UNIT I

Introduction: Importance of user Interface: Definition, Importance of Good Design, Benefits of Good Design, A Brief History of Screen Design.
The Graphical User Interface: Popularity of Graphics, the Concept of Direct Manipulation, Graphical System, Characteristics,
Web User – Interface Popularity, Characteristics- Principles of User Interface.

Importance of user Interface

- Greatly improved technology in the late twentieth century eliminated a host of barriers to good interface design and unleashed a variety of new display and interaction techniques wrapped into a package called the *graphical user interface* or, as it is commonly called, GUI.
- Web site design has greatly expanded the range of users and introduced additional interface techniques such as multimedia.
- It is said that the amount of programming code devoted to the user interface now exceeds 50 %.

Defining the User Interface

- 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.
- HCI designers must consider a variety of factors:
  - what people want and expect,
  - what physical limitations and abilities people possess,
  - how their perceptual and information processing systems work, and
  - what people find enjoyable and attractive.
- Designers must also consider technical characteristics and limitations of the computer hardware and software.
- 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 a person communicates his or her needs or desires to the computer. Some common input components are the keyboard, mouse,trackball, one's finger (for touch-sensitive screens or pads), and one's voice (for spoken instructions).
- *Output* is how the computer conveys the results of its computations and requirements to the user.
- Proper interface design will provide a mix of well-designed input and output mechanisms that satisfy the user's needs, capabilities, and limitations in the most effective way possible.

The Importance of Good Design

- A well-designed interface and screen are terribly important to users. They are their window to view the capabilities of the system, the bridge to the capabilities of the software.
- To many users it *is* the system, because it is one of the few visible components of the product its developers create.
- It is also the vehicle through which many critical tasks are presented. These tasks often have a direct impact on an organization's relations with its customers, and its profitability.
- A screen's layout and appearance and a system's navigation affect a person in a variety of ways. If they are confusing and inefficient, people will have greater difficulty doing their jobs and will make more mistakes. It can also lead to aggravation, frustration, and increased stress.
- Poor interface design can also have a huge financial cost to users and organizations. A critical system, such as one used in air traffic control or in a nuclear power plant, may compromise the safety of its users and/or the general public.

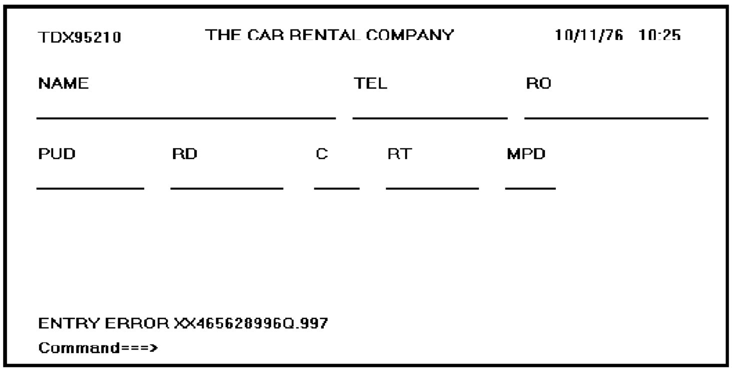
The Benefits of Good Design

- Imagine the productivity benefits we could gain through proper design. Based on an actual system that requires processing of 4.8 million screens per year, an analysis established that if poor clarity forced screen users to spend one extra second per screen, almost one additional person-year would be required to process all screens. Twenty extra seconds in screen usage time adds an additional 14 person-years.
- 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. Separate items, which had been combined on the same display line to conserve space, were placed on separate lines instead. The result: Screen users were about 20 percent more productive with the less crowded version.
- Other researchers reformatted a series of screens. 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 studies have also shown that the proper formatting of information on screens does have a significant positive effect on performance. Cope and Uliano (1995) found that one graphical window redesigned to be more effective would save a company about $20,000 during its first year of use.

- In recent years the productivity benefits of well-designed Web pages have also been scrutinized. Baca and Cassidy (1999) redesigned an organization's homepage because users were complaining they were unable to find information they needed. These designers established a usability objective specifying that after redesign users should be able to locate the desired information 80 percent of the time.
- Additional 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 from the improved service they receive.
- Identifying and resolving problems during the design and development process also has significant economic benefits. Pressman (1992) has shown that for every dollar spent fixing a problem during product design, $10 would be spent if the problem was fixed during development, and $100 would be spent fixing it after the product's release. A general rule of thumb: Every dollar invested in system usability returns $10 to $100 (IBM, 2001).

