3.1 Design Process of Interaction Design

- Design means achieving goals within constraint.
- Interaction design is the practice of designing interactive digital products, environments, systems, and services.
- The golden rule of design are as follows :
- Understand your materials : In the case of a physical design this is obvious. But for the chair with a steel frame and one with a wooden frame. They are very different : often the steel frames are tubular or thin L or H section steel.
- In contrast wooden chairs have thicker solid legs. If you made a wooden chair using the design for a metal one it would break; if you made the metal one in the design for the wooden one it would be too heavy to move.
- For Human - computer interaction the obvious materials are the human and the computer. That is we must :
- Understand computers : limitations, capacities, tools, platforms
- Understand people : psychological, social aspects, human error.

3.1.1 Interaction Design Process

- Fig. 3.1.1 shows interaction design process.

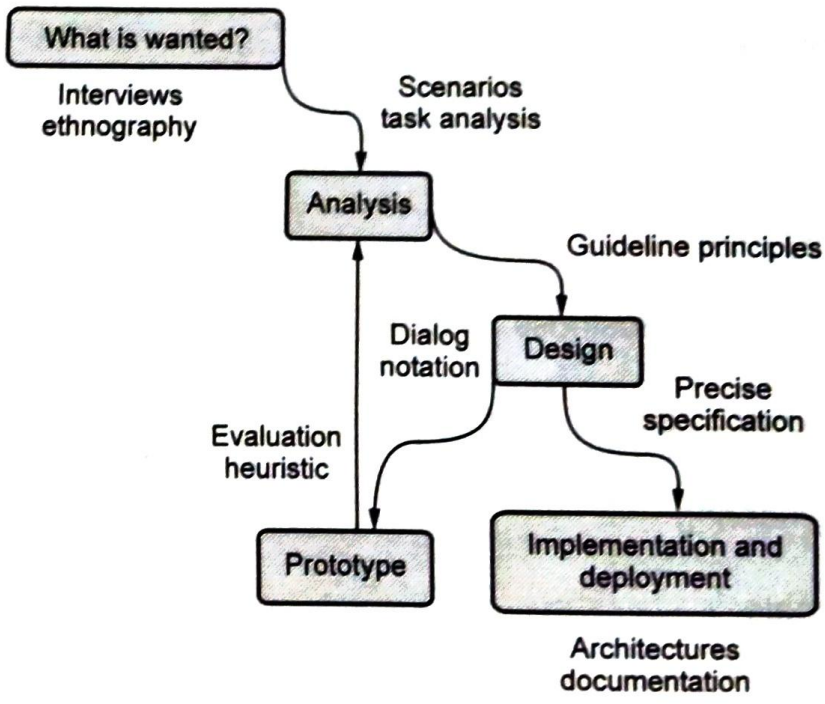

Fig. 3.1.1 : Interaction design process

- **Requirements :** What is wanted ? The first stage is establishing what exactly is needed. There are a number of techniques used for this in HCI : interviewing people, videotaping them, looking at the documents and objects that they work with, observing them directly.
- **Analysis :** The results of observation and interview need to be ordered in some way to bring out key issues and communicate with later stages of design.
- **Design :** There are numerous rules, guidelines and design principles that can be used to help Iteration and prototyping Humans are complex and we cannot expect to get designs right first time. We therefore need to evaluate a design to see how well it is working and where there can be improvements.
- **Iteration and prototyping :** Humans are complex and we cannot expect to get designs right first time. We therefore need to evaluate a design to see how well it is working and where there can be improvements.
- **Implementation and deployment :** This will involve writing code, perhaps making hardware, writing documentation and manuals - everything that goes into a real system that can be given to others.

