nonanthropomorphic: 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.
 - Nonpunishing: messages should remain factual and informative, and should not be punishable. Punishment is never a desirable way to force a change in behavior, especially among adults.

— Cautious in the use of humor: 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.

Messages

- ☐ Messages are communications provided on the screen to the screen viewer.
- ☐ 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.
- ☐ *Instructional* messages, sometimes referred to as *prompting* messages, are messages that tell the user how to work with, or complete, the screen displayed.

System messages.

- ☐ System messages are of several types, each reflecting a different purpose. Common message types are:
 - ☐ Status messages. A status message is used for providing information concerning the progress of a lengthy operation.
 - ☐ 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.
 - ☐ 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.
 - ☐ 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.
 - ☐ 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.

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.

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 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.

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.

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.

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.

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.

Presenting Text

- ☐ Fonts:
 - Use plain and simple fonts.
 - Choose a minimum point size of 12 to 14.
 - Use proportional fonts.
- ☐ Width:
 - Include no more than 40 to 60 characters on each line.
 - A double column of 30 to 35 characters separated by five spaces is also acceptable.
 - Do not right-justify.
 - Do not hyphenate words.
- ☐ Content:
 - Use headings to introduce a new topic.
 - 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.
- ☐ Miscellaneous:
 - Use paging (not scrolling).
 - Provide a screen design philosophy consistent with other parts of the system.

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.

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.

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.

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

Create Meaningful Graphics, Icons and Images

Icons

Icons are most often used to represent objects and actions with which users can interact with or that they can manipulate

Kinds of Icons

Icons fall into these categories by Marcus:

- ☐ **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.

An expanded definition by Roger's icon kinds are

- ☐ **Resemblance**—An image that looks like what it means. a book, for example , to represent a dictionary
- ☐ **Symbolic**—An abstract image representing something. A cracked glass, for example, can represent something fragile
- ☐ **Exemplar**—An image illustrating an example or characteristic of something. a knife and fork has come to indicate a restaurant
- ☐ **Arbitrary**—An image completely arbitrary in appearance whose meaning must be learned.
- ☐ **Analogy**—An image physically or semantically associated with something. a wheelbarrow full of bricks for the move command

Characteristics of Icons

An icon possesses the technical qualities of syntactics, semantics, and pragmatics

- ☐ *Syntactics* refers to an icon's physical structure.
- ☐ *Semantics* is the icon's meaning.
- ☐ *Pragmatics* is how the icons are physically produced and depicted.

Icon 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.

Choosing Icons

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.

Size

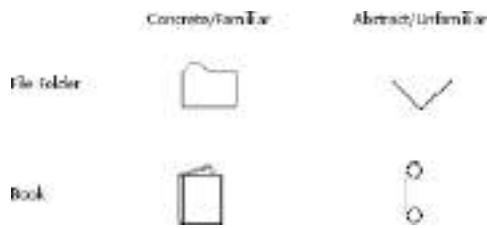
- ☐ Supply in all standard sizes.
 - - 16- and 256-color versions.
 - - 16- and 256-color versions.
 - Effective: 24 X □24 or 26 X □26 in 32 X □32 icon.
 - 48 X □48 pixels
 - 16- and 256-color versions.
- ☐ Use colors from the system palette.
- ☐ Use an odd number of pixels along each side.
 - Provides 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.

Choosing Images

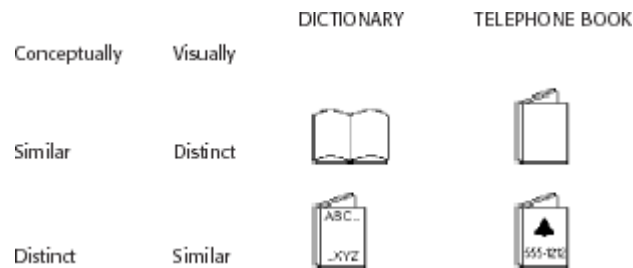
- ☐ Use existing icons when available. The International Standards Organization (ISO), for example, has developed standard shapes for a variety of purposes. Always consult all relevant reference books before inventing new symbols or modifying existing ones.
- ☐ Use images for nouns, not verbs.
- ☐ Use traditional images.
- ☐ Consider user 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.

Creating Images

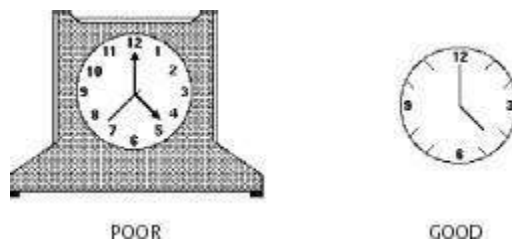
- ☐ Create familiar and concrete shapes. an icon's meaning should be self-evident. This is enhanced when concrete shapes are provided, those that look like what they are. An icon should also be intuitive or obvious, based upon a person's preexisting knowledge.
- ☐ Familiar shapes are those images that are well learned.



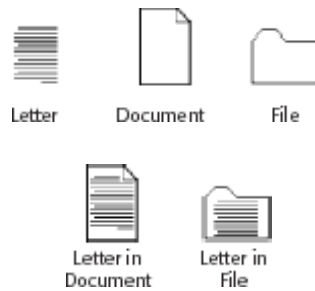
- ☐ Create visually and conceptually distinct shapes.
 - Incorporate unique features of an object.
 - Do not display within a border.
- ☐ Differentiation is aided when icons are visually different from one another. It is also aided when icons are conceptually different—that is, when they portray specific features of an object that are relatively unique within the entire set of objects to be displayed.



- ☐ Clearly reflect objects represented.
- ☐ Simply reflect objects represented, avoiding excessive detail. 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.



- ☐ Create as a set, communicating relationships to one another through common shapes. 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,



- ☐ Provide consistency in icon type.
- ☐ Create shapes of the proper emotional tone.

Drawing 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.

Icon Animation and Audition

- ☐ Animation:
 - 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.
 - 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.
 - It may be well suited to providing information:
 - About previous and possible interactions.
 - Indicating ongoing processes and modes.
 - Useful for navigation.
 - To support collaboration.

The 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.

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.