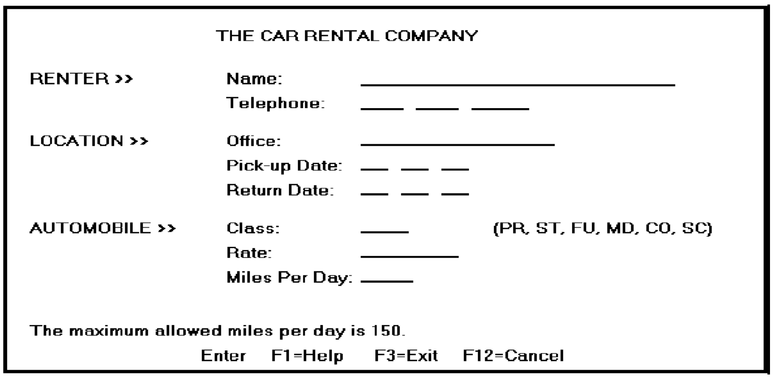
A Brief History of Screen Design

- While developers have been designing screens since a cathode ray tube display was first attached to a computer, more widespread interest in the application of good design principles to screens did not begin to emerge until the early 1970s, when IBM introduced its 3270 cathode ray tube text-based terminal.
- The 3270 was used in extremely number of ways in the office, and company-specific guidelines for good screen design occasionally began to surface (e.g., Galitz and DiMatteo, 1974).
- A1970s screen often resembled the one shown in Figure.

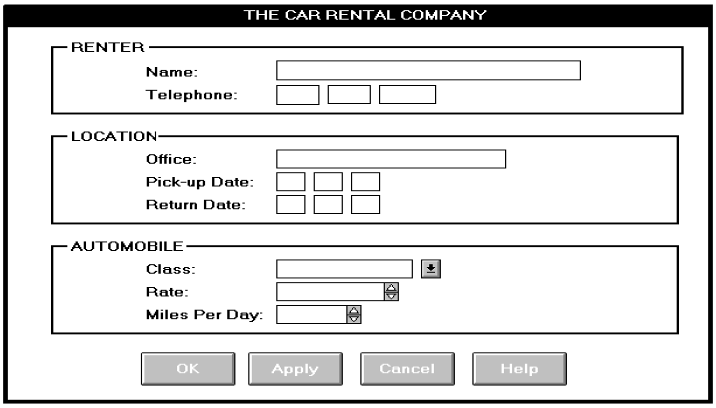


- It usually consisted of many fields with very cryptic and often unintelligible captions. It was visually cluttered and often possessed a command field that challenged the user to remember what had to be keyed into it.
- Effectively using this kind of screen required a great deal of practice and patience. Most early screens were monochromatic, typically presenting green text on black backgrounds.

- At the turn of the decade, guidelines for text-based screen design were finally made widely available (Galitz, 1980, 1981) and many screens began to take on a much less cluttered look through concepts such as grouping and alignment of elements, as shown in Figure.



- User memory was supported by providing clear and meaningful field captions and by listing commands on the screen, and enabling them to be applied through function keys. Messages also became clearer. These screens were not entirely clutter-free, however. Instructions and reminders to the user had to be inscribed on the screen in the form of prompts or completion aids such as the codes PR and SC.
- The advent of graphics yielded another milestone in the evolution of screen design, as shown in Figure.



- While some basic design principles did not change, such as groupings and alignment, borders were made available to visually enhance groupings, and buttons and menus for implementing commands replaced function keys.
- Multiple properties of elements were also provided, including different font sizes and styles, line thickness, and colors. The entry field was supplemented by many other kinds of controls, including list boxes, drop-down combination boxes, spin boxes, and so forth.
- These new controls were much more effective in supporting a person’s memory, now simply allowing for selection from a list instead of requiring a remembered key entry. Screens could also be simplified, the much more powerful computers being able to quickly present a new screen.

