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| **Module I Introduction** | |
| The user interface is the most important part of any computer system as it is the system to most users. It can be seen, it can be heard, and it can be touched. The piles of software code are invisible, hidden behind phosphor, keyboards, and the mouse. The goals of interface design are simple, to make working with a computer easy, productive, and enjoyable. | |
| **The Importance of the 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 or “gooey.” Almost every graphical platform now provides a style guide to assist in product design. Software to aid the GUI design process proliferates. Hard on the heels of GUIs has come the amazingly fast intrusion of the World Wide Web into the everyday lives of people. Web site design has greatly expanded the range of users and introduced additional interface techniques such as multimedia. (To be fair, in some aspects it has dragged interface design backwards as well, but more about that later.) It is said that the amount of programming code devoted to the user interface now exceeds 50 percent. Looking backwards, we have made great strides in interface design. Looking around today, however, too many instances of poor design still abound. Looking ahead, it seems that much still remains to be done | |
| **Defining the User Interface** | |
| **User interface design** | |
| **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. Technical characteristics and limitations of the computer hardware and software must also be considered | |
| **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** | |
| **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), and one’s voice (for spoken instructions). | |
| **Output** | |
| **Output** is how the computer conveys the results of its computations and requirementsto the user. Today, the most common computer output mechanism is the display screen, followed by mechanisms that take advantage of a person’s auditory capabilities: voice and sound. The use of the human senses of smell and touch output in interface design still remain largely unexplored. 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 best interface is one that it not noticed, one that permits the user to focus on the information and task | |
| **The Importance of Good Design** | |
| A well-designed interface and screen is terribly important to our users. It is their window to view the capabilities of the system. To many, it is the system, being one of the few visible components of the product we 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 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. I’ve heard of one user who relieved his frustrations with his computer with a couple of well-aimed bullets from a gun. I recently heard of another who, in a moment of extreme exasperation and anger, dropped his PC out of his upper-floor office window. | |
| **The Benefits of Good Design** | |
| Imagine the productivity benefits we could gain through proper design. Based on an actual system requiring processing of 4.8 million screens per year and illustrated in Table 1.1, 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. Separate items, which had been combined on the same display line to conserve space, were placed on separate lines instead. Theresult: screen users were about 20 percent more productive with the less-crowded version. Other researchers reformatted a series of screens following many of the same concepts to be described in this book. The result: screen users of the modified screens completed transactions in 25 percent less time and with 25 percent fewer errors thanthose 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. In a second study comparing 500screens, it was found that the time to extract information from displays of airline or lodging information was 128 percent faster for the best format than for the worst.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 companyabout $20,000 during its first year of use | |
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| **Producivity benefits of well designed pages** | |
| **In recent years, the productivity benefits of well-designed Web pages have also been scrutinized.** | |
| **(i)Baca and Cassidy (1999)** redesigned an organization’s home page 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. After one redesign, 73 percent of the searches were completed with an average completion time of 113 seconds. Additional redesigns eventually improved the success rate to 84 percent, and reduced the average completion time to 57 seconds. | |
| **(ii) Fath and Henneman (1999)** evaluated four Web sites commonly used for online shopping. Participants performed shopping tasks at each site. In three of the Web sites only about one-half of the shopping tasks could be completed, in the fourth 84 percent were successful. (In the former, one-third of the shopping tasks could not be completed at all.) The more successful, and more usable, site task completion rate was about 65 percent higher than that of the less successful sites | |
| **(iii) 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 usability returns $10 to $100 (IBM, 2001). | |
| **A Brief History of the Human-Computer Interface** | |
| The need for people to communicate with each other has existed since we first walked upon this planet. | |
| **First Level of Communication** | |
| The lowest and most common level of communication modeswe share are movements and gestures. Movements and gestures are language-independent, that is, they permit people who do not speak the same language to dealwith one another. | |
| **Next Higher Level of Communication** | |
| The next higher level, in terms of universality and complexity, is spoken language. Most people can speak one language, some two or more. A spoken language is a veryefficient mode of communication if both parties to the communication understand it | |
| **Third Level of Communication** | |