Multimedia

- ☐ The graphical flexibility of the Web permits inclusion of other media on a screen, including images, photographs, video, diagrams, drawings, and spoken audio.
- ☐ Multimedia can hold the user's attention, add interest to a screen, entertain, and quickly convey information that is more difficult to present textually.
- ☐ Good interface design employs multimedia in a conservative and appropriate manner.

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.

Images

- ☐ General:
 - Use standard images.
 - 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 5K.
 - Restrict page images to 20K.
 - 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.
- ☐ Screen design:
 - Reuse images on multiple pages.

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.

Photographs/Pictures

- Use:
 - When every aspect of the image is relevant.
- Guidelines:
 - Use JPEG format.
 - On the initial page:
 - Display a small version.
 - A thumbnail size image.
 - Zoom-in on most relevant detail.
 - Link to larger photos showing as much detail as needed.

Video

- Uses:
 - To show things that move or change over time.
 - To show the proper way to perform a task.
 - 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.

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.
- Guidelines:
 - Provide simple diagrams.
 - Provide cutaway diagrams or exploded views to illustrate key points.

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.

Animation

- Uses:
 - To explain ideas involving a change in:
 - Time.
 - Position.
 - To illustrate the location or state of a process.
 - To show continuity in transitions.
 - To enrich graphical representations.
 - To aid visualization of three-dimensional structures.
 - To attract attention.
- Disadvantages:
 - Very distracting.
 - Slow loading.
- Guidelines:
 - Use only when an integral part of the content.
 - Create short segments.
 - Provide a freeze frame and stop mode.
 - Avoid distracting animation.

Audition

- Uses:
 - As a supplement to text and graphics.
 - To establish atmosphere.
 - To create a sense of place.
 - To teach.
 - To sample.
- 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.

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.

Importance of combining multimedia

- ☐ **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 Bowers and Lee study, the various graphical combinations yielded the higher learning rates.

- ❑ **Single-dimensional textual media are not as successful when used alone.** In the Bowers and Lee 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 Bowers and Lee 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 user to coordinate and integrate the visual materials. Presenting spatially separated text and related graphics places greater demands on working memory.

Choose the Proper Colors

What is a color?

- ❑ 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 milli microns.
- ❑ 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

Red	700
Orange	600
Yellow	570
Yellow-green	535
Green	500
Blue-green	493
Blue	470
Violet	400

- ❑ A color possesses three properties
 - *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.
 - 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.
- ❑ The long-wavelength colors (red) are commonly referred to as warm, and shortwavelength colors (blue) as cool.
- ❑ Color, then, is a combination of hue, chroma, and value.(HSV) or primary wavelength colors RGB

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.

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.

Possible Problems with Color

- ☐ 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 or the physiological characteristics of the human eye.
- ☐ **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.
 - The result is often bewilderment, confusion, and slower reading.
- ☐ **Interference with Use of Other Screens**
 - Indiscriminate or poor use of color on some screens will diminish the effectiveness of color on other screens.
- ☐ **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.

- 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.
 - 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.
- **Color-Viewing Deficiencies**
- A red viewing deficiency is called *protanopia*, a green deficiency is called *deutanopia*, and a blue deficiency is called *tritanopia*.
 - These common color deficiencies, their results, and the percentage of people who experience these problems are given below

ACTUAL COLOR	COLOR SEEN WITH:		
	RED-VIEWING DEFICIENCY (2.04%)	GREEN-VIEWING DEFICIENCY (6.39%)	BLUE-VIEWING 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

Cross-Disciplinary and Cross-Cultural Differences

- Colors can have different meanings in different situations to different people.
- The same color may also have a different connotation, depending upon its viewer. 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.
- 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

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.
- ☐ 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.

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.
- ☐ 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 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.
- ☐ 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,

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

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.

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.

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.

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.
 - in shades of black, white and gray.
 - 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.
- Use colors conservatively.
 - Do not use color where other identification techniques, such as location, are available.

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.

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, blue, red.
- To emphasize separation, use contrasting colors.
 - Red and green, blue and yellow.
- To convey similarity, use similar colors.
 - Orange and yellow, blue and violet.

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.
- 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.

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.

Ordering

- ☐ Order colors by their spectral position.
 - Red, orange, yellow, green, blue, indigo, violet.

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.

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.
- ☐ 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, 155–175 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.)

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 2 to 5 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.

Gray Scale

- ☐ For fine discriminations use a black-gray-white scale.
 - Recommended values are white, light gray, medium gray, dark gray, black.

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.

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.

Cultural, Disciplinary, and Accessibility Considerations

- ☐ Consider the impact of specific colors on:
 - Users of various cultures.
 - Users of various disciplines.
 - Users with color-viewing deficiencies.
 - Users relying on accessibility utilities.

Choosing Colors for Textual Graphic Screens

- ☐ For displaying data, text, and symbols on a textual graphical screen 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
- ☐ 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 given below
- ☐ 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.
 - Brown and green are the poorest background choices.

FOREGROUND	BACKGROUND							
	BLACK	BLUE	GREEN	CYAN	RED	MAGENTA	BROWN	WHITE
BLACK	x			Good		Good		Good
BLUE		x			Poor			Good
H.L.BLUE			Poor	Poor			Poor	Poor
CYAN	Good		Poor	x			Poor	
H.L.CYAN	Good	Good		Good	Good	Good		
GREEN	Good	Good	x	Poor	Good		Poor	Poor
H.L.GREEN		Good						
YELLOW	Good	Good		Good		Good		
RED			Poor		x	Poor	Poor	
H.L.RED			Poor					
MAGENTA			Poor		Poor	x	Poor	
H.L.MAGENTA	Good		Good			Poor		
BROWN			Poor			Poor	x	
GRAY		Poor			Poor		Poor	
WHITE		Good		Poor				x
H.L.WHITE	Good		Good	Good				

(H.L. = High Intensity)
From Lalomia and Happ (1987).

- ☐ Bailey and Bailey (1989), in their screen creation utility Protoscreens, have a table summarizing research-derived good foreground/background combinations.

BACKGROUNDS	ACCEPTABLE FOREGROUNDS	
Black	Dark Cyan Dark Yellow Dark White	Light Green Light Cyan Light Magenta Light Yellow Light White
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	

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.

