UNIT 1

Introduction

Pre-requisite(s):

Knowledge of Graphical User Interface, Object Oriented Programming, and Software Tools.

Objectives:

- To gain knowledge about Human-Computer Interface.
- To gain knowledge about the User Interface and its Components.
- To study the history of screen design.
- To appreciate the importance of Graphical User Interface.
- To explore the different objects of a Graphical User Interface.
- To study the characteristics of Graphical Systems.
- To understand the complexity in the design of a Web Interface.
- To understand the different characteristics of Web Interface.

Contents:

1.0 Introduction

Today, the use of the Internet, Web applications, and Mobile applications by organizations, businesses, and individual human users have increased greatly. A user interacts with a computer, website, or application through a fundamental platform called user interface (UI). The user interface (UI) has to be attractive, easy to use, and responsive for a better user experience (UX). In the context of a business, a good interface can help in converting its users into customers. For the better understanding of user interface design, we should know **Human-Computer Interaction (HCI).**

In the following sections, we shall study the following topics.

- Examine **what Human-Computer Interaction is** and the **factors to be considered by the HCI designers**.
- Define the **User Interface and study its components**.
- Look at the difference between **good and poor design**.
- Describe the **importance of a Good User Interface Design and its benefits**.
- Look at the **History of Screen Design**.

1.1 Human-Computer Interaction

It is the study of the interaction between humans and computers and the design of computing technologies. It basically deals with the study, planning, design,

implementation, and evaluation of how people and computers work together so that a person's needs are satisfied in the most effective way. It is a combination of user-centered design, user interface design, and user experience design.

As HCI deals with Humans and Computers, it is a cross-disciplinary area like engineering, psychology, and ergonomics.

In the context of HCI let us first understand the difference between interaction and interface. Interaction is an abstract model which is used to build systems where humans interact with the computing device for a given task, whereas an interface is a hardware or software used to implement a given interaction model. So the letter I in HCI refers to both interaction and interface, including the abstract model and the technological methodology as shown in **Figure 1.1.**

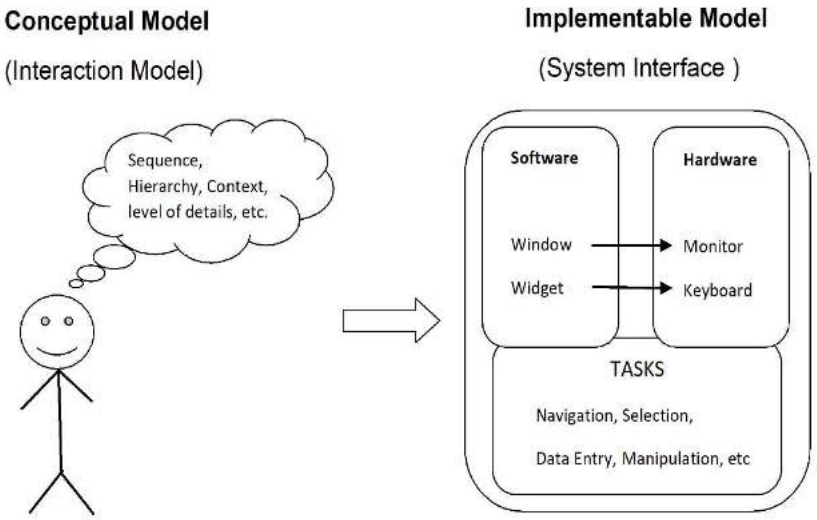

Fig. 1.1 The distinguishing concepts of Interaction (model) and Interface

1.2 Importance of HCI

"HCI will soon be everywhere, all the time" as said by Josh Bongard, a Professor of Computer Science at, University of Vermont.

As computers (and embedded systems) have become a part and parcel of our lives today, HCI has become much very important in recent years. HCI includes two important functionalities: one it makes the necessary computational functionalities available and second, it provides an interaction model and helps to implement interfaces for high usability. Usable and efficient interaction with the computing device results in higher productivity.

1.3 HCI Components

- **HCI includes components of three domains: Computer Science, Human Factor Engineering (HFE) and Cognitive Science**
- Computer science is the study of processes that interact with data in the form of programs.
- Human Factor Engineering (HFE) deals with the study of how people use systems or equipment for designing, developing, and creating technology that is safer and more effective.
- Cognitive Science is the study of the mind, intelligence, and learning. This domain includes research in psychology, philosophy, linguistics, and artificial intelligence.

The domains and subdomains of HCI are shown in Figure. 1.2

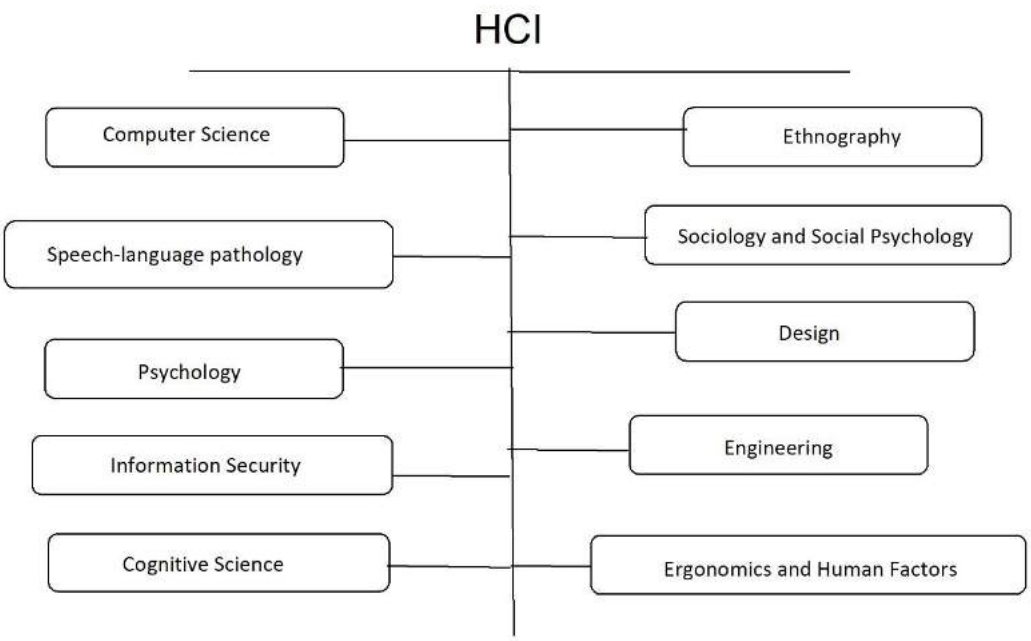

Fig. 1.2 Domains and Sub-Domains of HCI

1.4 Multimodal HCI (MMHCI) Implementation:

In this section we will see how HCI will be in the future. We discuss the techniques and applications developed recently in the context of MMHCI.

A multimodal HCI system responds to inputs in more than one modality or communication channel (e.g., speech, gesture, writing, and others). Multimodal techniques can be used to construct a variety of interfaces

for different applications with the help of **advanced HCI techniques** and **improved HCI devices.**

There are **two MMHCI techniques** based on the human senses used for developing the interfaces for different applications:

- **Core Vision Techniques** – uses large body movements, gestures and gaze of a person as the input.
- **Affective Computer Interaction** – recognizes facial expressions or emotions in audio of a person as the input.