| At the third and highest level of complexity is written language. While most people speak, not all can write. But for those who can, writing is still nowhere near as efficienta means of communication as speaking.In modern times, we have the typewriter, another step upward in communicationcomplexity. Significantly fewer people type than write. (While a practiced typist canfind typing faster and more efficient than handwriting, the unskilled may not find thisthe case.) Spoken language, however, is still more efficient than typing, regardless oftyping skill level | |
| **Conclusion** | |
| Through its first few decades, a computer’s ability to deal with human communication was inversely related to what was easy for people to do. The computer demanded rigid, typed input through a keyboard; people responded slowly using this device and with varying degrees of skill. The human-computer dialog reflected the computer’s preferences, consisting of one style or a combination of styles using keyboards, commonly referred to as Command Language, Question and Answer, Menu Selection, Function Key Selection, and Form Fill-In. For more details on the screens associated with these dialogs see Galitz (1992).Throughout the computer’s history, designers have been developing, with varying degrees of success, other human-computer interaction methods that utilize more general, widespread, and easier-to-learn capabilities: voice and handwriting. Systems that recognize human speech and handwriting now exist, although they still lack the universality and richness of typed input. | |
| **Introduction of the Graphical User Interface** | |
| **(i)**In the 1970s, Research at Xerox’s Palo Alto Research Center provided an alternative to the typewriter, an interface using a form of human gesturing, the most basic of all human communication methods | |
| **(ii))** The Xerox systems, Altus and STAR, introduced the mouse and pointing and selecting as the primary human-computer communication method. The user simply pointed at the screen, using the mouse as an intermediary. These systems also introduced the graphical user interface as we know it today | |
| **(iii)** Ivan Sutherland at the Massachusetts Institute of Technology (MIT) is given credit for first introducing graphics with his Sketchpad program in 1963. Lines, circles, and points could be drawn on a screen using a light pen | |
| Xerox worked on developing handheld pointing devices in the 1960s and patented a mouse with wheels in 1970. | |
| In 1974, Xerox patented today’s ball mouse, after a researcher was suddenly inspired to turn a track ball upside down. Xerox was never able to market the STAR successfully, but Apple quickly picked up the concept and the Macintosh, released in 1984, was the first successful mass-marketsystem | |
| **A new concept was born, revolutionizing the human-computer interface. A chronological history of GUIs is found in Table 1.2.** | |
| **Table 1.2** Chronological History of Graphical User Interfaces | |
| 1973 | |
| Pioneered at the Xerox Palo Alto Research Center Introduced First to pull together all the elements of the modern GUI | |
| **1981** | |
| First commercial marketing as the Xerox STAR Widely introduced pointing, selection, and mouse | |
| **1983** | |
| Apple introduces the List Features pull-down menus and menu bars | |
| 1984 | |
| Apple introduces the Macintosh Macintosh is the first successful mass-marketed system | |
| 1985 | |
| Microsoft Windows 1.0 released Commodore introduces the Amiga 1000 | |
| 1987 | |
| (i)X Window System becomes widely available.  (ii)IBM’s System Application Architecture released Including Common User Access (CUA).  IBM’s Presentation Manager released. Intended as graphics operating system replacement for DOS.  (iii)Apple introduces the Macintosh II The first color Macintosh | |
| 1988 | |
| 1988 NeXT’s NeXTStep released First to simulate three-dimensional screen | |
| 1989 | |
| 1989 UNIX-based GUIs released.  (i)Open Look by AT&T and Sun Microsystems.  (ii)Innovative appearance to avoid legal challenges.  (iii)Motif, for the Open Software Foundation by DEC andHewlett-Packard.  (iv) Appearance and behavior based on Presentation Manager Microsoft Windows 3.0 released | |
| **1992** | |
| (i)OS/2 Workplace Shell released.  (ii)Microsoft Windows 3.1 released | |
| **1993** | |
| Microsoft Windows NT released | |
| 1995 Microsoft Windows 95 released.  1996 IBM releases OS/2 Warp 4.  Microsoft introduces NT 4.0.  1997 Apple releases the Mac OS 8.  1998 Microsoft introduces Windows 98.  1999 Apple releases Mac OS X Server A UNIX-based OS.  2000 Microsoft Windows 2000 released.Microsoft Windows ME released  2001 Microsoft Windows XP released | |
| **The Blossoming of the World Wide Web** | |
| **Table 1.3** Chronological History of the Internet | |
| 1945 | Hypertext concept presented by Vannear Bush |
| 1960 | J. C. R. Licklider of MIT proposes a global network of computers |
| 1962 | Design and development begins on network called ARPANET |
| 1969 | ARPANET is brought online which connects computers at four major universities.  Additional universities and research institutions soon added to the network. |
| 1973 | ARPANET goes international |
| 1974 | Bolt, Beranek and Newman releases Telnet.  The first commercial version of ARPANET |
| 1976 | University of Vermont’s PROMIS released.  The first hypertext system released to the user community |
| 1982 | The term Internet is coined |
| 1983 | TCP/IP architecture now universally adopted |
| 1988 | Apple’s HyperCard released which presents the hypertext idea to a wider audience.  The first Internet unleashed |
| 1989 | Tim Berners-Lee and others at the European Laboratory for Particle Physics  (CERN) propose a new protocol for distributing information based upon hypertext |
| 1990 | HTML created In conjunction with Berners-Lees protocol.  ARPANET is decommissioned  Berners-Lee’s work is credited with hatching the World Wide Web.  Gopher developed the first friendly interface at the University of Minnesota |