3.2 Interaction Styles

- An interaction style is simply the method, or methods, by which the user and computer system communicate with one another.
- Interaction is a dialog between the computer and the user. Types of common interface styles are as follows :

1. Command line interface
2. Menus
3. Natural language
4. Question/answer and query dialog
5. Form-fills and spreadsheets
6. WIMP
7. Point and click
8. Three - dimensional interfaces

1. Command line interface :

- It provides a means of expressing instructions to the computer directly, using function keys, single characters, abbreviations or whole - word commands. In some systems it is the only way of communicating with the system, e.g. remote access using telnet. Interaction between user and computer where user input series of command lines into program.

❑ 2. Menus :

- The set of available options is displayed on the screen, and selected using the mouse, or numeric or alphabetic keys. These visible options rely on recognition rather than recall, but still need to be meaningful and logically grouped. Menus may be nested hierarchically, with the grouping and naming of menu options the only cue for finding the required option.

❑ 3. Natural language :

- Natural language is very difficult for a machine to understand. It is ambiguous, syntactically and semantically. It is difficult to provide the machine with context.

❑ 4. Question/answer, query dialogue :

- Question/answer dialogue is a simple mechanism for providing input to an application in a specific domain. The user is asked a series of questions and is led through the interaction step by step. Easy to learn and use, but limited in functionality and power.

❑ 5. Form-fills and spreadsheets :

- Used primarily for data entry but also useful in data retrieval. The display resembles a paper form, with slots to fill in. It may be based on an actual form with which the user is familiar.
- Spreadsheets are a sophisticated variation of form filling. The spreadsheet comprises a grid of cells, each of which can contain a value or a formula.

❑ 6. WIMP :

- **WIMP** stands for Windows, Icons, Menus and Pointers and is the default interface style for the majority of interactive computer systems in use today, especially in the PC and desktop workstation arena. Examples of WIMP interfaces include Microsoft Windows for IBM PC compatibles, MacOS for Apple Macintosh compatibles and various X Windows-based systems for UNIX.

❑ 7. Point and click :

- The point-and-click style has been popularized by World Wide Web pages, which incorporate all the above types of point-and-click navigation: highlighted words, maps and iconic buttons.

❑ 8. Three-dimensional interfaces :

- There is an increasing use of three-dimensional effects in user interfaces. The most obvious example is virtual reality, but VR is only part of a range of 3D techniques available to the interface designer.

3.2.1 Interaction with Natural Language

- Natural Language Interaction (NLI) is the convergence of a diverse set of natural language principles that enables people to interact with any connected device or service in a humanlike way.
- Language is ambiguous at a number of levels. First, the syntax, or structure, of a phrase may not be clear. If we are given the sentence :

The boy hit the dog with the stick

- We cannot be sure whether the boy is using the stick to hit the dog or whether the dog is holding the stick when it is hit.
- Even if a sentence's structure is clear, we may find ambiguity in the meaning of the words used.
- Natural language interaction technology takes Natural Language Processing (NLP) and Natural Language Understanding (NLU) to the next level.
- An analysis of "Carry Me" airlines conversational data, a fictitious name for an airline, but based on real data, showed that questions about baggage are one of the more frequent topics, however, when we drill down, it's possible to see that customers use "baggage" and "luggage" differently.
- Luggage is much more likely to refer to carry-on bags. This type of information is tremendously useful when building an NLI app that is sensitive to the expectations of customers.
- This is where analysis on unstructured data using NLI comes into its own because human intuitions about conversational data are often wrong. Businesses need the facts that NLI provides to guide them, otherwise enterprises risk misunderstanding the voice of the customer.
- It allows enterprises to create advanced dialogue systems that utilize memory, personal preferences, and contextual understanding to deliver a proactive natural language interface.
- Natural language interaction removes the need for your customers to know and understand your terminology.
- The deep understanding that Natural language interaction delivers gives enterprises the information they need to deliver a superior customer experience and have a positive impact on their bottom line.
- In interface design, natural-language interfaces are sought after for their speed and ease of use, but most suffer the challenges to understanding wide varieties of ambiguous input.