Figure.1.3 shows the MMHCI Implementation Model

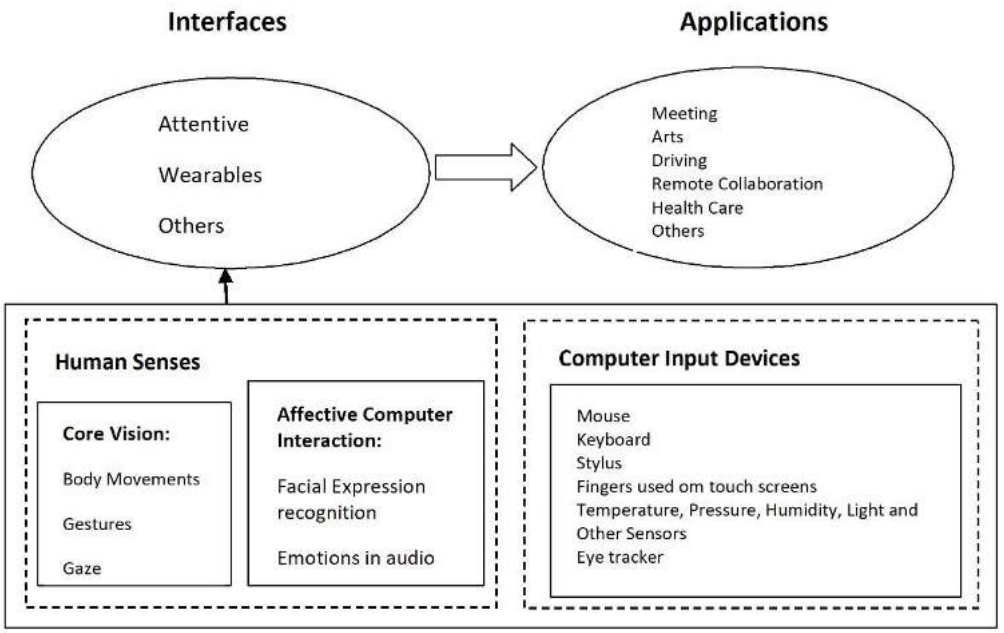

Figure 1.3 MMHCI Implementation Model

1.5 Factors to be considered by HCI designers

The two important factors that should be considered in the design of HCI are **functionality** and **usability.**

- Functionality defines a set of actions or services that it provides to its users and is visible only when it becomes possible to be efficiently utilized by the user.
- Usability of a system can be defined for specific functionality. It is the range and degree by which the system can be used efficiently and adequately by the users to accomplish certain goals.

The designers of the HCI should have a proper understanding of,

- The requirements and expectations of the users.
- The physical limitations and abilities possessed by the users.
- How their perceptual and information processing systems work.
- How to make the users enjoy the experience of using the computer.
- The technical characteristics and limitations of the computer hardware and software.

2.0 Definition of User Interface

The user interface is a **subset of HCI** and forms the part of a computer and its software that **users can see, hear, touch, and talk to.**

2.1 Components of User Interface

A user interface has two components: **Input** and **Output**

- The user communicates his or her needs or desires to the computer through the **input** component.
  Examples: Keyboard, mouse, trackball, joystick, one's finger (for touch-sensitive screens or pads), and one's voice (for spoken instructions).
- The computer conveys the results of its computations and requirements to the user through the **output** component.
  Examples: Display screen and speakers.

3.0 The Importance of Good Design

The screen and the interface are the only visible components for a developer to create a product and, for many users, they form the complete system. So, it is very important to have a well-designed interface.

They are also important because,

- All the capabilities of the system can be viewed on the screen through the interface.
- The form a bridge between the user the capabilities of the software.
- They also form a vehicle through which many critical tasks are presented which in turn would affect the organization's relations with its customers and its profitability.
- A bad screen's layout and appearance and a system's navigation sometimes may confuse the user and make it difficult to do their jobs and may make more mistakes.

- Poor design may increase the stress level of the user and leads to frustration. This can stop the user from using the system permanently which can create a huge financial loss for users and organizations.
- In critical systems, like air traffic control or a nuclear power plant, the safety of its users and/or the general public may become compromised.

3.1 Good and Poor Design

Every application is different and there are no rules or standard formulae for creating a perfect user interface. But there is a list of things to be considered for a better design with respect to usability. To appreciate the importance of the study of this course, some of the design issues are considered and discussed below.

3.1.1 Lack of text hierarchy

Text is the primary unit of informational content, so it must always be legible, organized, and comprehensible. For better perception of information by the users, the text must be properly formatted. A comparison of good and bad text hierarchy is as shown in **Figure. 1.4**

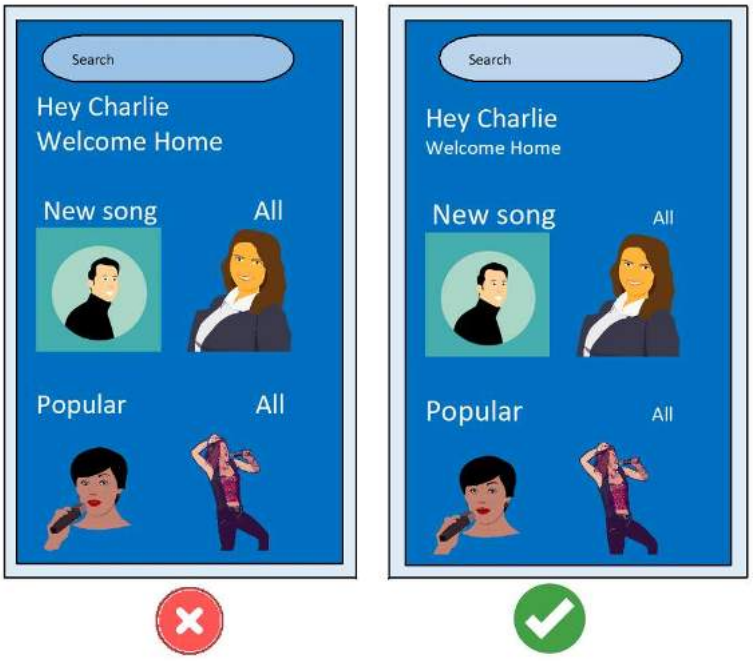

Fig. 1.4 Text Hierarchy

3.1.2 Confusing Forms

In the design of forms, it is very important to provide guidance before and after submitting the form. A demonstration is given in **Figure. 1.5**