| 1992 | Delphi released.  First to provide commercial online Internet access to subscribers.  Mosaic created by the National Center for Supercomputing Applications  (NCSA) at the University of Illinois.  The first popular graphic-based hypertext browser |
| 1994 | Netscape Navigator Version 1.0 released.  World Wide Web Consortium founded.  To promote and develop Web standards. |
| 1995 | Microsoft Internet Explorer Versions 1.0 and 2.0 released.  AOL, CompuServe, Prodigy, Yahoo, and Lycos come online.  National Science Foundation ends Internet support.  HTML 2.0 approved as proposed Web standard.  Netscape Navigator Versions 2.0 and 3.0 released.  Microsoft Internet Explorer Version 3.0 released.  Opera Version 2.1 released.  Browser for computers with small resources.  Written from scratch (not based upon Mosaic).  Version 2.1 the first widely available.  HTML 3.2 draft released.  NCSA halts development of Mosaic.  Netscape Navigator Version 4.0 released.  Microsoft Internet Explorer Version 4.0 released.  Opera Version 3.0 released.  HTML 4.0 certified as proposed standard.  Microsoft Internet Explorer Version 5.0 released.  XHTML 1.0 first working draft released. |
| **Characteristics of Graphical and Web User Interfaces** | |
| **The Graphical User Interface** | |
| **Introduction** | |
| The graphical user interface differed significantly from its text-based forefather 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. This device is the electronic equivalent to the human hand. 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. All objects have standard resulting behaviors. | |
| **The Popularity of Graphics** | |
| Graphics revolutionized design and the user interface. A graphical screen bore scant resemblance to its earlier text-based colleagues. Whereas the older text-based screen possessed a one-dimensional, text-oriented, form-like quality, graphic screens assumed a three-dimensional look. Information floated in windows, small rectangular boxes 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-downs. 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 alternatives also became available. Screen objects and actions were 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 the user’s actions to be reacted to quickly, dynamically, and meaningfully. This new interface is characterized as representing one’s “desktop” with scattered notes, papers, and objects such as files, trays, and trashcans arrayed around the screen. It is sometimes referred to as the WIMP interface: windows, icons, menus, and pointers. 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 | |
| **Direct and Indirect Manipulation Methods** | |
| **Concept of Direct Manipulation** | |
| **Concept of Direct Manipulation is best explained by the means of its characteristics** | |
| **(i)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. A person has the power to access and modify these objects, among which are 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. | |
| **(ii) Continuous visibility of objects and actions** | |
| Like one’s desktop, objects are continuously visible. Reminders of actions to be performed are also obvious, labeled buttons replacing complex syntax and command names. Cursor action and motion occurs in physically obvious and intuitively natural ways. Nelson Based on the concept of “virtual reality,” a representation of reality that can be manipulated and also WYSIWYG” (what you see is what you get) | |
| **(iii) Actions are rapid and incremental with visible display of results.** | |
| Since tactile feedback is not yet possible (as would occur with one’s hand when one touches something), the results of actions are immediately displayed visually on the screen in their new and current form. Auditory feedback may also be provided. | |
| (iv) **Incremental actions are easily reversible** | |
| Finally, actions, if discovered to be incorrect or not desired, can be easily undone | |
| **Indirect Manipulation Methods** | |
| **Introduction** | |
| In practice, direct manipulation of *all* screen objects and actions may not be feasible because of the following: | |
| (i)The operation may be difficult to conceptualize in the graphical system.  (ii)The graphics capability of the system may be limited.  (iii)The amount of space available for placing manipulation controls in the window border may be limited  (iv) It may be difficult for people to learn and remember all the necessary operations and actions | |
| **Henceforth 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. Which style of interaction—direct manipulation, indirect manipulation, or a combination of both—is best, under what conditions and for whom, remains a question whose answer still eludes us | |
| **Graphical Systems: Advantages and Disadvantages** | |
| Graphical systems burst upon the office with great promise. The simplified interface they presented was thought to reduce the memory requirements imposed on the user, make more effective use of one’s information-processing capabilities, and dramatically reduce system learning requirements. Experience indicates that for many people theyhave done all these things | |
| **Advantages** | |
| **(i) 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. An example of a good classification scheme that speeds up recognition are the icons developed for indicating the kind of message being presented to the user of the system. The text of an informational message is preceded by an “i” in a circle, a warning message by an exclamation point, and a critical message by another unique symbol. These icons allow speedy recognition of the type of message being presented | |
| (ii) **Faster learning.** | |
| Research has also found that a graphical, pictorial representation aids learning, and symbols can also be easily learned | |
| (iii) **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. Symbols have also been found to be effective in conveying simple instructions | |
| (iv) **Easier remembering** | |
| Because of greater simplicity, it is easier for casual users to retain operational concepts | |
| (v)**More natural** | |