UNIT 5: Software Tools

Specification Methods

- Grammars
- Menu-selection and dialog-box trees
- Transition diagrams
- Statecharts

Interface-Building Tools

- Interface mockup tools
- Software-engineering tools

Evaluation and Critiquing Tools

A software tool is programmatic software used to create, maintain, or otherwise support other programs and applications.

UIs should be: reliable, standard, safe, inexpensive, effective widely acceptable and be build on a predictable schedule

Software tools help to achieve this!

UI Architect needs:

- Simple and quick methods of sketching UIs
- Precise methods for working out details with the client, for coordinating with team-members and for telling the developers whatto do

3 sets of tools are available:

- UI specification methods
- Software tools to support design and software engineering
- Evaluation and critiquing tools

Trends:

- Desktop ↓
- Web, Mobile, Universal Usability and Customization ↑
 - UI building tools need to be adapted for these changes

Specification Methods

The methods used to specify the GUI.

Natural-language specifications

- The default language for specifications in any field is natural language, e.g., English
- Communication medium, e.g., sketchpad, or blackboard

These specifications tend to be:

- lengthy
- vague
- ambiguous

Therefore often are difficult to prove:

- correct
- consistent
- complete

Formal and Semiformal languages

- Have a specified grammar
- Have specified and effective procedures to determine whether a string adheres to Grammar

Grammars for command languages are effective

But For GUI they are too short and are used to describe sequences of actions

Grammars

Useful to specify textual commands or expressions that a program should understand

Eg : **Backus-Naur Form – BNF**

Used to describe programming languages

High-level components are described by **nonterminals**

Specific strings are described as **terminals**

Grammars Example : Telephone book entry

```
<Telephone book entry> ::= <Name><Telephone number>
<Name> ::= <Last name>, <First name>
<Last name> ::= <string>
<First name> ::= <string>
<string> ::= <character>|<character><string>
<character> ::= A|B|C|D|E|F|G|H|I|J|K|L|M|N|O|P|Q|R|S|T|U|V|W|X|Y|Z
<Telephone number> ::= (<area code>) <exchange>-<local number>
<area code> ::= <digit><digit><digit>
<exchange> ::= <digit><digit><digit>
<local number> ::= <digit><digit><digit><digit>
<digit> ::= 0|1|2|3|4|5|6|7|8|9
```

LHS are nonterminals given in < > and are defined by RHS

Examples of acceptable entries

- WASHINGTON, GEORGE (301) 555-1234
- BEEF, STU (726) 768-7878
- A, Z (999) 111-1111

Incomplete

- Good to specify the format, but fails to specify content, such as valid exchanges or area codes.
- A second level of software is used to validate content

Complex

- As BNF Grammar grows, it becomes very complex and difficult to follow or change

Multiparty grammars

- Used for showing interactions between more than one party (Shinderman, 1982)
- Non-terminals labeled by the party which generates (i.e. U for user and C and for Computer)
- Effective for text-oriented command sequences which have repeated exchanges

Eg : opening steps in a login process

```
<Session> ::= <U: Opening><C: Responding>
<U: Opening>:= LOGIN <U: Name>
<U: Name> ::= <U: string>
<C: Responding>:= HELLO [<U: Name>]
```

Pros

- Verification of completeness and correctness

Cons:

- Two-dimensional styles, such as form fillin or direct manipulation and graphical layouts, are more difficult to describe with multiparty grammars.

Menu-selection and dialog-box trees

- A menu-selection tree has a simple structure that guides designers and users alike, making it an excellent selection style for many applications.
- Specification methods include online tools to help in the construction of menu trees and simple drawing tools that enable designers and users to see the entire tree at one time
- Due to the intention of avoiding clutter such trees are incomplete, are restricted to a “static view” and do not show the entire structure of possible user actions

Problem:

- In some aspects of UI design a precise specification of every possible action is required
- In cases of non-menu systems there might be a need to express the set of possible states and allowed transitions

Solution: Use Transition Diagrams

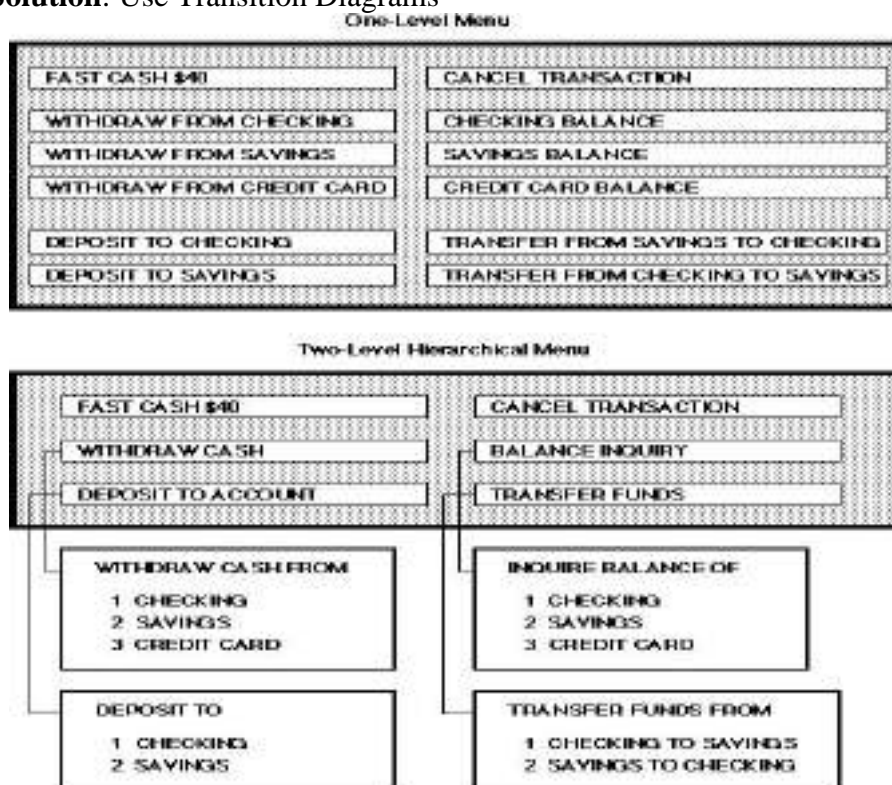


Figure 8.2: Two menu arrangements for automatic teller machines.