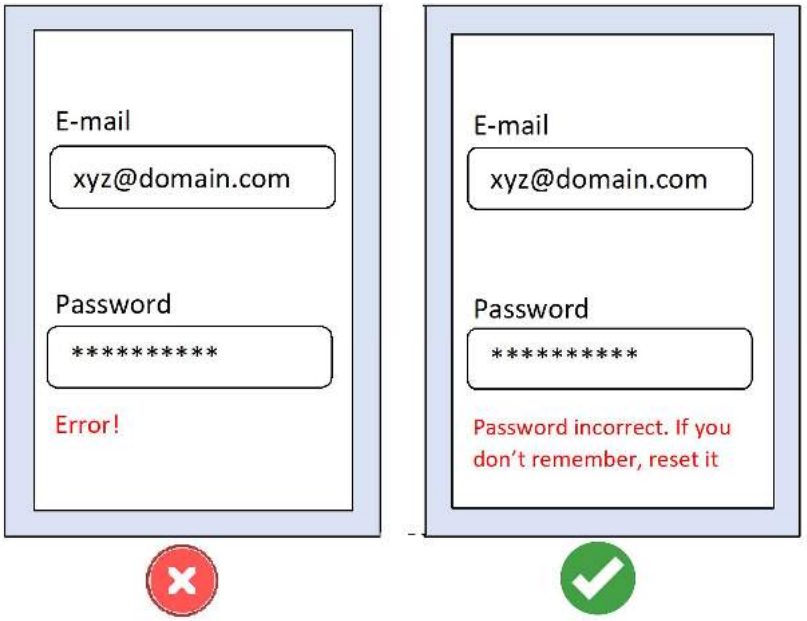

Fig. 1.5 Guidance for submitting the form

3.2 The benefits of Good Design

Research work in the area of Interface design has shown that productivity benefits could be gained through proper design.

It was found that, on an actual system that requires the processing of 4.8 million screens per year, even if one extra second per screen is spent on viewing a screen due to poor clarity, then almost one additional person-year would be required to process all screens. **Table 1.1.** indicates the result of the above analysis.

Table. 1.1 Impact of Inefficient Screen Design on Processing Time

Additional seconds required per screen in seconds	Additional person-years required to process 4.8 million screens per year
1	0.7
5	3.6
10	7.1
20	14.2

Summary: Twenty extra seconds in screen usage time adds an additional 14 person-years.

3.2.1 Results of research in Screen Design

- Less crowded version of the screens improved the productivity of the users by 20 percent.
- Reformatting screens took 25 percent less time for the transactions and with 25 percent fewer errors than those who used the original screens.
- Reformatting inquiry screens after following good design principles reduced decision-making time by about 40 percent, resulting in a savings of 79 person-years in the affected system.
- Another study was done by comparing 500 screens that were used to extract information from displays of airline and lodging information, it was found that the time to extract information was faster by 128 percent for the best format.
- Proper formatting of information on screens has been found to have a positive effect on performance. In 1995, Cope and Uliano found that one graphical window which is redesigned to be more effective would save a company about $20,000 during its first year of use.
- In the area of web design, Baca and Cassidy (1999) redesigned an organization's homepage due to complaints by users unable to locate information. 73 percent of the searches were completed with an average completion time of 113 seconds after one redesign. The further redesigns improved the success rate to 84 percent and the average completion time was reduced to 57 seconds.
- Redesign and Iterative testing showed that there was a 15 percent improvement in search success rate and 50 percent improvement in search time between the first and final designs.
- Four websites commonly used for online shopping were evaluated by Fath and Henneman in 1999. The task completion rate was found to be higher in the websites with better interface designs and hence good business.
- There are other benefits also from good design (Karat, 1997). A good screen design needs less training to the users which reduces training costs. Also, fewer assist calls are generated which reduces the support line costs. This increases employee satisfaction.

- Pressman (1992) has shown that identifying and resolving problems during the design and development process also has significant economic benefits.

Summary: Every dollar invested in system usability returns $10 to $100 (IBM, 2001).

4.0 A Brief History of Screen Design

- IBM introduced the first 3270 cathode ray tube text-based terminal. The 3270 was used in many ways in the offices and the need for a better design was being considered.
- In the 1970's, the user screen looked as shown in **Figure. 1.6**
  - The screen looked cluttered with unintelligible captions.
  - The screens possessed a command field which required the user to remember what has to be keyed in. This required a great amount of practice and patience.
  - Also, the screens were monochromatic.

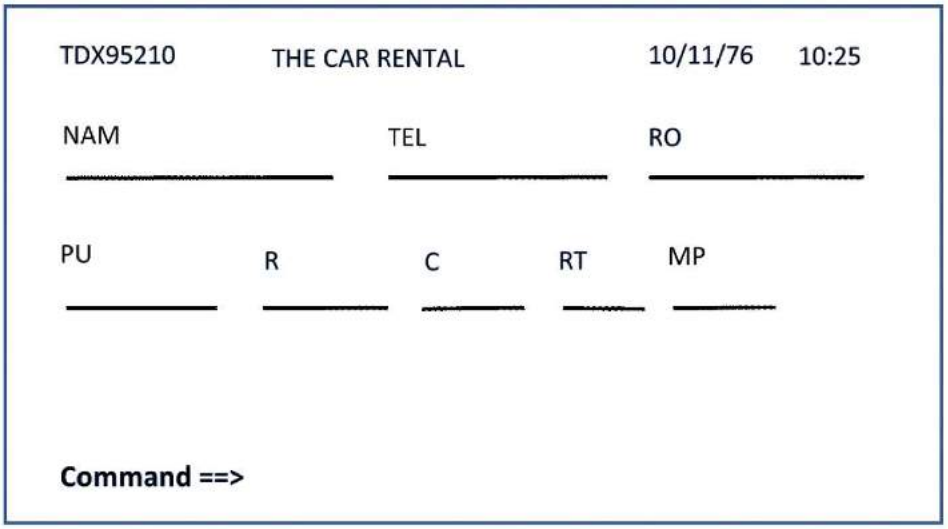

Fig.1.6 A 1970s screen

- The screen design was improved in the 1980's and is shown in **Figure.1.7**
  - In the second stage of design, the screens were visually less cluttered, with concepts such as grouping and alignment of elements being developed.
  - The commands were listed on the screen and there were clear and meaningful field captions.

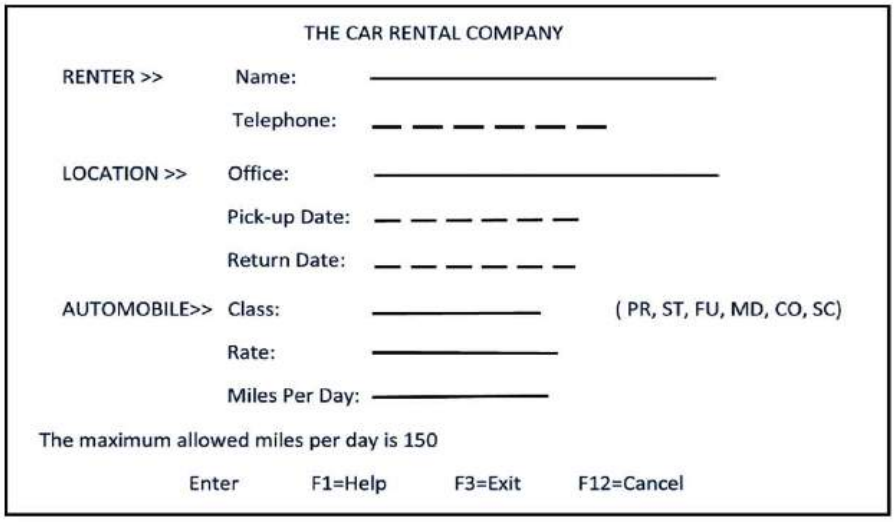

Fig.1.7 A 1980's screen

- In the 1990s screen designs evolved greatly by the use of graphics and is as shown in **Figure. 1.8**
  - Borders were used to enhance groupings, buttons and menus were used.
  - Multiple properties of elements like different font sizes, styles, line thickness, and colors were introduced.
  - The entry field was supported by many controls like list boxes, drop-down combination boxes, spin boxes etc, which removed the need to remember the key entries.