| Graphic representations of objects are thought to be more natural and closer to innate human capabilities. In human beings, actions and visual skills emerged before languages. It has also been suggested that symbolic displays are more natural and advantageous because the human mind has a powerful image  memory | |
| (vi) **Exploits visual/spatial cues.** | |
| Spatial relationships are usually found to be understood more quickly than verbal representations. Visually thinking is believed to be better than logical thinking | |
| (vii)**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 therefore minimized | |
| **(viii) Provides context** | |
| Displayed objects are visible, providing a picture of the current context | |
| (ix)**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 | |
| (x) **Increased feeling of control.** | |
| The user initiates actions and feels in control. This increases user confidence and hastens system mastery | |
| (xi) **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 | |
| (xii)**Predictable system responses** | |
| Predictable system responses also speed learning | |
| (xiii)**Easily reversible actions** | |
| The user has more control. This ability to reverse unwanted actions also increases user confidence and hastens system mastery | |
| **(xiv)Less anxiety concerning use.** | |
| Hesitant or 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 | |
| (xv)**More attractive** | |
| Direct-manipulation systems are more entertaining, cleverer, and more appealing. This is especially important for the cautious or skeptical user | |
| (xvi)**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. This, however, is not always the case. | |
| (xvii)**Replaces national languages** | |
| Language-based systems are seldom universally applicable. Language translations frequently cause problems in a text-based system. Icons possess much more universality than text and are much more easily comprehended worldwide | |
| (xviii) **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 | |
| (xix)**Low typing requirements** | |
| Pointing and selection controls, such as the mouse or trackball, eliminate the need for typing skill | |
| (xx)**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** | |
| **(i) 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 numbering in excess of 50. (Conversely, alternatives available to the text based screen designer numbered about 15.) This design potential may not necessarily resulting better design, unless the choices are thoughtfully selected and consistently and simply applied. Proper window types must also be chosen and colors selected from a seemingly unending rainbow of alternatives. With graphics, the skill of the designer is increasingly challenged. Poor design can undermine acceptance | |
| (ii)**Learning still necessary** | |
| The first time one encounters many graphical systems, what to do is not immediately obvious. The meanings of many words and icons may not be known. It is not often possible to guess their meanings, especially the more arbitrary symbols. How to use a pointing device may also have to be learned. A severe learning and remembering requirement is imposed on many users, and it takes a while to get up to speed. A text-based system could easily be structured to incorporate a set of clear instructions: (1) Do this, (2) now do this, and so on. System providers estimate that becoming accustomed to a graphical interface should require about eight hours of training. Other experts say the learning time is closer to 20 or 30 hours | |
| (iii) **Lack of experimentally-derived design guidelines** | |
| The graphical interface is still burdened today by a lack of widely available experimentally-derived design guidelines. Early on, more developer interest existed in solving technical rather than usability issues, so few studies to aid in making design decisions were performed. Today, studies being performed in usability laboratories are rarely published. This occurs because of a number of factors. First, builders of platforms and packages will not publish their study results because they want to maintain competitive advantage. If a better way is found to do something, or present something, why tell the competition? Let them make the same mistake, or find the answer themselves. Second, the studies are often specific to a particular function or task. They may not be generally applicable. Third, it takes time and effort to publish something. The developer in today’s office seldom has the time. Finally, it is also difficult to develop studies evaluating design alternatives because of increased GUI complexity. Too many variables that must be controlled make meaningful cause and effect relationships very difficult to uncover. Consequently, there is too little understanding of how most design aspects relate to productivity and satisfaction | |
| **(iv)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 about the interface. The result is that learning, and relearning, for both designers and users is much more difficult than it should be | |
| **(v)Working domain is the present** | |
| While direct-manipulation systems provide context, they also require the user to work in the “present.” Hulteen (1988), in a parody of “WYSIWYG,” suggests “What you see is all you get.” Walker (1989)  Argued that language takes you out of the here and now and the visually present. Language, she continues, makes it easier to find things | |
| **(vi)Not always familiar** | |
| Symbolic representations may not be as familiar as words or numbers. We have been exposed to words and numbers for a long time. Researchers found that numeric symbols elicit faster responses than graphic symbols in a visual search task. One developer had to modify a new system during testing by  Replacing iconic representations with a textual outline format. The users, lawyers, were unfamiliar with icons and demanded a more familiar format | |