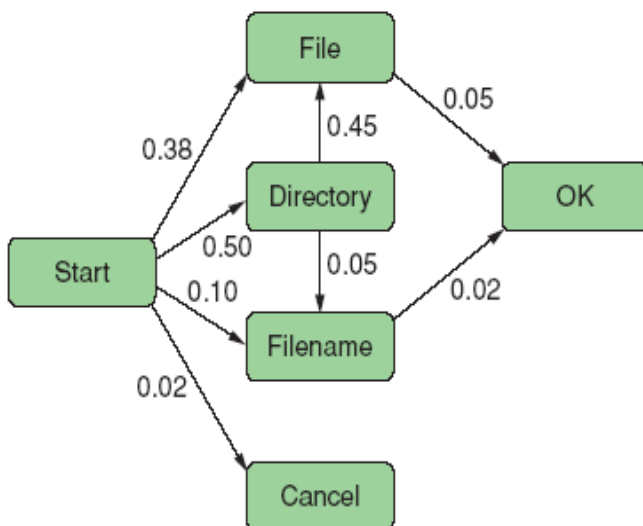
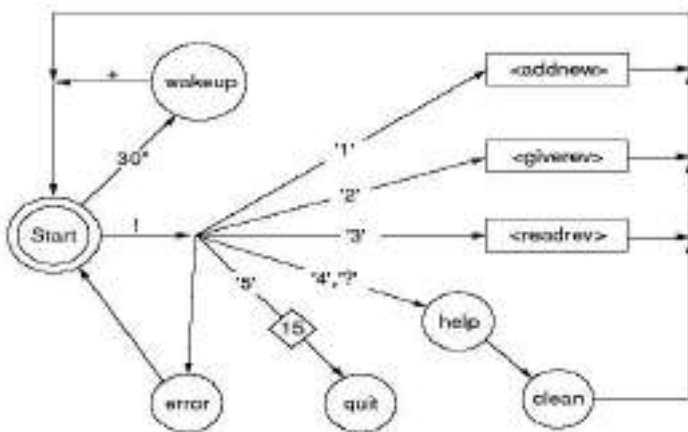
Transition Diagrams

- Transition diagram has a set of nodes that represent system states and a set of links between the nodes that represent possible transitions.
- Each link is labeled with the user action that selects that link and possible computer responses.

Pros: can be effective for keeping track of the current state and options of the UI/System, can also be verified

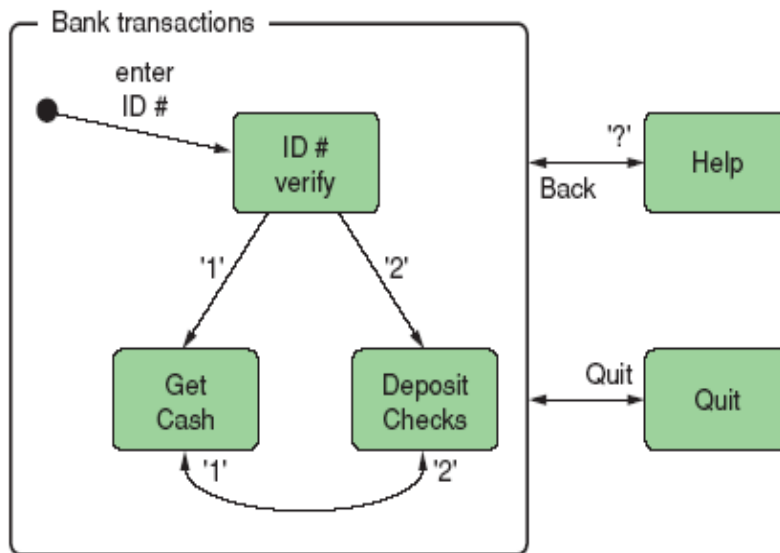
Cons: Too complex with growing system complexity (too many states and possible transitions), confusing when many nodes need a link to “help”, “back”, “quit”, etc., in their basic form poor representation of concurrency and synchronization

Alternative: State-Charts



Statecharts

- Statecharts have several virtues in specifying interfaces.
- Because a grouping feature is offered through nested roundtangles repeated transitions can be factored out to the surrounding roundtangle.
- Extensions to statecharts-such as concurrency, external interrupt events, and user actions-are represented in **I-Logix's**, which is a user-interface tool based on statecharts. The UML also uses statechart to specify the behavior of general program, thus they should be familiar to software engineers.



Interface-Building Tools

1. Specification methods are important for the design of components of a system, such as command languages, data-entry sequences, and widgets.
2. Screen-transition diagrams drawn or printed on paper are an excellent means of providing an overview of the system.
3. They allow user-interface architects, designers, managers, users, and software engineers to sit around a table, discuss the design, and prepare for the big job that lies ahead.
3. Paper-based designs are a great way to start, but the detailed specification of complete user interfaces requires software tools such as :

Interface Mockup Tools

- i. User interface architects recognize that creating quick sketches is important during the early stages of design to explore multiple alternatives, to allow communication within the design team, and to convey to clients what the product will look like.
- ii. User interface mockups can be created with paper and pencil, word processors, or slide show presentation software (such as Microsoft PowerPoint or Apple Keynote).
- iii. Resourceful designers have also built user-interface prototypes with multimedia construction tools, such as Dreamweaver.
- iv. These programs can quickly generate animated or even interactive programs and be distributed via the Web.



This Flash MX design shows a multimedia presentation with a time line on top, a color palette on the top right, alignment options on the bottom right, and standard graphic tools on the left. Once created, a Flash file is saved that can be made available through the Internet and run on most web browsers using a free plug-in.