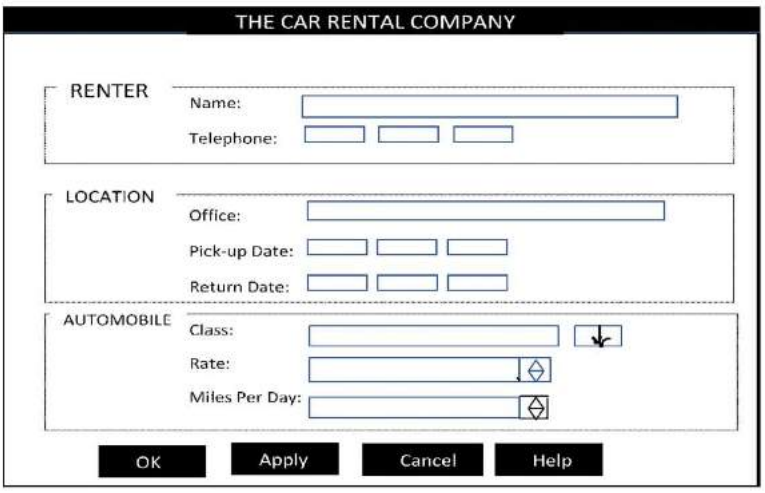

Fig.1.8 1990's and Beyond screen

5.0 Introduction to the Graphical User Interface (GUI)

A user interacts with an application by providing some information to the application. This can be done in two ways, the first is **Character User Interface (CUI)** where the user interacts with the application by typing some characters. This interface is not user-friendly as the user has to type all the commands and the user has to remember all the commands. Example: **DOS**.

The second way is **Graphical User Interface (GUI)** where the user interacts with the application through some graphics like menus, icons, images, etc. known as **objects** with the help of pointing devices. The **desktop** is an example of a GUI. The input devices used here will be an electronic equivalent of the human hand. The GUI objects convey information and represent actions that can be taken by the user. As the objects on a GUI prompt the user with options or menus, this interface is very user-friendly.
Examples: **Windows XP, Windows 7, etc**.

The GUI was first developed by Alan Kay, Douglas Engelbart, and a group of other researchers in 1981 at XEROX PARC. Later, Apple introduced a GUI on its Computer called Lisa on January 19, 1983.

Users can also interact with a computer application through **voice** and **gestures**.

- Smart assistants such as Alexa on Amazon devices, use **voice** control.
- In Virtual reality games users interact with 3D design environments through their **bodily gestures or movements.**

Figure 1.9 shows the User Interface implementation loop with different ways of interaction such as visual objects, voice and gestures.

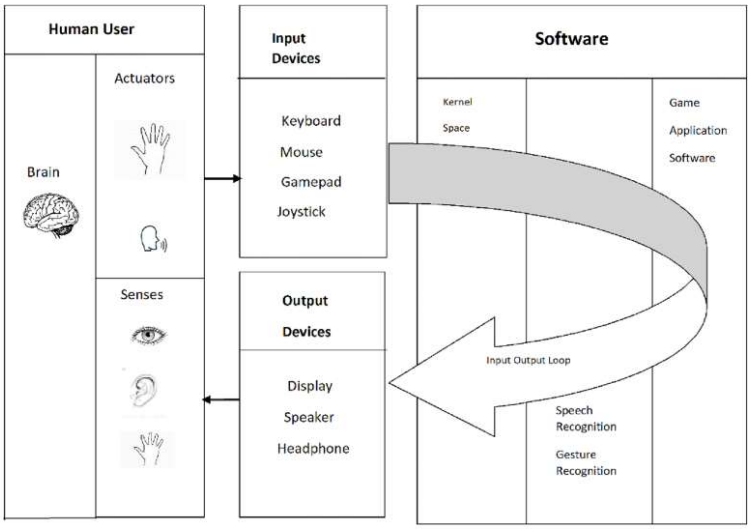

Fig. 1.9 User Interface Implementation Loop

In the following sections, we shall study the following topics.

- Understand **an Object, which is the visible component of a GUI**
- List the **different interaction styles**.
- Understand the reason for the **popularity of Graphics**
- Describe the **concept of Direct Manipulation**
- Look at the **advantages and disadvantages of Graphical Systems**
- List the **different characteristics** of a GUI

5.1 GUI Objects

The users interact in a GUI through a collection of elements called **Objects**.

- The objects can be seen, touched, or heard.
- The objects are always visible to the users and are used to perform tasks.
- When the user interacts with the objects, they change color, size, or visibility.
- Every object is an independent entity.
- The operations or actions performed by the users on the objects are,
    - Accessing and modifying objects by pointing.
    - Selecting
    - Manipulating.
- All objects have standard resulting behavior

Figure 1.10 shows a GUI for a Gaming application with some visible objects.

Fig 1.10 Game GUI

5.2 Interaction Styles

Before we study a GUI in detail, let us understand some Interaction styles.

Interaction styles are methods used for communicating between a user and a computer. There are many interaction styles to choose for an interface designer to design a graphical system, a Web page, or an application. The user interfaces evolved due to the different interaction styles which aided them. They are:

- Command Line
- Menu selection
- Form fill-in
- Direct manipulation
- Anthropomorphic

The type of system being developed and the characteristics of the input and output devices to be used for the interface define the choice of interaction styles.

5.2.1 Interaction Style Comparison.

Table 1.2 compares all the interface styles.

Table 1.2 Comparison of Interaction Styles

Style	Method of Interaction	Advantages	Disadvantages
Command Line	• Press of a key or typing a command	• Is powerful and gives immediate access to the system functions.	• The commands must be learnt and remembered.

		• Commands can include options or parameters to change their behavior. • This mode conserves screen space.	• The command lines can be cryptic and have complex syntax. • They cause typing errors which can lead to user frustration.
Menu Selection	• Choosing from a set of options with a pointing device or a keystroke. • The options could be given in reaction to a visual screen menu shown or options provided by voice.	• Screen menus are better as they use a person's powers of recognition and not remembrance.	• Menus are effective, only if menu choice labels are meaningful and understandable, otherwise the speed of use will be degraded and errors will increase. • Menus break a complex interaction into small steps, which structure and aid the decision-making, this helps infrequent users who are not familiar with the system.