The Graphical User Interface:

- A *user interface*, is a collection of techniques and mechanisms to interact with something. In a *graphical* interface, the primary interaction mechanism is a pointing device. This device is the electronic equivalent to the human hand. What the user interacts with is a collection of elements referred to as *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. Graphic screens assumed a three-dimensional look.
- Information floated in windows, small rectangular boxes that seemed to rise above the background plane. Windows could also float above other windows. Controls appeared to rise above the screen and move when activated. Lines appeared to be etched into the screen.
- Information could appear and disappear as needed, and in some cases text could be replaced by graphical images called icons. These icons could represent objects or actions.
- Screen navigation and commands are executed through menu bars and pull-down menus.Menus "pop up" on the screen.
- In the screen body, selection fields such as radio buttons, check boxes, list boxes, and palettes coexisted with the reliable old text entry field. More sophisticated text entry fields with attached or drop-down menus of alternative options also became available.
- Screen objects and actions are typically selected through use of pointing mechanisms, such as the mouse or joystick, instead of the traditional keyboard.
- Increased computer power and the vast improvement in the display enable a system to react to the user's actions quickly, dynamically, and meaningfully. This new interface was characterized as representing one's "desktop" with scattered notes, papers, and objects such as files, trays, and trash cans arrayed around the screen. It is sometimes referred to as the WIMP interface: windows, icons, menus, and pointing device.
- Graphic presentation of information utilizes a person's information-processing capabilities much more effectively than other presentation methods. Properly used, it reduces the requirement for perceptual and mental information recoding and reorganization, and also reduces the memory loads.
- It permits faster information transfer between computers and people by permitting more visual comparisons of amounts, trends, or relationships; more compact representation of information; and simplification of the perception of structure.
- Graphics also can add appeal or charm to the interface and permit greater customization to create a unique corporate or organization style.

The Concept of Direct Manipulation

The term used to describe graphical systems with this style of interaction 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**.
- It is assumed that a person is already familiar with the objects and actions in his or her environment of interest. The system simply replicates them and portrays them on a different medium, the screen.
- A person has the power to access and modify these objects, including windows.
- 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.
- **Objects and actions are continuously visible**.
- Reminders of actions to be performed are also obvious, where labeled buttons replace complex syntax and command names.
- Cursor action and motion occurs in physically obvious and intuitively natural ways. 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). Rutkowski (1982) described it as *transparency*, where one's intellect is applied to the task, not the tool.
- One problem in direct manipulation, however, is that there is no direct analogy on the desk for all necessary windowing operations. A piece of paper on one's desk maintains a constant size, never shrinking or growing. Windows can do both. Solving this problem required embedding a control panel. This control panel is manipulated, not the window itself.
- **Actions are rapid and incremental with visible display of results**.
- Because tactile feedback is not yet possible, 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

Earlier Direct Manipulation Systems

- The concept of direct manipulation actually preceded the first graphical system. The earliest full-screen text editors possessed similar characteristics.
- Screens of text resembling a piece of paper on one's desk could be created (extension of real world) and then reviewed in their entirety (continuous visibility).
- Editing or restructuring could be easily accomplished (through rapid incremental actions) and the results immediately seen. Actions could be reversed when necessary. It took the advent of graphical systems to crystallize the direct manipulation concept, however.

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 of 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. Most window systems are a combination of both direct and indirect manipulation. A menu may be accessed by pointing at a menu icon and then selecting it (direct manipulation). The menu itself, however, is a textual list of operations (indirect manipulation).
- When an operation is selected from the list, by pointing or typing, the system executes it as a command.

Graphical Systems: Advantages and Disadvantages

The simplified interface reduce the memory requirements of the user, make more effective use of one's information-processing capabilities, and reduce system learning requirements.

Advantages

The success of graphical systems has been attributed to a host of factors. The following have been commonly referenced as advantages of these systems:

- **Symbols recognized faster than text**. Research has found that symbols can be recognized faster and more accurately than text, and that the graphical attributes of icons, such as shape and color, are very useful for quickly classifying objects, elements, or text by some common property.
- **Faster learning**. Research has also found that a graphical, pictorial representation aids learning, and symbols can also be easily learned.
- **Faster use and problem solving**. Visual 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**. Graphic representations of objects are thought to be more natural and closer to innate human capabilities.
- **Exploits visual/spatial cues**. Spatial relationships are usually understood more quickly than verbal representations. Visual thinking is believed to be better than logical thinking.
- **Fosters more concrete thinking**. Displayed objects are directly in the high-level task domain, or directly usable in their presented form. There is no need mentally to decompose tasks into multiple commands with complex syntactic form. The need for abstract thinking is minimized.
- **Provides context**. Displayed objects are visible, providing a picture of the current context.
- **Fewer errors**. More concrete thinking affords fewer opportunities for 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 and hastens system mastery.
- **Immediate feedback**. The results of actions furthering user goals can be seen immediately. Learning is quickened. 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**. The user has more control. This ability to reverse unwanted actions also increases user confidence and hastens system mastery.