Software-engineering tools

- Main Purpose: Build the final product
- In earlier days, general purpose languages (e.g., Java,C++) were used to build UIs from scratch
- Today, this is supported through software tools, APIs and Frameworks, etc.
- A classification of UI building tools:
 - Layer 1: Windowing Toolkit
 - Layer 2: GUI Toolkit
 - Layer 3: Application Framework/Specialized Languages
 - Layer 4: Application Level

The following table lists the four software layers that can be used to build a user interface and their associated interactive tools

Software layers	Visual Tools	Examples
4 Application	Model-Based Building Tools	Microsoft Access, Sybase PowerDesigner
3 Application Framework/ Specialized Language	Conceptual Building Tools	Macromedia Director, Tcl/Tk, Microsoft MFC
2 GUI Toolkit	Interface Builder	Eclipse, Borland JBuilder, Microsoft Visual Studio
Windowing System	Resources Editor	Microsoft Win32/GDI+, Apple Quartz, X11 Windowing System

Windowing-system layer

Sometimes when with new platforms, working at a low-level is required.

Involves Extensive programming

Interfaces for some mobile devices or cell phones should currently be done at the windowing-system level

E.g., for a new platform, all programs have the following form

- The while(true) main loop exists in every interactive program
- This loop manages the state transitions, triggered by events arriving from the windowing system or the operating system

Programming at this level is sometimes appropriate when no higher-level tool exists or when memory or performance is critical

```

main() {
    InitializeSystem();
    SetInitialState();
    DisplayInitialGraphics();
    while(true) {
        Event event = readNextEvent();
        switch(event.type) {
            case EVENT_REDISPLAY: redisplay(); break;
            case EVENT_PEN_DOWN: doPenDown(event.x, event.y); break;
            case EVENT_CHAR: doInputChar(event.detail); break;
            ...
            default: doSystemDefault(event); break;
        }
    }
}

```

GUI-toolkit layer

- Provides software libraries and widgets (e.g., frames, dialog boxes, scrollbars) including event encapsulation as building blocks
- **Pros:** Abstraction, shorter development times, great flexibility, often based on general-purpose languages (makes it easier to combine UI with application logic)
- **Cons:** Possibly high learning times, building and maintenance time is still high, no support for consistency, experienced programmer needed
- Example for Toolkits: ILOG Views, Gtk, Qt, Java (AWT, Swing, SWT), .Net GUI toolkit

Application framework and specialized language layer

- Application Framework
 - Software architecture specifically designed for building GUIs
 - **Idea:** Many UI-based programs have a similar structure, capture structure, translate it to classes, objects and methods, which can then be extended/reused
 - Commonly uses widgets from the GUI Toolkit layer
 - Based on convenient visual programming, simple scripting languages, or general purpose languages
 - Less support for non-graphical part of the application
 - Example: Cocoa, MFC, Macromedia Director
- Specialized Languages
 - Languages specifically designed for building UIs
 - Can also be used for rapid prototyping
 - Example: Tcl, java script in combination with HTML

Application layer

- Interface Generators, also called: Model-Based Systems or UI Management Systems
- Visual tools, that allow for most parts of an application to be built with one tool and without coding
- Only available for a small class of applications (e.g., DB front-ends) or research prototypes

Selecting the right tool

- Obviously higher-level tools are more efficient, however, they are the most restricting as well
- Finding the right tool is a tradeoff between 6 criteria:
 - Which part of the application do you need to build using the tool?
 - How long can learning time be / or are experts available?
 - How long can the building time be?
 - Do you accept a methodology being imposed or rather advised?
 - Is communication with other subsystems required?
 - Do you need to consider extensibility and modularity?

Features of User-interface building tools

1. User interface independence
 - a. Separate interface design from internals
 - b. enable multiple user interface strategies and multiple platform support
 - c. establish role of UI architect
 - d. enforce standards
2. Methodology and Notation
 - a. Develop design procedures
 - b. find ways to talk about design
 - c. create project management
3. Rapid Prototyping
 - a. Try out new ideas very early
 - b. test, revise, test, revise, ...,
 - c. engage end-users, managers and customers
4. Software Support
 - a. Increase productivity
 - b. offer constraint and consistency checks
 - c. facilitate team approach
 - d. ease maintenance

Evaluation and Critiquing Tools

- Build-Time Tools
 - Example: From simple spell checks to more sophisticated tools that provide metrics reporting number of displays, widgets etc. or even more advanced: check depth of menu-trees, redundancies, inconsistencies in labels etc.
- Runtime Logging Software
 - Capture user pattern of activity
 - Example: reports on error-frequencies, menu selections, dialog box appearances, help invocations, or capture performance data

Interaction Devices

Several interactive devices are used for the human computer interaction. Some of them are known tools and some are recently developed or are a concept to be developed in the future.

Keyboard Layouts

QWERTY layout

- 1870 Christopher Latham Sholes
- good mechanical design and a clever placement of the letters that slowed down the users enough that key jamming was infrequent
- put frequently used letter pairs far apart, thereby increasing finger travel distances

Dvorak layout

- 1920
- reduces finger travel distances by at least one order of magnitude
- Acceptance has been slow despite the dedicated efforts of some devotees
- it takes about 1 week of regular typing to make the switch, but most users have been unwilling to invest the effort

ABCDE style

- 26 letters of the alphabet laid out in alphabetical order no typists will find it easier to locate the keys

Additional keyboard issues

- IBM PC keyboard was widely criticized because of the placement of a few keys
 - backslash key where most typists expect SHIFT key
 - placement of several special characters near the ENTER key
- Number pad layout
- wrist and hand placement

Keys

- 1/2 inch square keys
- 1/4 inch spacing between keys
- slight concave surface
- matte finish to reduce glare finger slippage
- 40- to 125-gram force to activate
- 3 to 5 millimeters displacement
- tactile and audible feedback important
 - certain keys should be larger (e.g. ENTER, SHIFT, CTRL)
 - some keys require state indicator, such as lowered position or light indicator (e.g. CAPS LOCK)

- key labels should be large, meaningful, permanent
- some "home" keys may have additional features, such as deeper cavity or small raised dot, to help user locate their fingers properly (caution -no standard for this)

Function keys

- users must either remember each key's function, identify them from the screen's display, or use a template over the keys in order to identify them properly
- can reduce number of keystrokes and errors
- meaning of each key can change with each application placement on keyboard can affect efficient use
- special purpose displays often embed function keys in monitor bezel
- lights next to keys used to indicate availability of the function, on/off status
- Typically, simply labeled F1, F2, etc, though some may also have meaningful labels, such as CUT, COPY, etc.
- frequent movement between keyboard home position and mouse or function keys can be disruptive to use
- alternative is to use closer keys (e.g. ALT or CTRL) and one letter to indicate special function

Cursor movement keys

- up, down, left, right
- some keyboards also provide diagonals
- best layout is natural positions
- inverted-T positioning allows users to place their middle three fingers in a way that reduces hand and finger movement
- cross arrangement better for novices than linear or box
- typically include typematic (auto-repeat) feature
- important for form-fill-in and direct manipulation
- Other movements may be performed with other keys, such as TAB, ENTER, HOME, etc.