			• Too many small steps slows the process of selection for a knowledgeable user.
Form fill-in	• Contains a screen with a series of controls and fields into which a user types or selects from options.	• Familiar format • Simplifies information entry • Requires minimal training	• Consumes screen space • Requires careful and efficient design • Does not prevent typing error
Direct Manipulation		• Faster learning • Easier remembering • Exploits visual/spatial cues • Easy error recovery • Provides context • Provides immediate feedback	• Greater design complexity • Window manipulation requirements • Inefficient for touch typists • Requires icon recognition • Screen clutter may increase.
Anthropomorphic	This interface tries to interact with people the same way people interact with each other.	• They are natural because these interfaces include spoken natural language dialogues, hand gestures, facial	• The development of these interfaces requires an understanding of human behavior.

		expressions, and eye movements.	• The interface designer should understand the meaning of gestures and expressions. So they are **difficult to implement.**

5.3 The Popularity of Graphics

The graphics screen became popular because of its **three-dimensional look** with a lot of graphical images called icons as compared to the older **one-dimensional** text-based screens.

The icons on a GUI represented objects or actions. The information on a GUI floated in the windows and seemed to rise above the background plane. The controls appeared to rise on the screens and could move when activated. Information could appear and disappear when needed. Also, the text could be replaced by icons. The increased computer power and improved displays have enabled a system to react quickly, dynamically, and meaningfully.

The user's screen on a personal computer is also known as a **Desktop**. It has a lot of user information or data stored in the form of objects representing notes, files, trays, and trash cans all scattered on the screens. This is also called as a **WIMP interface**: windows, icons, menus, and pointing devices.

All the above features helped in enhancing the person's information processing capabilities. Also, it reduced the requirement of perceptual and mental information recoding and reorganization, reducing the memory loads.
GUI also helps in faster information transfer and gives a more compact representation of information. Graphics also adds an appeal to the interface and allows the users to create a customized way of storing and organizing data.

5.4 The Concept of Direct Manipulation

Ben Shneiderman, a Professor of Computer Science at Maryland University, used this term to describe graphical systems with this style of interaction in 1982. He called them "direct manipulation" systems, and they have the following characteristics:

- **The system is designed to look like an extension of the real world:**
  - Here the user interacts with the screen which has objects and actions which simply replicate his or her familiar environment. The user then accesses and modifies these objects, including windows.
  - Here the user focuses on the data and not the applications and tools used to develop them. The user is provided with a familiar environment to work with.
  - The physical organization of the system, which is unfamiliar, is hidden from view and is not a distraction.
- **Objects and actions are continuously visible:**
  - Labelled buttons replace complex syntax and command names, so actions performed need not be remembered.
  - Objects are continuously visible.
  - Cursor action and motion occur in physically obvious and intuitively natural ways.
- **Actions are fast and incremental and the results are displayed after every action:**
  - In the current interfaces, the results of actions are immediately displayed visually on the screen in their new and current form. This is because tactile feedback is not yet possible
  - Auditory feedback may also be provided
  - The impact of the previous action is quickly seen, and the evolution of tasks is continuous and effortless.
- **Incremental actions are easily reversible:**
  - Any incorrect action, can be easily undone

5.5 Graphical Systems: Advantages and Disadvantages

Graphical Systems were developed with the following goals:

- To reduce the memory requirements imposed on the user

- To make effective use of the user's information-processing capabilities
- To reduce system learning requirements

5.5.1 Advantages

- Recognizing symbols is faster than text – graphical objects, elements, and text are represented in the form of icons. The attributes of icons, such as shape and color help in recognizing a message faster.
- Visual or spatial representation of information is easier to be retained and manipulated than textual information.
- Symbols are more effective in conveying simple instructions.
- A human mind can easily remember symbolic displays than text, because actions and visual skills in humans developed before languages. So graphic representations of objects are found to be more natural and closer to human capabilities.
- Displayed objects are visible on the screen so a picture gives the current context.
- As the user initiates actions there is a feeling of control, which results in faster adaptation to the system.
- As the actions result in immediate responses, errors can be rectified if the action does not result in a correct response. This feature is very helpful for new users.
- Graphical interfaces are more attractive and appealing.
- Icons can be spaced nearby which can result in more information in a smaller space.
- Graphical interfaces avoid language translations that exist in text-based systems.
- These systems can be easily enhanced by adding text displays in case graphical design is posing a limitation.
- Typing skills are not needed in graphical interfaces.

5.5.2 Disadvantages

- As the graphical screen designer has a lot of options to choose to design the controls, it becomes complicated and the design may not be better if choices are not done thoughtfully.
- The users of a graphical interface need more time to learn the system as they may not know the meanings of many words and icons. The user has to learn to use a pointing device.

- There are not enough experimentally-derived design guidelines for a developer.
- There are differences in techniques and terminologies used by various graphical system providers, even among successive versions of the same system, because of copyright and legal implications, product differentiation considerations, and expanding knowledge of the interface. This results in difficulty in learning, and relearning, both for the designers and users.
- Many users such as lawyers, found icons difficult to use, compared to a textual format , so they demanded a better format. Also, numeric symbols were found to provide faster responses in visual search tasks.
- There is a limitation to human comprehension, so the number of symbols and icons has to be restricted.
- An experienced touch typist is more comfortable using a keyboard than a mouse.
- Inefficient for expert users. Inefficiencies develop when there are more objects and actions that can fit on the screen.
- Not all users prefer a pure iconic interface so it is not always a preferred style.
- A study has found that graphic instructions on an automated bank teller machine were inferior to textual instructions so graphics screen is not always the fastest style of interaction.
- A graphical system does not guarantee the elimination of clutter on a screen and thus increases the possibility of confusion.
- Some applications such as a listing of names and telephone numbers in a textual format will require less space on the screen than a graphical equivalent.
- A good design requires hardware of adequate power, processing speed, screen resolution, and graphic capability so a limitation in this area may not result in a very efficient graphic system.

6.0 Characteristics of the Graphical User Interface

A graphical system possesses a set of characteristics as discussed below:

6.1 Sophisticated Visual Presentation

The main objective of a graphical interface design is to create a screen reflecting the real-world of the user in a very realistic, meaningful, clear, and simple way because the visual presentation of the interface is what people see on the screen.

A sophisticated graphical system includes drawings and icons, and also different styles and sizes of fonts. There are millions of choices for colors and graphics that also allow animation and the presentation of photographs and motion video.

The interface elements visually presented to the user in a graphical system also include windows, menus, icons to represent objects such as programs or files, assorted screen-based controls like text boxes, list boxes, combination boxes, scroll bars, and buttons, a mouse or other pointing device, and the cursor.

6.2 Pick-and-Click Interaction

The user of a GUI identifies the element on a graphical screen and selects it for some function. Identifying an element is called pick and performing an action is called a click.

There are **two mechanisms** to point and select elements of a graphical screen and perform an action upon that element,

- Through the input device, mouse, and its buttons, which allow rapid selection and feedback.
- Through the input device, keyboard.

6.3 Restricted Set of Interface Options

The number 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. So, the screen size may become a restriction for the number of options. This concept is known as “what you see is what you get”, the acronym of which is WYSIWYG.

6.4 Visualization

Voluminous data or too abstract information is difficult to understand. Such information can be made understood easily by a cognitive process called Visualization. The best visualization method helps a user learn from the data.

In visualization, an entity’s representation is changed to gradually reveal the structure and/or function of the underlying system or process. Presenting specialized graphic pictures facilitates visualization.

The goal of presenting realistic graphical images is to convey the most relevant information to the user.