- **Less anxiety concerning use**. New users feel less anxiety when using the system because it is so easily comprehended, is easy to control, and has predictable responses and reversible actions.
- **More attractive**. Direct-manipulation systems are more entertaining, clever, and appealing.
- **May consume less space**. Icons may take up less space than the equivalent in words. More information can often be packed in a given area of the screen.
- **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.
- **Smooth transition from command language system**. Moving from a command language to a direct-manipulation system has been found to be easy. The reverse is not true.

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.

- **Greater design complexity**. The elements and techniques available to the graphical screen designer far outnumber those that were at the disposal of the text-based screen designer. Controls and basic alternatives must be chosen from a pile of choices (> 50).
- **Learning still necessary**. The first time one encounters many graphical systems, what to do is not immediately obvious. The user may not know the meanings of many words and icons. The user may also have to learn how to use a pointing device.
- **Lack of experimentally-derived design guidelines**. The graphical interface is still burdened today by a lack of widely available experimentally-derived design guidelines.
- **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. These inconsistencies occur because of copyright and legal implications, product differentiation considerations, and our expanding knowledge of the interface.
- **Working domain is the present**. While direct-manipulation systems provide context, they also require the user to work in the present.

- **Not always familiar**. Symbolic representations may not be as familiar as words or numbers. Research has found that numeric symbols elicit faster responses than graphic symbols in a visual search task.
- **Human comprehension limitations**. Human limitations may also exist in terms of one's ability to deal with the increased complexity of the graphical interface. The number of different icons that can be introduced is also restricted because of limitations in human comprehension. The motor skills required may also challenge all but the most sophisticated users. Correctly double-clicking a mouse, for example, is difficult for some people.
- **Window manipulation requirements**. Window handling and manipulation time are still excessive and repetitive.
- **Production limitations**. The number of symbols that can be clearly produced using today's technology is still limited.
- **Few tested icons exist**. Icons, like typefaces, must appear in different sizes, weights, and styles. 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. Moving a mouse or some other pointing mechanism may be slower.
- **Inefficient for expert users**. Inefficiencies develop when there are more objects and actions than can fit on the screen. Concatenation for a command language is impossible.
- **Not always the preferred style of interaction**. Not all users prefer a pure iconic interface.
- **Not always fastest style of interaction**. Another study has found that graphic instructions on an automated bank teller machine were inferior to textual instructions.
- **Increased chances of clutter and confusion**. A graphical system does not guarantee elimination of clutter on a screen. Instead, the chance for clutter is increased, thereby increasing the possibility of confusion.
- **The futz and fiddle factor**. With the proliferation of computer games, computer usage can be wasteful of time. Experts have said that the most used program in Microsoft Windows is Solitaire! Futzing and fiddling does have some benefits, however. It is a tool for learning how to use a mouse, for example, and it is a vehicle for exploring the system and becoming familiar with its capabilities. It is of value when done in moderation.
- **May consume more screen space**. Not all applications will consume less screen space.
- **Hardware limitations**. Good design also requires hardware of adequate power, processing speed, screen resolution, and graphic capability. Insufficiencies in these areas can prevent a graphic system's full potential from being realized.

Characteristics of the Graphical User Interface

- A graphical system possesses a set of defining concepts that includes sophisticated visual presentation, pick-and-click interaction, a restricted set of interface options, visualization, object orientation, use of a person's recognition memory, and concurrent performance.
- ***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 display of 16 million or more colors is possible on some screens. Graphics also permit animation and the presentation of photographs and motion video.
  - The meaningful interface elements visually presented to the user in a graphical system include windows, menus, icons to represent objects such as programs or files, assorted screen-based controls, a mouse or other pointing device, and the 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***
  - Elements of a graphical screen upon which some action is to be performed must first be identified. The motor activity required of a person to identify this element for a proposed action is commonly referred to as *pick*, and 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. The user moves the mouse pointer to the relevant element (pick) and the action is signaled (click).
  - The secondary mechanism for performing these selection actions is the keyboard. Most systems permit pick-and-click to be performed using the keyboard as well.
- ***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, nothing more. This concept fostered the acronym WYSIWYG.
- ***Visualization***
  - Visualization is a cognitive process that enables people to understand information that is difficult to perceive, because it is either too voluminous or too abstract.
  - Presenting specialized graphic facilitates visualization. The best visualization method for an activity depends on what people are trying to learn from the data.
  - Effective visualizations can facilitate mental insights, increase productivity, and more accurate use of data.