- Natural - language interfaces are an active area of study in the field of natural-language processing and computational linguistics. An intuitive general natural-language interface is one of the active goals of the Semantic Web.
- An important problem in Natural Language Generation (NLG) is obtaining and representing in the system the knowledge required producing texts. This includes the knowledge from which texts are generated and linguistic knowledge required to produce the texts.
- In some cases, information produced by HCI researchers or practitioners can be exploited in this way for NLG systems. For example, task models can be exploited to generate documentation and on-line help. They can provide both the information to be included in the texts, and guide the structure of the texts to be generated.

3.2.2 Elements of WIMP

- WIMP stands for windows, icons, menus and pointers and is the default interface style for the majority of interactive computer systems in use today, especially in the PC and desktop workstation arena.
- Examples of WIMP interfaces include Microsoft Windows for IBM PC compatibles, MacOS for Apple Macintosh compatibles and various X Windows-based systems for UNIX.
- Elements of the WIMP interfaces are called **widgets** and they comprise the toolkit for interaction between user and system.

1. Windows

- Windows are areas of the screen that act like individual terminals for an application. Behaviour of windows determined by the system's window manager.
- Fig. 3.2.1 shows parts of windows.

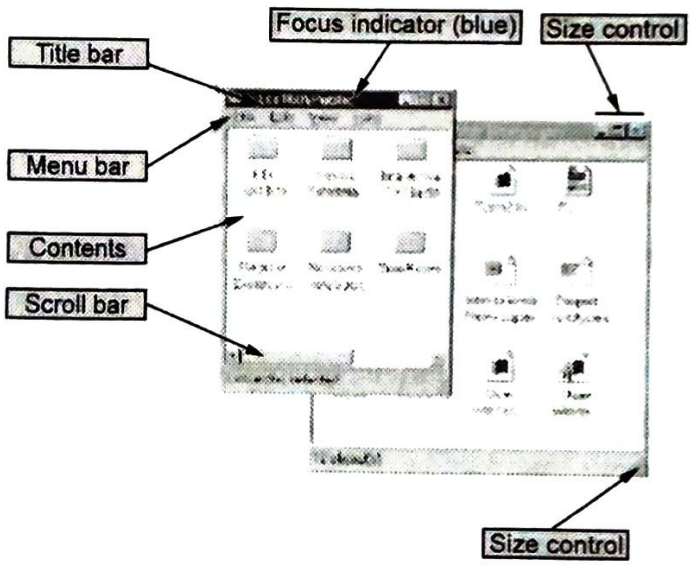

Fig. 3.2.1 : Parts of windows

- Windows can contain text, graphics, menus, toolbars, etc. It can be moved, resized, closed, minimized, and maximized.
- **Layout Policy :** Multiple windows may exist simultaneously. Physical arrangement determined by the window manager's layout policy.
- Layout policy may be fixed or user-selectable. Possible layouts include :
  1. Overlapping - One window partially obscures another
  2. Tiled - Adjoin but don't overlap
  3. Cascading - A sequence with each window offset from the preceding according to a rule.

2. Icon

- A small picture is used to represent a closed window, and this representation is known as an **icon**.
- Icons are signs and represent a significant degree of cognitive complexity. A good design of icons is important.
- Fig. 3.2.2 shows various icon.