| **(vii)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 variety of visual displays can still challenge all but the most sophisticated users. The number of different icons that can be introduced is also restricted because of limitations in human comprehension. Studies continually find that the number of different symbols a person can differentiate and deal with is much more limited than text. Some researchers note that claims for the easy understanding of pictograms are exaggerated, and that recognizing icons requires much perceptual  Learning abstracting ability, and intelligence. 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 | |
| **(viii)Window manipulation requirements**. | |
| Window handling and manipulation time share still excessive and repetitive. This wastes time and interrupts the decision making needed to perform tasks and jobs | |
| **(ix)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 | |
| **(x)Few tested icons exist.** | |
| Icons, like typefaces, must appear in different sizes, weights, and styles. As with text, an entire font of clearly recognizable symbols must be developed. It is not simply a question of developing an icon and simply enlarging or reducing it. Changing an icon’s size can differentially affect symbol line widths,  open areas, and so forth, dramatically affecting its recognizability. Typeface designs literally the product of 300 years of experimentation and study. 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 | |
| **(xi)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 | |
| **(xii)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 | |
| **(xiii)Not always the preferred style of interaction** | |
| Not all users prefer a pure iconic interface A study comparing commands illustrated by icons, icons with text, or text-only, found that users preferred alternatives with textual captions | |
| **(xiv)Not always fastest style of interaction** | |
| Another study has found that graphic instructions on an automated bank teller machine were inferior to textual instructions | |
| **(xv)Increased chances of clutter and confusion.** | |
| A graphical system does not guarantee limitation of clutter on a screen. Instead, the chance for clutter is increased, thereby increasing the possibility of confusion. How much screen clutter one can deal with is open to speculation. The possibility that clutter may exist is evidenced by the fact that many people, when working with a window, expand it to fill the entire display screen. This may be done to reduce visual screen clutter. Mori and Hayashi (1993) found that visible windows, not the focus of attention, degraded performance in the window being worked on | |
| **(xvi)The futz and fiddle factor** | |
| With the proliferation of computer games, computer usage can be wasteful of time. Stromoski (1993) estimates that five hours a week in the office are spent playing and tinkering. Experts have said that the most used program in Microsoft Windows is Solitaire! Tinkering includes activities such as creating garish documents reflecting almost every object property (font size, style, color, and so on.) available.  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 | |
| **(xvii)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 | |
| **(xviii)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 | |
| **Conclusion** | |
| (i)The design of an interface, and not its interaction style, is the best determinant of ease of use.  (ii)User preferences must be considered in choosing an interaction style  (iii)In the overwhelming majority of cases, words are more meaningful to users than icons.  (iv)The content of a graphic screen is critical to its usefulness. The wrong presentation or a cluttered presentation may actually lead to greater confusion, not less.  (v)The success of a graphical system depends on the skills of its designers in following established principles of usability | |
| **Characteristics of the Graphical User Interface** | |
| A graphical system possesses a set of defining concepts. Included are sophisticated visual presentation, pick-and-click interaction, a restricted set of interface options, visualization, object orientation, extensive use of a person’s recognition memory, and concurrent performance of functions | |
| **(i)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. | |
| (ii) **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*, 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. | |
| (iii) **Restricted Set of Interface Option** | |
| 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. | |
| (iv) **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. It involves changing an entity’s representation to reveal gradually the structure and/or function of the underlying system or process. | |
| (v) **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. A well-designed system keeps users focused on objects, not on how to carry out actions. Objects can be composed of sub objects. For example, an object may be a document. The document’s sub objects may be a paragraph, sentence, word, and letter. | |
| **The Web User Interface** | |
| **Popularity** | |
| 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. Aspects such as typography and colors can be changed, graphics turned off, and decisions made whether or not to transmit certain data over non-secure channels or whether to 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 a341,634 percent annual growth rate. In 1996, there were nearly 10 million hosts onlineand 40 million connected people (PBS Timeline).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 undesirablesite features often results in user abandonment of the site for others with amore 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 a number of characteristics, some similar to a GUI interface, and, as has already been shown, some different. In the following paragraphs many of these specific commonalities and differences will be examined. Also, the differing characteristics of printed page design and Web page design will be compared. | |
| **GUI versus Web Page Design** | |
| **(i)Devices** | |