6.5 Object Orientation

A graphical system is made up of objects and actions. These two components as a single unit. A well-designed system helps the users focus on the objects and not on the actions to be carried out on them. Objects can contain **sub-objects**.

Eg: If we consider a document as an object, then a paragraph, sentence, word, and letter may be thought of as sub-objects.

According to IBM's System Application Architecture Common User Access, Advanced Interface Design Reference (SAA CUA), **objects** can be divided into **three classes: data, container, and device**.

- **Data objects**
  - These objects present information in the form of either text or graphics and they appear in the body of the screen.
  - These are the screen-based controls that are used for information collection or presentation.
- **Container objects**
  - These are objects that hold other objects.
  - For easy access and retrieval, they can be used to group two or more related objects.
  - Container objects are of three types: **the workplace, folders, and work areas.**
    - The **workplace** is the desktop, a storage area for all the other objects.
    - **Folders** are general-purpose containers for the long-term storage of objects.
    - **Work areas** are temporary storage folders used for storing multiple objects currently being worked on.
- **Device objects**
  - These objects represent physical objects in the real world, such as printers or trash cans.
  - These objects may contain other objects to act upon
  - For example, a file may be placed in a printer for printing its contents.

6.5.1 Characteristics of objects

- Objects can be characterized **based on the relationships** that exist between them.
- The object's type is defined by these relationships.
- The objects of the same type possess the same traits and behaviors.
- These relationships are called **collections, constraints, composites and, containers.**
- **Collections relationship**
  - Here the objects share a common aspect.
  - A query or multiple selections of objects may result in a collection
  - Operations can be applied to a collection of objects.
- **Constraints relationship**
  - In this type of relationship, an object in a set affects some other object in the set.
  - **Example:** A document organized into pages.
- **Composite relationship**
  - Here the relationship between objects combines them into one object.
  - **Examples:** Range of cells organized into a spreadsheet.
  - A collection of words organized into a paragraph.
- **Containers relationship**
  - Here one object contains or exists within another object.
  - **Example:** The text in a document or documents in a folder.
  - A container influences the behavior of its content.
  - A container may add or suppress certain properties or operations of objects placed inside it.
- **Example:** This relationship can control access to its content or it can control access to the kinds of objects it will accept.
- One important characteristic of objects is persistence, which gives the state of the object after it is established.
  - **Example:** window size, cursor location, scroll position, etc should be preserved when the user changes it

6.5.2 Properties or Attributes of Objects

Properties are the unique characteristics of an object which help to describe them and can be changed by users.

Examples: text styles, font sizes, or window background colors.

6.5.3 Actions

Users take **actions** on objects in **two ways**:

- They manipulate objects by **giving specific commands**.
  - Actions through command can be performed in many ways by direct manipulation or a command button
  - **Examples**: opening a document, printing a document, closing a window, and quitting an application.
- They modify the **properties or attributes of objects**.
  - When objects are selected for modifying their properties or attributes, the selection will remain in effect until they are deselected.
  - **Examples:** selecting cascaded windows to be displayed, a particular font style, or a particular color.

6.5.4 Application versus Object or Data Orientation

The earlier graphical systems were application-oriented, whereas the present graphical systems are object or data-oriented.

Today the users think about tasks to be performed in an application. To implement this, actions are performed on objects. This **object:action** approach allows people to focus more on their **tasks** and reduces the visibility of the **operating system** and other **applications.**

Table 1.3 shows the steps taken by the Action: Object approach in the Application-oriented approach and Object-oriented approach.

Table 1.3 Action : Object Approach

Steps	Application-oriented approach	Object-oriented approach
1	**Action:** The user opens an application such as word processing	**Object:** The user chooses an object such as a memo
2	**Object:** The user then selects a file or other object such as a memo	**Action:** The user then selects an application such as word processing

6.5.5 Views

The **ways of looking at an object's information** are called **views.**

IBM's SAA CUA gives **four kinds** of views: composed, contents, settings, and help.

- **Composed view**
  - This view presents information and the objects contained within an object.
  - This view is associated with data objects and is specific to tasks and products which are being worked upon.
- **Content view**
  - This view lists the components of objects.
- **Settings view**
  - This view permits the seeing and changing of object properties.
- **Help view**
  - This view gives all the help functions.

6.6 Use of Recognition Memory

As the objects and actions are continuously visible in the current graphical systems, the user recognizes and remembers them.

6.7 Concurrent Performance of Functions

Graphic systems may perform more than one task at a time and multiple programs will run simultaneously to perform these tasks. This is known as multitasking.

Data can be transferred between programs or stored temporarily on a clipboard for later transfer or automatically swapped between programs.

There are **two ways of multitasking**:

- Cooperative multitasking:
  - If a system is not busy on a primary task, it can process a background task.
- Preemptive multitasking
  - Here applications are running as separate tasks and the processing power is divided into time slices and allocated to small portions to each application.

7 Web User Interface

7.0 Introduction

The World Wide Web (WWW) was initially developed for serving as a communication medium for researchers and scientists. But today it has entered into businesses, organizations, and homes around the world. As the web has its roots in a **market-driven society**, the important design considerations are the **amount of information available** and its **convenient access**. To **access the web applications**, an **interface** is needed and this is known as a **Web Interface**.

In the earlier stages of Web interface design, navigation and the presentation of information were considered very essential, so content was the priority and not data. This type of Content- or information-focused interface design is called Web page design. But today, as many of the earlier applications developed for use on graphical systems have migrated to the Web for their foundation, the design of Web applications has increased. These applications also need an interface. This type of application-focused interface is referred to as Web application design.

Web Page Design:

- **The main goal is to provide information.**
- It is designed to build a hierarchy of menus and pages.
- The pages are well structured, easy to use, natural and truthful.
- The design should properly balance the structure and relationships of menus, content, and other linked documents or graphics.
- The design should create an environment where people can navigate and move easily between pages of information.

Web Application Design:

- **The main goal is to collect and process data.**
- Is designed for a user to do and save something.
- Application pages are spread across the screen.
- The pages seek the user's attention for a longer period of time.
- Applications may be kept up and running continuously.

In the following sections, we shall study the following topics.

- Understand **the complexity in the design of a Web Interface.**
- Describe the **popularity of the World wide web.**
- Understand the **different characteristics of Web Interface**.
- List the **Principles of User Interface Design.**

7.1 Complexity in Web Interface Design:

- The design language is HTML and its intended users were technical people and not the general population. It had limited objects and interaction styles, and could not provide a platform for presenting information in the most effective way for people.
- Browser navigation through the “Back” and “Forward” buttons or links can take time.
- The main issue of concern is the information architecture and task flow, which is not easy to standardize. The availability of the various types of multimedia makes it difficult to choose. Also, users are ill-defined and have greatly variable characteristics.

7.2 The Popularity of the Web

The **graphical user interface** revolutionized the **user interface** whereas the **Web** revolutionized **computing**.

The *World Wide Web* is also referred to as **WWW**, **W3**, or **the Web. The Web** is an interconnected system of public web pages accessible through the Internet. There are many applications built on top of the internet and the Web is one of them.