- ***Object Orientation***

- A graphical system consists of objects and actions. *Objects* are what people see on the screen. They are manipulated as a single unit. Objects can be composed of *subobjects*.
- IBM's System Application Architecture Common User Access (SAA CUA) Advanced Interface Design Reference (SAA CUA) (IBM, 1991) breaks objects into three meaningful classes: **data, container, and device.**
- *Data objects* present information. This information, either text or graphics, normally appears in the body of the screen.
- *Container objects* are objects that hold other objects. They are used to group two or more related objects for easy access and retrieval. There are three kinds of container objects: the workplace, folders, and workareas. The *workplace* is the desktop, the storage area for all objects. *Folders* are general-purpose containers for long-term storage of objects. *Workareas* are temporary storage folders used for storing multiple objects currently being worked on.
- *Device objects* represent physical objects in the real world, such as printers .These objects may contain others for acting upon. A file, may be placed in a printer for printing of its contents.
- Microsoft Windows specifies the characteristics of objects depending upon the relationships that exist between them. 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.
- A *collection* is the simplest relationship — the objects sharing a common aspect. A collection might be the result of a query or a multiple selection of objects.
- A *constraint* is a stronger object relationship. Changing an object in a set affects some other object in the set. A document being organized into pages is an example of a constraint.
- A *composite* exists when the relationship between objects becomes so significant that the aggregation itself can be identified as an object. Examples include a range of cells organized into a spreadsheet, or a collection of words organized into a paragraph.
- A *container* is an object in which other objects exist. Examples include text in a document or documents in a folder.
- Another important object characteristic is *persistence*. Persistence is the maintenance of a state once it is established.

Properties or Attributes of Objects

- Objects also have properties or attributes. Properties are the unique characteristics of an object. Properties help to describe an object and can be changed by users. Examples of properties are text styles (such as normal or italics), font sizes (such as 10 or 12 points), or window background colors (such as black or blue).

- **Actions**

- In addition to objects, there are actions. People take actions on objects. They manipulate objects in specific ways (commands) or modify the properties of objects (property or attribute specification).
- *Commands* are actions that manipulate objects. They may be performed in a variety of ways, including direct manipulation or a command button.
- *Property/attribute specification* actions establish or modify the attributes or properties of objects. The following is a typical property/attribute specification sequence:
  1. The user selects an object such as several words of text.
  2. The user then selects an action to apply to that object, such as the action Bold.
  3. 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 the following:

  Action> 1. The user opens an application such as word processing.

  Object> 2. The user then selects a file or other object such as a memo.
- An object-oriented object:action approach does the following:

  Object> 1. The user chooses an object such as a memo.

  Action> 2. The user then selects an application such as 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.

  Composed views present information and the objects contained within an object. They are typically associated with data objects and are specific to tasks and products being worked with. *Contents* views list the components of objects. *Settings* views permit seeing and changing object properties. *Help* views provide all of the help functions.

- ***Use of Recognition Memory***

- Continuous visibility of objects and actions encourages use of a person's more powerful recognition memory. This eliminates the "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. When a system is not busy on a primary task, it may process background tasks (cooperative multitasking).
- Data may also be transferred between programs. It may be temporarily stored on a clipboard for later transfer or automatically swapped between programs.

The Web User Interface

- Initially, Web interface design was essentially the design of navigation and the presentation of information. It was about content, not data. In recent years dual focus has emerged the design of Web applications.
- Applications previously developed for use on graphical systems have increasingly migrated to the Web for their foundation. Content- or information-focused interface design is typically called *Web page* design. An application-focused interface is usually referred to as *Web application* design.
- Web page 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 page is a navigation environment where people move frequently between pages of information.
- A Web application is usually designed to collect and process data. Applications typically consume most or all of a screen, and can monopolize the user's attention for a long period of time. Applications also may be kept up and running continuously.
- The dividing line between page and application design is not always clear. In general, however, a Web page's design intent is to mostly provide information. An application is designed to let a person do and save something.
- Web interface design is difficult for several reasons.
- First, its underlying design language, HTML, was never intended for creating screens to be used by the general population. HTML was limited in objects and interaction styles, and did not provide a means for presenting information in the most effective way for people.
- Second, browser navigation retreated to the pre-GUI era. This era was characterized by a "command" field whose contents had to be learned, and a navigational organization and structure that lay hidden beneath a mostly dark and blank screen.
- A third reason that Web page interface design is more difficult is 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 also more difficult because users are ill defined and have greatly variable characteristics. The user's tools are also very variable in nature.