| **In GUI design,** the characteristics of interface devices such as monitors and modems are well defined, and design variations tend to be restricted. Monitor display capabilities, such as installed fonts and screen size, are established and easily considered in the design process. | |
| **In Web design,** no assumptions about the user’s interface devices can be made. User devices may range from handheld mechanisms to high-end workstations. (In GUI design, the difference in screen area between a laptop and a high-end workstation is a factor of six, in Web page design this difference may be as high as 100.) Connection speed bandwidths may also vary by a factor of 1,000. Consequently, WYSIWYG no longer exists in page design | |
| **(ii)User focus** | |
| **GUI**systems are about well-defined applications and data, about transactions and processes. Thorough attention must usually be addressed to tasks in need of completion. | |
| **The Web**is about information and navigation, an environment where people move back and forth in an unstructured way among many pages of information. Web use is most often characterized browsing and visual scanning of information to find what information is needed. | |
| (iii) **Data/information.** | |
| **GUI** data is typically created and used by known and trusted sources, people in the user’s organization or reputable and reliable companies and organizations. The properties of the system’s data are generally known, and the information is typically organized in an understandable and meaningful fashion. | |
| **The Web**is full of unknown content typically placed there by others unknown to the user. Typical users don’t put information on the Web (except for publishing their own pages). The reliability and truthfulness of found information cannot always be ascertained and trusted. Web content is usually highly variable in organization, and the privacy of the information is often suspect. | |
| (iv) **User tasks** | |
| **GUI system** users install, configure, personalize, start, use, and upgrade programs. They open, use, and close data files. Fairly long times are spent within an individual application, and people become familiar with many of its features and its design. | |
| **Web users** do things like linking to sites, browsing or reading pages, filling out forms, registering for services, participating in transactions, and downloading and saving things. Movement between pages and sites is often a very rapid activity, with people not gaining familiarity with many sites. The typical Web user has no notion of programs and tends to be much less aware of computer mechanics. | |
| (v) **User’s conceptual space** | |
| **In a GUI environment** the user’s conceptual space is controlled by the program and application. A user’s access to data is constrained, and space is made available where their data can be stored and managed. | |
| **A Web user’s** space is infinite and generally unorganized. Little opportunity for meaningful organization of personal information exists. | |
| (vi) **Presentation elements** | |
| The main presentation elements for **GUIs**are various kinds of windows, menus, controls, toolbars, messages, and data. Many elements are transient, dynamically appearing and disappearing based upon the current context of the interaction. They are also generally standardized as a result of the toolkits and style guides used. Elements are presented on screens exactly as specified by the designer. | |
| Web systems possess two components: the browser and page. Many browsers are substantially GUI applications with traditional GUI presentation elements. Within a page itself, however, any combination of text, images, audio, video, and animation may exist. Complex, cluttered, and visually distracting pages are easy to generate and often exist. This occurs because many designers have focused on implementing that which is new, pretty, or attention getting, with little thought given to usability | |
| **(v) Navigation** | |
| **GUI users** navigate through structured menus, lists, trees, dialogs, and wizards. Paths are constrained by design (grayed out menu choices, for example), and the navigation mechanisms standardized by toolkits and style guides. Navigation is a weakly established concept, a supplement to more important task functions and actions. | |
| **Web users** control their own navigation through links, bookmarks, and typed URLs. Navigation is a significant and highly visible concept with few constraints. The immense size of the Web, and the user’s ability to easily wander just about anywhere, frequently causes a lost “sense of place,” or “Where am I right now?” feeling. Web navigation has few standards beyond the browser’s Back button and underlined links. Typically most navigation is part of page design that fosters a lack of consistency, and often confuses users. Establishing a continual sense of place for the user is a critical aspect of Web page design. | |
| **(vi) Context** | |
| **GUI systems** enable the user to maintain a better sense of context. Paths are restricted, and multiple overlapping windows may be presented and be visible, enabling users to remember how what they are doing fits into the overall task picture. | |
| **Web pages** are single entities with almost unlimited navigation paths. They do not bring up separate dialog boxes to ask questions, provide or request supplemental information, or present messages. Contextual clues become limited or are hard to find. | |
| **(vii) Interaction.** | |
| **GUI interactions** consist of such activities as clicking menu choices, pressing buttons, selecting choices from list, keying data, and cutting, copying, or pasting within context established by an open window and an active program. | |
| **The basic Webinteraction** is a single click. This click can cause extreme changes in context such as moving to another site or changing the displayed information within a site. The user may not notice subtle changes when they occur. Additionally, the browser provides parallel mechanisms like the Back button that may function differently depending on context. The distinction between an action and navigation link is not always obvious. | |