Keyboard and keypads for small devices

- Wireless or foldable keyboards
- Virtual keyboards
- Cloth keyboards
- Soft keys
- Pens and touch screens

Pointing Devices

Pointing devices are applicable in six types of interaction tasks:

1. Select:

- User chooses from a set of items.
 - Used for traditional menu selection, identification of a file in a directory, or marking of a part in an automobile design.
2. Position:
- User chooses a point in a one-, two-, three-, or higher-dimensional space
 - Used to create a drawing, to place a new window, or to drag a block of text in a figure.
3. Orient:
- User chooses a direction in a two-, three-, or higher-dimensional space.
 - Direction may simply rotate a symbol on the screen, indicate a direction of motion for a spaceship, or control the operation of a robot arm.
4. Path:
- User rapidly performs a series of position and orient operations.
 - May be realized as a curving line in a drawing program, the instructions for a cloth cutting machine, or the route on a map.
5. Quantify:
- User specifies a numeric value.
 - Usually a one-dimensional selection of integer or real values to set parameters, such as the page number in a document, the velocity of a ship, or the amplitude of a sound.
6. Text:
- User enters, moves, and edits text in a two-dimensional space. The Pointing device indicates the location of an insertion, deletion, or change.
 - More elaborate tasks, such as centering; margin setting; font sizes; highlighting, such as boldface or underscore; and page layout.

Types of Pointing Devices

Pointing devices can be grouped into :

- Direct control on the screen surface, such as the touchscreen or stylus, and
- Indirect control away from the screen surface, such as the mouse, trackball, joystick, graphics tablet, or touchpad.

Direct control pointing devices :

Lightpen : The lightpen is a device that enabled users to point to a spot on a screen and then press a button to perform a select, position, or other task.

Touchscreen : Touchscreen is robust and does not require picking up an external device; instead, it allows users to make direct-control touches on the screen with a finger.

Stylus : The stylus is an attractive device because it is familiar and comfortable for users, and users can guide the stylus tip to the desired location while keeping the whole context in view.

Indirect control pointing device :

- **Mouse**
 - the hand rests in a comfortable position, buttons on the mouse are easily pressed, even long motions can be rapid, and positioning can be precise
- **Trackball**
 - usually implemented as a rotating ball 1 to 6 inches in diameter that moves cursor

- **Joystick**
 - are appealing for tracking purposes
- **Graphics tablet**
 - A touch-sensitive surface separate from the screen
- **Touchpad**
 - built-in near the keyboard offers the convenience and precision of a touchscreen while keeping the user's hand off the display surface



Comparison of pointing devices

- Some results
 - direct pointing devices faster, but less accurate
 - graphics tablets are appealing when user can remain with device for long periods without switching to keyboard
 - mouse is faster than isometric joystick
 - for tasks that mix typing and pointing, cursor keys are faster and are preferred by users to a mouse
 - muscular strain is low for cursor keys

- **Fitt's Law**

Fitts's Law accurately predicts the amount of time taken to move to and select a target. Fitts's Law is typically applied to movement through the graphical user interface using a cursor or other type of pointer.



Speech Recognition Digitization and Generation

Speech Recognition

Speech recognition is the technology that enable machines, such as a computer or smartphone, to understand and interpret human speech. It is also known as Automatic Speech Recognition(ASR) or speech-to-text technology.

Speech recognition systems use algorithms and machine learning model to convert spoken language into the text. The process involves breaking down speech into the individual sounds of phonemes, and then using statistical model to match those sounds or word in a language model. Once the system has recognized the words, it can be then translate them into the text that can be processed and analyzed by the computer.

Speech recognition has numerous applications, including in virtual assistants, dictation software and voice activated devices. It can also be used in Healthcare, Education, Customer service to improve communication between the human and the Machine.

While speech recognition technology has come a long way, it is still face challenge in accurately recognizing speech in different languages, accents and the contexts. Ongoing research is focused on improving the accuracy of speech recognition system and making them more robust and adaptable to the different environments.

Speech Digitization

Speech digitization is the process to convert analog audio signals, which represent human speech, into digital data that can be processed and stored by a computer. The process involves two main stage: **Sampling and Quantization**.

In the Sampling stage, the continuous analog audio signal is converted into discrete signal by taking samples of the audio signals at the regular intervals. These samples are the **quantized**, which means that the analog signal is represented by a set of discrete value that can be stored as a digital data.

Speech digitization is important because it enable speech to be easily transmitted, stored and processed by the digital device any memory device such as computer or the smart phones. Digitized speech can be compressed to reduce its size for efficient storage and transmission, and it can also be easily manipulated and analyzed using Digital Signal Processing techniques.

Speech digitization has numerous applications, including in speech recognition system, Voice over Internet Protocol (VOIP) systems, and digital voice recording devices. It has also enabled the development of speech-based interface for various applications, such as virtual assistant and voice activated devices.

Overall, speech digitization has played a significant role in enabling human speech to be easily processed and transmitted into the digital age

Speech and Auditory Interfaces

Obstacle to Speech Recognition

- Increased cognitive load compared to pointing
- Interference from the noisy environment
- Unstable recognition across changing users environment and time

Obstacle to the Speech Output

- The slow pace of speech output compared to the visual displays
- Short term nature of the speech

- Difficulty is scanning/searching

Opportunities

- When users have vision impairments
- When the speakers hands are busy
- When Mobility is required
- When the speaker's eyes are occupied
- When harsh or cracked conditions preclude use of the keyboard

Technologies

- Speech store and forward
- Discrete-word recognition
- Continuous-speech recognition
- Voice information systems
- Speech generation

Speech Store and Forward

Speech Store and Forward refers to the process of capturing spoken language, storing it, and forwarding it to another location for later processing or analysis.