The Popularity of the Web

- While the introduction of the graphical user interface revolutionized the user interface, the Web revolutionized computing. It enables millions of people scattered across the globe to communicate, access information, publish, and be heard.
- It enables people to control much of the display and the rendering of Web pages. People can also change aspects such as typography and colors, turn off graphics, decide whether or not to transmit certain data over non-secure channels, and accept or refuse cookies. Nowhere in the history of computing has the user been given so much control. Web usage has reflected this popularity.
- The number of Internet hosts has risen dramatically. In 1984 hosts online exceeded 1,000; in 1987, 10,000; in 1989, 100,000; in 1990, 300,000; in 1992 hosts exceeded one million.
- Commercialization of the Internet saw even greater expansion of the growth rate. In 1993, Internet traffic was expanding at a 341,634 percent annual growth rate. In 1996, there were nearly 10 million hosts online and 40 million connected people (PBS Timeline). In 2005 the number of Internet hosts exceeded 350 million (Zakon.org, 2006), the number of users one billion (Nielsen, 2005g).
- The largest percentage of Internet users are in the Asia/Pacific region (36%) according to Morgan Stanley (2005). Percentage of users in other world regions are Europe (24%), North America (23%), South America (5%), and the rest of the world (12%).
- User control has had some decided disadvantages for some Web site owners as well. 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 result in user abandonment of the site for others with a more agreeable interface. People are quick to vote with their mouse, and these warnings should not go unheeded.

Characteristics of a Web Interface

- A Web interface possesses many characteristics, some similar to a GUI interface.

  GUI versus Web Page Design

- GUI and Web interface design are similar. Both are software designs, they are used by people, they are interactive, they are heavily visual experiences presented through screens, and they are composed of many similar components.

	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/ Information	Typically created and used by known and trusted sources. Properties generally known. Typically placed into system by users or known people and organizations. Typically organized in a meaningful fashion. A notion of private and shared data exists.	Full of unknown content. Source not always trusted. Often not placed onto the Web by users or known people and organizations. Highly variable organization. Privacy often suspect.
User Tasks	Install, configure, personalize, start, use, and upgrade programs. Open, use, and close data files. Fairly long times spent within an application. Familiarity with applications often achieved.	Link to a site, browse or read pages, fill out forms, register for services, participate in transactions, download and save things. Movement between pages and sites very rapid. Familiarity with many sites not established.
User's Conceptual Space	Controlled and constrained by program.	Infinite and generally unorganized.
Presentation Elements	Windows, menus, controls, data, toolbars, messages, and so on. Many transient, dynamically appearing and disappearing. Presented as specified by designer. Generally standardized by toolkits and style 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 specifications. Little standardization.

	GUI	WEB
Navigation	Through menus, lists, trees, dialogs, and wizards. Not a strong and visible concept. Constrained by design. Generally standardized by toolkits and style guides.	Through links, bookmarks, and typed URLs. Significant and highly visible concept. Few constraints, frequently causing a lost "sense of place." Few standards. Typically part of page design, fostering a lack of consistency.
Context	Enables maintenance of a better sense of context. Restricted navigation paths. Multiple viewable windows.	Poorer maintenance of a sense of context. Single-page entities. Unlimited navigation paths. Contextual clues become limited or are difficult to find.
Interaction	Interactions such as clicking menu choices, pressing buttons, selecting list choices, and cutting/copying/pasting 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.
Visual Style	Typically prescribed and constrained by toolkits. Visual creativity allowed but difficult. Little significant personalization.	Fosters a more artistic, individual, and unrestricted presentation style. Complicated by differing browser and display capabilities, and bandwidth limitations. Limited personalization available.
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. Limited only 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 everyone.