| **(vii)Response time.** | |
| Compared to the Web, response times with a **GUI**system are fairly stable, if not nearly instantaneous | |
| **Web response** times can be quite variable, and often aggravatingly slow. Line transmission speeds, system loads, and page content can have a dramatic impact. Long response times can upset and frustrate users. | |
| (viii) **Visual style.** | |
| In **GUI systems**, the visual style is typically prescribed and constrained by toolkit. (Exceptions are entertainment and multimedia applications.) Visual creativity in screen design is allowed but it is difficult to do. While some user options and style choices do exist, little opportunity exists for screen personalization. | |
| **In Web page design**, a more artistic, individual, and unrestricted presentation style is allowed and encouraged. Much design freedom exists, but differing browser and display capabilities, multiple screen sizes, and bandwidth limitations, often complicate and restrict this freedom. Limited personalization of the system is available, at a browser or site level, for users. | |
| (ix) **System capability** | |
| **GUI**system capabilities are only limited in proportion to the capability of the hardware in terms of speed, memory, and configuration, and the sophistication of the software. | |
| **The Web**is more constrained, being limited by constraints imposed by the hardware, browser, and software. It is also limited by the willingness of the page owner to provide certain functions and elements, and the willingness of the user to allow features because of response time, security, and privacy issues and concerns.**)** | |
| **(x) Task efficiency.** | |
| **GUIsystems** are targeted to a specific audience performing specific tasks. Generally, the efficiency of performing a task is only limited by the amount of programming undertaken to support it. | |
| **Browser and network capabilities limit Web task efficiency.** The actual user audience is usually not well understood, since many Web sites are intended for anyone and everyone. | |
| (xi) **Consistency.** | |
| **Consistency in GUI system design** is a major objective in most development efforts. While they are far from perfect, an attempt is made to be consistent both within applications and across applications. Many organizations possess interface and screen design standards and toolkits to aid in the standardization process. Toolkits and guidelines also allow a certain degree of universal consistency in GUI products | |
| **In Web page design**, the heavy emphasis on graphics, a lack of design standards, and the desire of Web sites to establish their own identities results in very little consistency across sites. Web sites often establish standards within a site, but in too many instances developers ignore guidelines existing for GUI components used in Web pages. These problems are especially found in the presentation of screen controls on pages. | |
| (xii) **User assistance** | |
| User assistance is an integral part of most **GUI systems** applications. This assistance is accessed through standard mechanisms such as the F1 key and Help menus. Message and status areas are also provided on the screen. Documentation, both online and offline, is normally provided, as is a support desk to answer user questions and provide guidance and assistance. | |
| **Web pages** do not yet provide similar help systems. What little help that is available is built into the  Page. Customer service support, if provided, is generally oriented to the product or service offered.. Deficiencies in Web page help then become more obvious. | |
| (xiii) **Integration** | |
| A primary goal of most **GUI applications** is the seamless integration of all pieces. Common functions are supported across applications and import/export capabilities exist. Again, toolkits and their components are key elements in accomplishing this objective. | |
| **In Web design**, some integration is apparent within a site for basic functions such as navigation and printing. But because sites strive for individual distinction, interoperability between sites is almost nonexistent. | |
| (xiv) **Security** | |
| In a **GUI environment**, security and data access can be tightly controlled, in proportion to the degree of willingness of an organization to invest resources and effort. For home applications, security is not an issue for most PC users | |
| **The Web is** renowned for security exposures. This is a major inhibitor of Web use for both businesses  and consumers. Browser-provided security options have typically not been well understood by average Web users. When employed, these security options often have function-limiting side effects. (Disabled cookies, for example.) Attempts to create a more trustworthy appearance are being made through the use of security levels and passwords to assure users that the Web is a secure environment. | |
| **(xv) Reliability** | |
| Like security, reliability in **GUI systems is** established and controlled in proportion to the degree of willingness of an organization to invest resources and effort. The computer being used influences reliability as does, if applicable, the local area network. | |
| **Web reliability** is susceptible to disruptions from many directions. Telephone line and cable providers, Internet service providers, hosting servers, and remotely accessed sites all can contribute to the problem. Accessed applications and user mistakes may also cause reliability problems. A lack of reliability can be a great inhibitor of Web use | |
| **Characteristics of an Intranet versus the Internet** | |
| An intranet has many of the same characteristics as the Internet. They differ, however, in some important ways which are listed as mentioned below | |
| **(i) Users** | |