In the context of telecommunication, speech store and forward is often used to describe the process of capturing voicemail messages. When a caller leaves a voicemail message, their spoken language is captured and stored into the digital format. The voicemail system then forwards the message to the intended recipient, who can later listen to the message and respond accordingly.

Speech store and forward can also be used in other applications such as transcription services. In this case spoken language is captured and stored, and then forward to the human or machine transcriptionist who convert the speech into the written text.

The advantages of speech store and forward include the ability to capture and process spoken language at a later time, which can be useful for recording important information or messages. Additionally, speech store and forward can be used to enable Communication in situation when real-time communication is not possible or desirable, such as when communicating across different time zone and when dealing with sensitive or confidential information.

Overall, speech Stone forward is an important technology that enable the capture, storage and processing of a spoken language in variety of applications.

Discrete-word recognition

Discrete-word recognition, also known as isolated-word recognition, is a type of Automatic Speech Recognition (ASR) that focus on recognizing individual words rather than continuous speech. In discrete-word recognition, each spoken word is treated as a separate unit and is recognized independently.

The process of discrete-word recognition involves several steps. First, the spoken word is captured by a microphone and pre-processed to remove noise and the other distortion

Next, the audio signal is analyzed and segmented into individual word using techniques such as Dynamic Time Warping (DTW) or Hidden Markov models(HMMs).

Once the audio signal is segmented, each individual word is matched against a set of pre-defined word models, which are based on acoustic and language models. The acoustic model is used to match the sound of the spoken word with the corresponding phonemes, while the language model is used to determine the

probability of each possible word based on the context of the speech.

Discrete-word recognition is commonly used in applications such as voice-activated assistants, voice dialing, and voice authentication. It is well-suited to situation where the user is expected to speak a limited set of predefined words, such as in phone menu system or in voice-controlled device with a limited vocabulary.

Discrete-word Recognition

- Recognizes individual words spoken by a specific person; works 90 -98% reliability
- Speaker-dependent training - repeat full vocabulary once or twice
- Speaker-independent training - not as accurate but eliminates training to expand the scope of commercial applications.
- Quiet environments, head-mounted microphones, and careful word choices improve recognition rates to both.

Continuous-Speech Recognition

- Speech dictation products, IBM via voice: to help dictate letters and compose reports verbally for automatic transcription
- Can be used to scan and retrieve radio or television programs, court proceedings, lectures or telephone calls for specific words or topics.
- Summaries can be generated from audio conversations.
- Closed Caption generation
- Used for security systems and voice search in court

Voice Information Systems

- Interactive voice Response systems: to check on airline flight departure/arrival times
- Voicemail Systems: Telephone based speech systems enabling users to store or forward messages.
- Apple iPod: allows to store large audio databases and retrieve selected segments

Speech Generation

Speech generation, is also known as text-to-speech (TTS) synthesis, is the process of converting written text into spoken words by a machine. TTS systems use algorithms and synthetic voices to read text aloud in a natural sounding way, giving the impression of a human speaker.

The process of speech generation involves several Stages. First, the text is analyzed and processed by Natural Language Processing (NLP) algorithm, which breaks it down into individual words and phrases. Next, the TTS system applies rules of pronunciation and intonation to generate a phonetic representation of the text.

This phonetic representation is then used for the synthesize the speech, either by concatenating pre-recorded speech fragments or by using a form of statistical parametric synthesis, which involves modelling the relationship between written text and corresponding acoustic features. Finally, the synthesized speech is outputted as an audio file or through a speaker.

Speech generation has numerous applications, including in assistive technologies for people with visual impairments or reading difficulties, as well as in virtual assistant and automated customer service systems. It can also be used in language learning and the pronunciation practice tools.

The development of speech generation technology has greatly improved the accessibility and usability of text-based content for individuals who may have difficulty reading or accessing written text. As the technology continues to advance, it is likely that speed generation will become more natural-sounding and capable of expressing a wide range of emotion and nuances in language.

Uses of speech Generation

- Widespread in consumer applications and the telephone applications.
- Used in automobile navigation systems, Internet services, utility-control rooms, and the children's games.
- Applications are good for the blind for text-to-speech utilities like Microsoft Windows Narrator
- Speech enabled readers: for documents, newspapers, statistical data and maps
- Web-based voice applications and telephone-based voice information systems.

Non-speech auditory interfaces

Non-speech auditory interfaces are interfaces that communicate with users through sound, but do not involve speech. These interfaces are often used in situation where visual interface may not be practical, such as in low light conditions, for people with visual impairments, or in situations where the user needs to be able to focus on task without looking at a screen.

Non-speech auditory interfaces can be particularly useful in situation where visual information is limited or unreliable such as dark or noisy environments. They can also be used to provide an additional layer of information to user who may be visually impaired or who prefer to interact with the technology in a non-visual way.

Some examples of non-speech auditory interface include:

- Tactile feedback devices that use sound to convey information through vibrations, such as wearable devices that notify the user of incoming calls or messages
- Sonification, which is the use of sound to represent data, such as in Scientific or Medical Visualizations.
- Auditory icons, which are sound that represent specific actions or events, such as the sound of camera shutter when taking a photo.
- Earcons, which are shorter musical phrases used to report specific actions or events, such as startup sound of the computer.
- Environmental sounds, such as the sound of car engine or the hum of the refrigerator which can be provide information about the status of the device or system

Image and Video displays

Visual display unit (VDU) has become the primary source of feedback to the user from the computer. Important features, of VDU are :

- Rapid operation
- Reasonable size
- Reasonable resolution
- Quiet operation
- No paper waste
- Relatively low cost
- Reliability
- Highlighting
- Graphics and animation

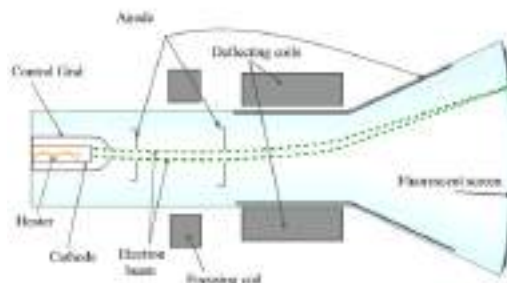
For certain applications, monochrome displays are adequate and are attractive because of their low cost.