	GUI	WEB
Consistency	Major objective exists within and across applications. Aided by platform toolkit and design guidelines. Universal consistency in GUI products generally created through toolkits and design guidelines.	Sites tend to establish their own identity. Standards frequently set within a site. Frequent ignoring of GUI guidelines for identical components, especially controls.
User Assistance	Integral part of most systems and applications. Accessed through standard mechanisms. Documentation, both online and offline, usually provided. Personal support desk also usually provided.	No similar help systems. The little available help is built into the page. Customer service support, if provided, oriented to product or service offered.
Integration	Seamless integration of all applications into the platform environment a major objective. Toolkits and components are key elements in accomplishing this objective.	Apparent for some basic functions within most Web sites (navigation, printing, and so on). 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 not understood by average users. When employed, may have function-limiting side effects.
Reliability	Tightly controlled in business systems, proportional to degree of willingness to invest resources and effort.	Susceptible to disruptions caused by user, telephone line and cable providers, Internet service providers, hosting servers, and remotely accessed sites.

Printed Pages versus Web Pages

CONCEPT	PRINTED PAGES	WEB PAGES
Page size	• Large and fixed in size.	• Web pages are small and variable • Varies according to the user's browser, monitor.
Page rendering (availability)	• Printed pages are presented as complete entities, and their entire contents.	• Web pages elements are often rendered slowly. • Dozens of seconds may be consumed waiting for a page to completely appear.
Page layout	• The format of printed page is precise keeping. The user focused on it.	• The format of web page is estimated with less designing principles and features of user's technologies.
Page resolution	• The intent of print characters is fast and useful as we can read the document fast.	• The purpose of screen character is not much useful and is rendered slowly.
User focus	• The printed pages provides well furnished complete information	• The web pages provide separate information in pieces to the users.
Page navigation	• Navigating printed materials is as simple as page turning	• Navigating the Web requires innumerable decisions concerning
Interactivity	• Design allows the users to move their eyes over fixed content	• Web page design permits the users to use their hands for scrolling, pointing, etc.,
Page independence	• The pages are dependent on one another.	• Independent

Principles of User Interface Design

- An interface must really be just an extension of a person. This means that the system and its software must reflect a person's capabilities and respond to his or her specific needs.
- The interface 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
- Many principles are based on research, others on the collective thinking of behaviorists working with user interfaces

Principles for the Xerox STAR

- The design of the Xerox STAR was guided by a set of principles that evolved over its lengthy development process (Smith, et al., 1982; Verplank, 1988). These principles established the foundation for graphical interfaces and are as follows:
- **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. Verplank called this "graphics with handles on it."
- **Visual order and viewer focus**. Attention must be drawn, at the proper time, to the important and relevant elements of the display. Effective visual contrast between various components of the screen is used to achieve this goal
- **Revealed structure**. The distance between one's intention and the effect must be minimized.
- **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.
- **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 fundamental to the design and implementation of all effective interfaces, including both GUI and Web.
- ***Accessibility:*** Systems should be designed to be usable, without modification, by as many people as possible.
- ***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.
- ***Availability***
  - Make all objects available at all times.
  - Avoid the use of modes.
- ***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.
- ***Configurability:*** ■ Permit easy personalization, configuration, and reconfiguration of settings to do the following:
  - Enhance a sense of control.
  - Encourage 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.

- ***Control:***
  - The user must control the interaction.
  - 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 because 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.
  - Provide constructive messages when an error does occur.
- ***Immersion***
  - Foster immersion within tasks.

- ***Obviousness:*** A system should be easily learned and understood. A user should know the following:
  - What to look at
  - What it is
  - 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.
- ***Operability:*** Ensure that a system's design can be used by everyone, regardless of physical abilities.
- ***Perceptibility:*** Assure that a system's design can be perceived, regardless of a person's sensory abilities.
- ***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.
  - Do not bundle or combine actions.
- All expectations should be fulfilled uniformly and completely.
- ***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.
- ***Safety:*** Protect the user from making mistakes.
  - Provide visual cues, reminders, lists of choices, and other aids either automatically or upon request.

- ***Simplicity:***
  - Provide as simple an interface as possible.
  - Ways to provide simplicity:
  - Use progressive disclosure, hiding things until they are needed.
  - Provide an obvious visual hierarchy.
  - Provide defaults.
  - Minimize screen alignment points.
  - Make common actions simple at the expense of uncommon actions being made harder.
  - Provide uniformity and consistency.
  - Eliminate unnecessary elements.
- ***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.
- ***Visibility:***
  - A system's status and methods of use must be clearly visible.
  - Improve visibility through:
  - Hierarchical organization.
  - Context sensitivity.