| The users of intranets, being organization employees, know a lot about the organization, its structure, its products, its jargon, and its culture. Internet sites are used by customers and others who know much less about the organization, and often care less about it. | |
| The intranet user’s characteristics and needs can be much more specifically defined then can those of the general Internet user. | |
| **(ii)Tasks** | |
| An intranet is used for an organization’s everyday activities, including complex transactions, queries, and communications | |
| The Internet is mainly used to find information, with a supplementary use being simple transactions. | |
| (iii) **Type of information** | |
| An intranet will contain detailed information needed for organizational functioning. Information will often be added or modified. | |
| The Internet will usually present more stable information: marketing and customer or client information, reports, and so forth. | |
| (iv) **Amount of information** | |
| Typically, an intranet site will be much larger than an organization’s Internet site. Massive amounts of information and processes seem to be needed to make an organization function | |
| It has been estimated that an intranet site can be ten to one hundred times larger than its corresponding public site. | |
| (v) **Hardware and software** | |
| Since intranets exist in a controlled environment, the kinds of computers, monitors, browsers, and other software can be restricted or standardized. The need for cross-platform compatibility is minimized or eliminated, more predictable design. Upgraded communications also permit intranets to run from a hundred to a thousand times faster than typical Internet access can. | |
| This allows the use of rich graphics and multimedia, screen elements that contribute to very slow download times for most Internet users. | |
| (vi) **Design philosophy** | |
| Implementation on the intranet of current text-based and GUI applications will present a user model similar to those that have existed in other domains. This will cause a swing back to more traditional GUI designs—designs that will also incorporate the visual appeal of the Web, but eliminate many of its  useless, promotional, and distracting features. | |
| **Principles of User Interface Design** | |
| **Introduction** | |
| 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. 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. While the damage the user inflicts on the computer tends to be physical (a frustrated pounding of the keyboard), the damage caused by the computer is more psychological (a threat to one’s self-esteem) | |
| **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, Harslem, Irby, Kimball, and Verplank, 1982; Verplank, 1988). These principles established the foundation for graphical interface | |
| **(i)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, and how to select them must be self-evident. | |
| **(ii)Visual order and viewer focus** | |
| Effective visual contrast between various components of the screen is used to achieve this goal (STAR was monochromatic so color was not used). Animation is also used to draw attention, as is sound. Feedback must also be provided to the user. Since the pointer is usually the focus of viewer attention, it is a useful mechanism for providing this feedback | |
| **(iii)Revealed structure** | |
| The distance between one’s intention and the effect must be minimized. Most often, the distance between intention and effect is lengthened as system power increases. The relationship between intention and effect must be tightened and made as apparent as possible to the user. The underlying structure is often revealed during the selection process. | |
| **(iv)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. | |
| **(v)Appropriate effect or emotional impact** | |
| The interface must provide the appropriate emotional effect for the product and its market taking into account whether it Is a corporate, professional, and secure business system or whether it is a fantasy, wizardry, and bad puns of computer games | |
| **(v)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 of interfaces for effective design and implementation** | |
| 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. | |
| **(i)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. | |
| **(ii)Clarity** | |
| The interface should be visually, conceptually, and linguistically clear, including:  Visual elements  Functions  Metaphors  Words and text | |
| **(iii)Compatibility** | |
| Provide compatibility with the following:  The user  The task and job  The product  Adopt the user’s perspective. | |
| **(iv)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. | |
| **(v)Configurability** | |
| Permit easy personalization, configuration, and reconfiguration of settings.  Enhances a sense of control.  Encourages an active role in understanding. | |
| **(vi)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. | |
| **(vii)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. | |
| **(viii)Directness** | |
| Provide direct ways to accomplish tasks.  Available alternatives should be visible.  The effect of actions on objects should be visible. | |
| **(ix)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. | |
| **(X)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. | |
| **(xii)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 | |
| **(xii)Forgiveness** | |
| Tolerate and forgive common and unavoidable human errors.  Prevent errors from occurring whenever possible.  Protect against possible catastrophic errors.  When an error does occur, provide constructive messages | |
| **(xiii)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. | |
| **(xiv)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. | |
| **(xv)Responsiveness** | |
| The system must rapidly respond to the user’s requests.  Provide immediate acknowledgment for all user actions:  Visual, Textual & Auditory | |
| **(xvi)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. | |
| **(xvii)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. | |
| **(xviii)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. | |