Web helps people scattered across the globe to communicate, access information, publish, and be heard. It not only enables people to control the display and the rendering of Web pages it can also help people change the typography and colors, turn off graphics, decide whether or not to transmit certain data over non-secure channels, and accept or refuse cookies. The number of Internet hosts has increased since 1984. From 1000 in 1984 they exceeded one million in 1992.

Commercialization of the Internet further increased this growth rate. In 1993, Internet traffic expanded at a 341,634 percent annual growth rate. With nearly 10 million hosts

online, 40 million people got connected in 1996. In 2005 the number of Internet hosts exceeded 350 million and the number of users was one billion.

7.3 Characteristics of a Web Interface

In this section let us understand the characteristics of a Web Interface by comparing them with the Graphical User Interface and also comparing a Printed page with a Web page. Though GUI and Web page design are similar in the ways like they both are used by people, are interactive, are both are presented with a lot of visual components on the screen, they are also different in many ways. **Table 1.4** gives a comparison between GUI and Web design

7.3.1 GUI versus Web page design.

Table 1.4 GUI Versus Web Design

Criteria	GUI	Web Design
Devices	• User hardware variations are limited. • User hardware characteristics are well defined, such as in modems and monitors. • Screens appear exactly as specified.	• User hardware variations are enormous and the devices may range from handheld mechanisms to high-end workstations. • Screen appearance gets affected by the hardware.
User Focus	• Data and Applications	• Navigation and Information
Data/Information	• Properties of the data are known and it is created and used by known and trusted sources. • Data is organized in a meaningful way and placed into the system by users or known people and organizations. • Data is separated as private and shared data.	• Data is unknown and is created by an unknown and untrusted. • Data is not organized and is placed onto the Web by users or known people and organizations. • Data is not private.

Navigation	• Navigation is not through visible components but happens through menus, lists, trees, dialogs, and wizards. • Designed is standardized by toolkits and style guides.	• Navigation is through visible components like links, bookmarks, typed URLs. • Not many design standards are available so page design is not very inconsistent.
Response Time	• Instantaneous.	• Is variable and depends on transmission speeds, page content, etc.
System Capability	• Almost unlimited and depends on the capabilities of hardware and software.	• They are limited and depend on the capabilities of the hardware, browser, software, client support, and also on the user's requirements w.r.t to response time, security, and privacy.
Integration	• In order to provide seamless integration of all applications into the platform environment, standard tools and components are used.	• Individual sites are provided with some basic functions like navigation, printing with toolkits and components. • Individual sites are different.
Security	• Not implemented for home PC users. • For other users it is provided based on the requirements and user's investment and efforts.	• Security options provided by the browser are not always understood by the users and if used, they can limit some available functionality.
Reliability	• Provided based on the willingness to invest in resources and effort.	May be affected user, telephone line and cable providers, Internet service providers, hosting servers, and remotely accessed sites

7.3.2 Printed Page versus Web Pages

Printed pages have been in use for five and a half centuries and so a set of accepted guidelines for editorial style, element presentation, and text organization have already been proposed and used. Many of these guidelines have been incorporated in the design of Web pages and many more are being rethought, researched, and reformulated to cover the differences between them and a printed page.

Table 1.5 gives a comparison between a Printed page and a Web page.

Table 1.5 Comparison between a Printed Page and Web Page

Criteria	Printed Page	Web Page
Page size	• Large and of fixed size. • Designed as a single entity and the visual impact is maintained in a hard-copy form.	• Presented in pieces whose sizes depend on the browser technology used and the monitor size. • Designed as a single entity but the visual impact gets degraded as they are presented in parts and requires scrolling to bring the full view.
Page rendering	• Is superior as they are presented to the reader as complete entities.	• They are rendered slowly depending on the transmission speeds and content.
Page Layout	• Is very precise.	• Depends on the design toolkits, user browser characteristics, and screen sizes.
Page resolution	• Better	• Comparatively less
User Focus	• Information is presented as a complete set irrespective of the page size.	• Information is presented in snapshots and the length and depth of the page is unknown.

Page navigation	• Is simple and turning of pages is a motor skill learned early in life	• Is done through clicking on links that have to be followed after making some decisions.
Interactivity	• Happens by the user's eyes selectively traversing the static information on a page and understanding.	• Happens through eyes and hands used to scroll, point, expand and click on the required information. So doing while seeing is more memorable and has a stronger impact than only seeing.
Page Independence	• Pages are organized sequentially, in a standardized way, and also provide a clear sense of place.	• Pages here can be viewed randomly and each page is independent of each other w.r.t the content. • Headers and footers must be provided for a better understanding.

8.0 Principles of User Interface Design

A good interface acts as an extension of a person, reflecting his/her personality. It should be useful and respond to his or her specific needs and accomplish the business objectives for which it is built in a very effective and efficient way. Also, it should be easy to learn and fun to use.

Many researchers and writers have tried to define a set of general principles of interface design. In the following section, we will study these general principles to design a User Interface

8.1 General Principles

In this section, the design goals to create a user interface are discussed. These are fundamental to the design and implementation of effective GUI and Web interfaces.

They are derived from the various principles described by Galitz (1992), IBM (1991, 2001), Lidwell et al. (2003), Mayhew (1992), Microsoft (1992, 1995, 2001), Norman

(1988), Open Software Foundation (1993), Verplank (1988), and the World Wide Web Consortium (2001). The underlying structure is often revealed

Accessibility – this refers to a property that makes the design to be usable by everyone without any modification. There are four properties of an accessible design.

- Perceptibility - a design can be understood by everyone irrespective of their sensory abilities.
- Operability - a design can be used by anyone irrespective of their physical abilities
- Simplicity – a design that is easy to use.
- Forgiveness – a design that minimizes the occurrence and consequences of errors.

Aesthetically Pleasing – an interface looks visually appealing if,

- A meaningful contrast is provided between screen elements.
- Groupings are created.
- Screen elements and groups are aligned.
- A three-dimensional representation is provided.
- Color and graphics are effectively utilized.

Availability – refers to a feature where all the aspects of the system should be made available all the time without the use of modes and states.

Clarity – all the visual elements, functions, metaphors, words and text should be very clear visually, conceptually, and linguistically.

Compatibility – this refers to a design principle that helps in providing compatibility with the user, task and job, and the product. The design should also adopt the user's perspective.

Configurability – This permits easy personalization, configuration, and reconfiguration of settings so that the interface can be easily changeable according to the user's needs.

Consistency – In a consistent system all similar components should have the following:

- A similar look.
- Similar uses.
- Operate similarly.

Also, the same action should always give the same result, the function and position of the standard elements should not change.

Control – this aspect of interface design deals with the control that the user has over the interface.

- The user alone should initiate actions through requests.
- The actions should be performed quickly and they should be capable of interruption or termination.
- The user should not be interrupted during errors.
- The interface should be designed considering the user's skills, experiences, habits, and preferences.

Directness – the tasks should be performed using direct ways and any alternative methods should be made visible. The effect of any action should also be visible.

Efficiency – the control actions should need minimum eye and hand movements. Also, the navigation paths should be as short as possible.

Familiarity – the interaction design should use concepts and languages that are familiar to the user. Using real-world metaphors makes an interface looks naturalistic.