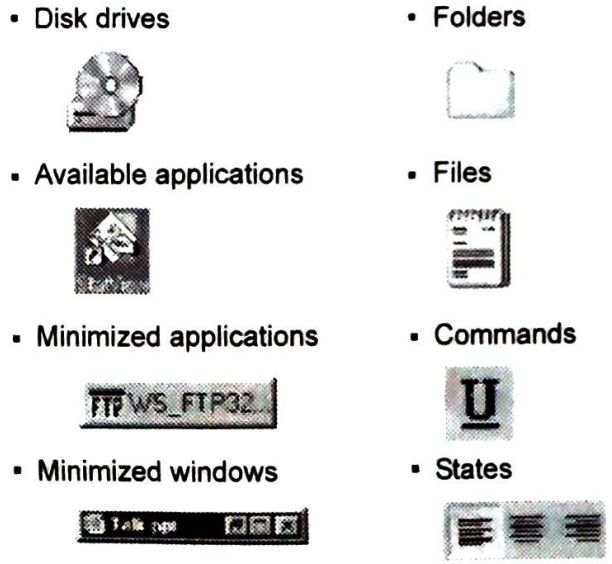

Fig. 3.2.2 : Icons

- A well-designed icon improves the user experience. An icon difficult to understand, vague but results in frustrating user experiences.
- The act of reducing a window to an icon is called **iconifying** or **minimizing**. A window may be restored by clicking on its icon.

- **Advantages of icons :**

  a) Save screen space

  b) Serve as a reminder of available dialogs, applications, or commands that may be restored or invoked.

❑ 3. Menu

- A menu presents a choice of operations or services that can be performed by the system at a given time.
- Menus afford access to system functionality. Menu option lists can consist of any type of data such as images or symbols.
- Options are generally indented in relation to the title. Frequently used items should be placed at the top. These lists can be ordered or unordered.

❑ 4. Tool Bar

- Toolbar is similar to a menu bar, but as the icons are smaller than the equivalent text more functions can be simultaneously displayed.
- Sometimes the content of the toolbar is fixed, but often users can customize it, either changing which functions are made available, or choosing which of several predefined toolbars is displayed.

❑ 5. Pointer

- A pointer is the input device used to interact with GUI components.
- The pointer (cursor) is the visual manifestation of the mouse or pointing device and, as such, acts as the user's proxy in the GUI environment.
- Allow us to do actions and also provide us with contextual information (e.g. wait).
- Examples are mouse, trackball, joystick, touchpad, finger, stylus, light pen.
- Two primary purposes are position control of the on-screen tracker and selection via buttons.

3.2.3 Difference between Menu and Tool Bar

- Menus provide information cues in the form of an ordered list of operations that can be scanned.
- Menus are inefficient when they have too many items, and so cascading menus are utilized, in which item selection opens up another menu adjacent to the item, allowing refinement of the selection.

- The major problems with menus in general are deciding what items to include and how to group those items. Including too many items makes menus too long or creates too many of them, whereas grouping causes problems in that items that relate to the same topic need to come under the same heading, yet many items could be grouped under more than one heading.
- Toolbar is similar to a menu bar, but as the icons are smaller than the equivalent text more functions can be simultaneously displayed.
- Sometimes the content of the toolbar is fixed, but often users can customize it, either changing which functions are made available, or choosing which of several predefined toolbars is displayed. ***Many times users face problems in understanding/learning toolbar icons. How to resolve this issue ?***

Learning toolbars

- Although many applications now have toolbars, they are often underused because users simply do not know what the icons represent.
- Once learned the meaning is often relatively easy to remember, but most users do not want to spend time reading a manual, or even using online help to find out what each button does, they simply reach for the menu.
- There is an obvious solution, put the icons on the menus in the same way that accelerator keys are written there. So in the 'Edit' menu one might find the option.

3.2.4 Advantages and Disadvantages of WIMP

Advantages

1. Easy to use
2. User friendly
3. Increased speed of learning
4. No need to learn complicated commands
5. Provides greater productivity.

Disadvantages

1. They use more processing power than other interface
2. Requires more space for storage.

3.3 Graphical User Interface

- Graphical User Interface (GUI) is an interface, or interactive system, that allows professionals to accomplish tasks on their computers through images and icons, rather than text command systems.
- Graphical user interfaces appear in computers, tablet devices and mobile devices. These graphical user interfaces can often be optimized to provide a more positive user experience.
- User interface is a collection of techniques and mechanisms to interact with somethings. In graphical interface, the primary interaction mechanism is a pointing device of same kind.
- User interacts with collection of elements referred to as objects. They can be seen, heard, touch.