Color displays can make video games educational simulations, CAD and many other applications more attractive and effective for users.

Display technologies include :

CRT :

- CRT is an evacuated glass tube equipped with various components.
- A beam of electrons (cathode rays), emitted by an electron gun, passes through focusing and deflection systems hits on the phosphor coated screen to generate the desired picture.
- The high speed electrons hit the phosphor coated screen to produce a spot of light controlled by a video controller.



Plasma panel :

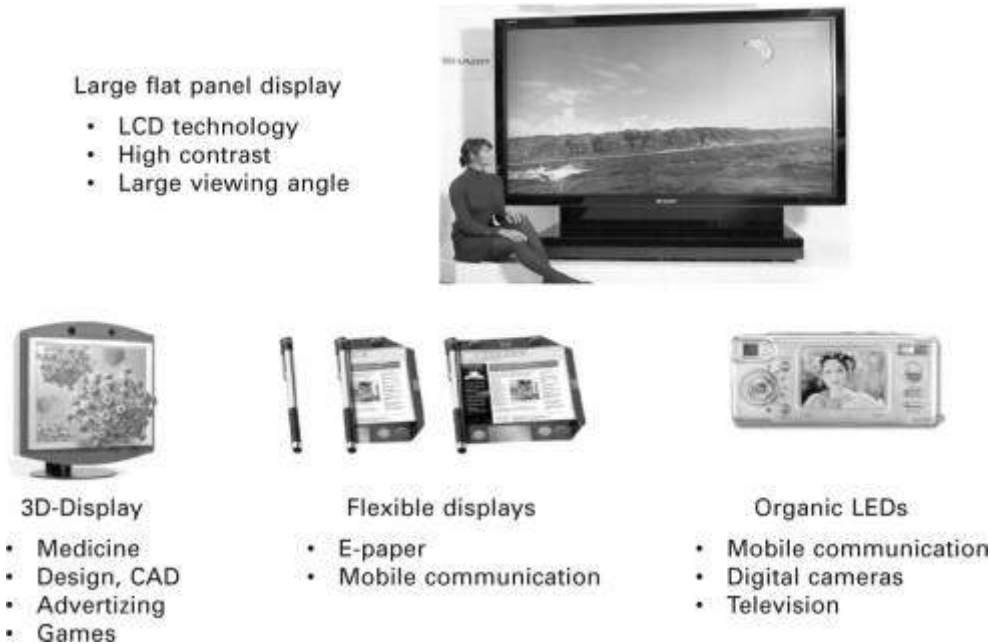
- Plasma panels, also called gas discharge displays, are constructed by filling the region between two glass plates with a mixture of gases that usually includes neon.
- A series of vertical conducting ribbons is placed on one glass panel and a set of horizontal ribbons is built into the other glass panel.

Liquid Crystal Displays (LCDs) :

- LCDs are non-emissive devices which produce a picture by passing polarized light from the surroundings of an internal light source through a liquid crystal material.
- Liquid crystals are almost transparent substances, exhibiting the properties of both solid and liquid matter

Flat panel display :

- Flat panel display is a display method that is designed to reduce the depth of the CRT display caused by the length of the tube.
- The screens of these flat panel displays are made up of pairs of electrodes.
- Each pair of electrodes is used to generate one picture element.



Characteristics of video display devices

Important characteristics of video display devices :

Persistence :

- Persistence is defined as the time it takes the emitted light from the screen to decay to one-tenth of its original intensity.
- Lower persistence phosphors require higher refreshing rates to maintain a picture on the screen without flicker. However it is useful for displaying animations.
- On the other hand higher persistence phosphors are useful for displaying static and highly complex pictures.

Resolution :

- Resolution indicates the maximum number of points that can be displayed without overlap on the CRT.
- It is defined as the number of points per centimeter that can be plotted horizontally and vertically.
- Resolution depends on the type of phosphor, the intensity to be displayed and the focusing and deflection systems used in the CRT.

Aspect ratio :

- It is the ratio of vertical points to horizontal points to produce equal length lines in both directions on the screen.
- An aspect ratio of 4/5 means that a vertical line plotted with four points has the same length as a horizontal line plotted with five points.

Printers

Important criteria for printers:

- Speed
- Print quality
- Cost
- Compactness
- Quiet operation
- Use of ordinary paper (fan folded or single sheet)
- Character set
- Variety of typefaces, fonts, and sizes
- Highlighting techniques (boldface, underscore, and soon)
- Support for special forms (printed forms, different lengths, and soon)
- Reliability

Dot-matrix printers

- print more than 200 characters per second, have multiple fonts, can print boldface, use variable width and size, and have graphics capabilities

Inkjet printers

- offer quiet operation and high-quality output

Thermal printers or fax machines

- offer quiet, compact, and inexpensive output on specially coated papers

Laser printers

- operate at 30,000 lines per minute

Color printers

- allow users to produce hardcopy output of color graphics, usually by an inkjet approach with three colored and black inks

Photographic printers

- allow the creation of 35-millimeter or larger slides (transparencies) and photographic prints

Drivers

- A driver is a program that interacts with a particular device or special (frequently optional) kind of software.
- The driver contains the special knowledge of the device or special software interface that programs using the driver do not. In personal computers, a driver is often packaged as a

Dynamic Link Library (DLL) file.

- A driver in software provides a programming interface to control and manage specific lower level interface that is often linked to a specific type of hardware, or other low-level service.
- In the case of hardware, the specific subclass of drivers controlling physical or virtual hardware devices is known as device drivers.
- The main purpose of device drivers is to provide abstraction by acting as a translator between a hardware device and the applications or operating systems that use it.
- Programmers can write higher-level application code independently of whatever specific hardware the end-user is using.

For example, a high-level application for interacting with a serial port may simply have two functions for “send data” and “receive data”. At a lower level, a device driver implementing these functions would communicate to the particular serial port controller installed on a user’s computer.