Flexibility – This principle refers to designing an interface considering the differing needs of its users. Further, the performance can be based upon,

- User's knowledge and skills.
- User's experience.
- User's personal preference.
- User's habits.

Forgiveness – this refers to the acceptance of mistakes done by users and recovering from them.

The design should,

- Tolerate and forgive human errors.
- Help in preventing errors from occurring whenever possible.
- Also provide protection against errors.
- Provide constructive messages when an error occurs.

Predictability – this principle helps in anticipating the progression of a task.

The design should consider the following features,

- Every action or operation should result in an expected output and also give a clue about the next operation.
- The screen elements should be distinct and recognizable.
- More than one action should not be combined.

Recovery – this principle helps in reversing and recovering from a wrong action.

A system should consider the following features:

- Commands or actions can be canceled or reversed.
- In the case of difficulty, users can return to a certain point from where they can retry.
- Due to errors, a user should never lose his work. The errors could be due to hardware, software, or communication problems.

Responsiveness – this principle helps in providing immediate acknowledgment for all user actions which can improve performance and instill confidence.

A system should consider the following feature:

- It should rapidly respond to the user's requests in the form of a textual message, a visual, or an auditory response.

Simplicity – helps in presenting a simple interface for the users.

The features to be considered are:

- The system should hide functions until needed and disclose them progressively.
- It should present common and necessary functions first and hide more sophisticated and less frequently used
- It should provide uniformity and consistency and eliminate unnecessary elements.

Transparency – this design principle allows the users to focus on the task or job and not on the mechanics of the interface.

Trade-Offs – this design principle gives trade-offs between the user requirements and the technical requirements for an interface design.

In the view of a designer, the design trade-offs can be in regard to the accuracy, time, cost, and ease of use. A proper understanding of the user and his requirements can help in making correct decisions.

A cardinal rule of system development says that “Human requirements always take precedence over technical requirements”.

9.0 Summary:

This unit provides an introduction to the human-computer interface. The initial discussion examines what an interface is, its importance, and its history. The later part of the topic reviews the two dominant user interfaces today: the graphical user interface (GUI) and the World Wide Web (WWW or Web). In the study of GUI interfaces, we study the components, characteristics, and advantages over the older text-based systems. We then compare Web interfaces both GUI interfaces and conventional printed documents. The content concludes with a statement of the basic underlying principles for interface design.

MCQs [All 1 mark]

Q1. Which of the following are important in the design focus of HCI?

a. The requirements and expectations of the user
b. Technical characteristics and limitations of the computer.
c. The physical limitations and abilities people possessed by the users.
d. All of the above

Q2. Which of the following statement is suitable to define User Interface Design.

a. It is an effective communication medium between a human and a computer.
b. It identifies interface objects and actions.
c. It creates a screen layout that forms the basis for a user interface prototype
d. All of the mentioned above

Q3. Which of the following option is not considered by the Interface design

a. The design of interfaces between software components
b. The design of interfaces between the software and human producers and consumers of information
c. The design of the interface between two computers
d. All of the mentioned

Q4. A software might allow a user to interact via,

a. Keyboard commands
b. Mouse movement
c. Voice recognition commands

d. All of the mentioned

Q5. You have to address a usability issue pertaining to a software interface. You will provide solutions after understanding:

a. How the developer uses the software
b. How the users use the software
c. How you use the software
d. How your friends use the software

Q6. Which of the following is golden rule for interface design?

a. Strive for consistency
b. Offer error prevention and simple error handling
c. Reduce short-term memory load
d. All of the mentioned

Q7. The benefits of a good screen design are,

a. Productivity of the users' increase
b. The task completion rate was found to be higher in the websites
c. Employee satisfaction is increased
d. All the above

Q8. GUI means

a. Graphical User Interface
b. Graphical User Interaction
c. Graphics Uniform Interaction
d. None of the above

Q9. The first GUI was developed in,

a. 1971
b. 1975
c. 1980
d. 1973

Q10. What is the visual component of a GUI

a. Container
b. Object

c. Composite
d. Icon

Q11. Which type of User Interface provide input by typing a string through the keyboard

a. Graphical User Interface
b. Command Line User Interface
c. Natural Language Interface
d. Menu Interface

Q12. Which of the following devices are mainly responsible for the user interface?

a. Input and output devices
b. Memory devices
c. Processor
d. None of the above

Q13. Which of the following define the characteristic of a good user interface?

a. Sophisticated Visual Presentation
b. Object Orientation
c. Concurrent Performance of Functions
d. All of the above

Q14. Which of the following is not a type of user interface?

a. Command language based
b. Menu based
c. Efficiency based
d. Direct manipulation based

Q15. The main function of user-interface is to

a. Convert program/ programs into machine language
b. Transmit data to a remote location
c. Connect users with an application through graphical options like icon, menu, text etc
d. None of these above

Q16. Which of the following is a golden rule of interface design?

a. Make the interface consistent
b. Reduce the user's memory load
c. Place the user in control
d. All of these

Q17. Which of the below is not an advantage of Graphical Systems

a. Faster Learning
b. Faster use and problem solving
c. Greater design Complexity
d. More attractive

Q18. Web interface design is complex because

a. Design language has limited objects and interaction styles
b. Browser navigation takes time
c. Information architecture and workflow cannot be standardized.
d. All the above

Q19. Which of the following is not a characteristic of Web Interface

a. Responsiveness
b. Reactive
c. Security
d. Reliability

Q20. Which of the following statements is false about Web page design

a. User hardware variations are limited.
b. User focus is on navigation and information
c. Data is not private
d. Response time depends on transmission speeds.

Q21. Which of the following statements is false about Web pages

a. Fixed page size.
b. Page rendering is slow
c. Page resolution is less
d. Page is viewed randomly

Q22. Which of the following are the principles of User Interface Design

a. Accessibility
b. Availability

c. Configurability

d. All the above

State whether the following statements are True or False [All 1 mark]

Q1. User Interface Design is implemented by software engineers; it is an iterative process that draws on predefined design principles.

True

False

Q2. The main goal of a Web Page Design is to provide information

True

False

Q3. The main goal of a Web Application Design is to collect and process data

True

False

Descriptive Questions:

Q1. What are the two important factors to be considered during HCI Design? [2 M]

Q2. Define a User Interface. Briefly describe its two components. [4 M]

Q3. Explain the importance of good interface design. [5 M]

Q4. From the results of the research in screen design, summarize the benefits of Good design. [6M]

Q5. List some important characteristics of GUI Objects. [2M]

Q6. Explain any two interaction styles of a GUI stating their advantages and disadvantages. [8M]

Q7. Explain the concepts of direct manipulation.[6M]

Q8. Explain any four characteristics of a GUI. [8M]

Q9. What are the complexities involved in Web Interface Design [4 M]

Q10. Compare GUI with Web design based on different criteria. [8M]

Q11. Compare a printed page with web page based on different criteria. [6M]

Q12. Explain any six general principles of User Interface Design. [8M]

Answers to MCQs:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	21
d	d	c	d	b	d	d	a	d	b	b	a	d	c	c	d	c	d	b	a	a	d

Answers to True/False Questions:

1	2	3
a	a	a

Links to additional information on HCI:

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