3.3.1 Popularity of Graphics

- A graphical screen bore scant resemblance to its earlier text-based colleagues. Older text-based screen possessed a one dimensional.
- Graphic screens assumed a three-dimensional look. Controls appeared to rise above the screen and move when activated. Information could appear and disappear, as needed.
- Text could be replaced by graphical images called **icons**. These icons could represent objects or actions.
- Selection fields such as radio buttons, check boxes, list boxes and palettes coexisted with the reliable old text entry field.
- Objects and actions were selected through use of pointing mechanisms. It increased computer power. User's actions to be reacted to quickly, dynamically and meaningfully.
- Graphic presentation is much more effective 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.
- Graphics also can add appeal or charm to the interface and permit greater customization to create a unique corporate or organization style.

3.3.2 Characteristics and Disadvantages of the Graphical User Interface

Characteristics :

- 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.
- In a GUI multiple windows with different information can simultaneously be displayed on the user screen.
- Iconic information representation and symbolic information manipulation is possible in a GUI. Symbolic information manipulation such as dragging an icon representing a file to a trash can be deleting is intuitively very appealing and the user can instantly remember it.
- A GUI usually supports command selection using an attractive and user-friendly menu selection system.
- In a GUI, a pointing device such as a mouse or a light pen can be used for issuing commands. The use of a pointing device increases the efficacy issue procedure.
- 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.
- Object Orientation : A graphical system consists of objects and actions. Objects are what people see on the screen as a single unit.
- Pick-and-Click Interaction : The primary mechanism for performing this pick-and-click is most often the mouse and its buttons. The user moves the mouse pointer to the relevant element (pick) and the action is signaled (click). Pointing allows rapid selection and feedback.
- Actions : A series of actions may be performed on a selected object. Performing a series of actions on an object also permits and encourages system learning through exploration.

Disadvantages :

1. Greater design complexity.
2. May consume more screen space.
3. Good design also requires hardware of adequate power, processing speed, screen resolution and graphic capability.
4. Inefficient for touch typists : For an experienced touch typist, the keyboard is a very fast and powerful device.

5. Not always the preferred style of interaction : Not all users prefer a pure iconic interface. User will also prefer alternatives with textual captions.
6. Not always fastest style of interaction : Graphic instructions on an automated bank teller machine were inferior to textual instructions.

3.3.3 Concept of Direct Manipulation

- Direct manipulation is an interaction style in which the objects of interest in the UI are visible and can be acted upon via physical, reversible, incremental actions that receive immediate feedback.
- Here users act on displayed objects of interest using physical, incremental, reversible actions whose effects are immediately visible on the screen.
- The term direct manipulation was introduced by Ben Shneiderman in his keynote address at the NYU Symposium on User Interfaces.
- Features of a direct manipulation interface :
  1. Visibility of the objects of interest
  2. Incremental action at the interface with rapid feedback on all actions
  3. Reversibility of all actions, so that users are encouraged to explore without severe penalties
  4. Syntactic correctness of all actions, so that every user action is a legal operation
  5. Replacement of complex command languages with actions to manipulate directly the visible objects.
- Direct Manipulation Examples :
  a) Drive a car
  b) If you want to turn left, what do you do ?
  c) What type of feedback do you get ?
  d) How does this help ?
  e) Think about turning left using a menu/text interface.
- Fig. 3.3.1 shows example of direct manipulation. [Refer Fig. 3.3.1 on next page]
- **Example :** Discuss the ways in which a full-page word-processor is or is not a direct manipulation interface for editing a document using Shneiderman's criteria.

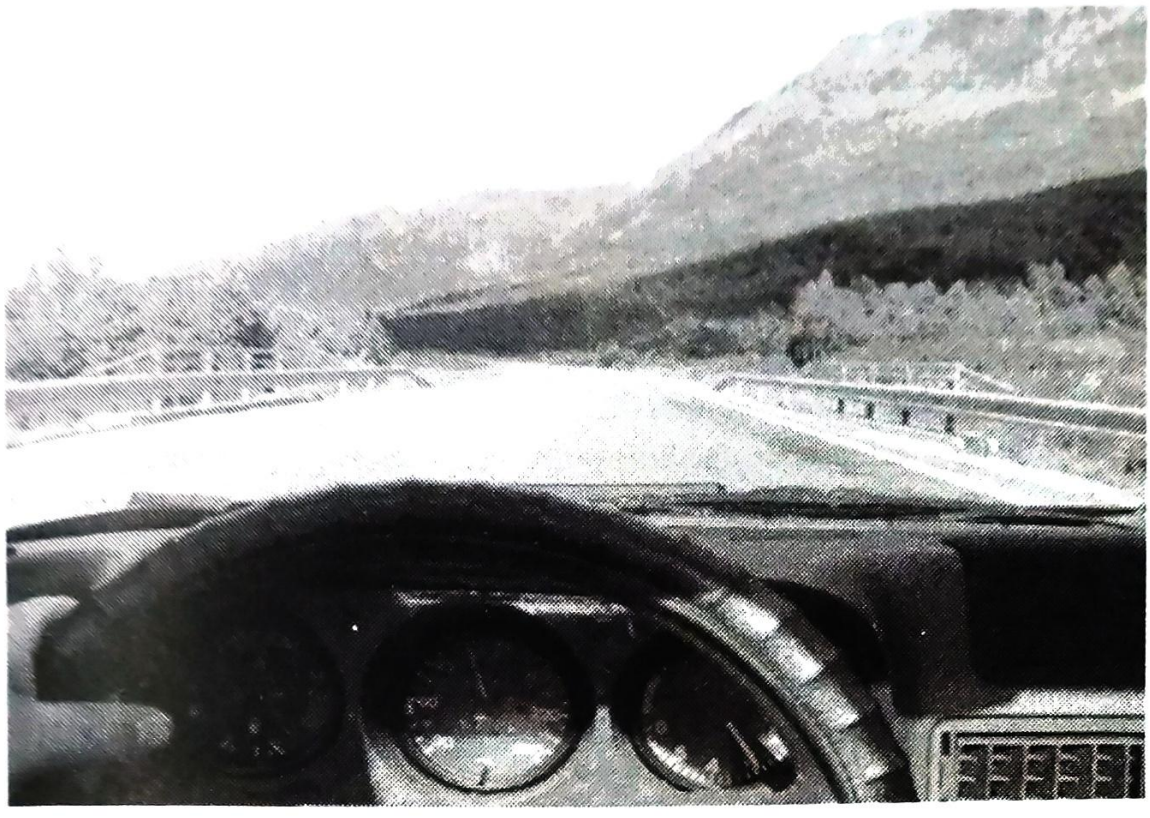

Fig. 3.3.1 : Example of direct manipulation

- **Visibility of the objects of interest :** The most important objects of interest in a word-processor are the words themselves. Indeed, the visibility of the text on a continual basis was one of the major usability advances in moving from line-oriented to display oriented editors.
- Depending on the user's application, there may be other objects of interest in word-processing that may or may not be visible.
- For example, are the margins for the text on screen similar to the ones which would eventually printed ? Is the spacing within a line and the line-breaks similar ? Are the different fonts and formatting characteristics of the text visible ?
- Incremental action at the interface with rapid feedback on all actions : We expect from a modern word-processor that characters appear in the text as we type them it at the keyboard, with little delay.
- If we are inserting text within a paragraph, we might also expect that the format of the paragraph adjust immediately to accommodate the new changes.
- Various word processors do this reformatting automatically, whereas others do it occasionally or only at the explicit request of the user.
- One of the other important actions which require incremental and rapid feedback is movement of the insertion point, usually by means of arrow keys.

- If there is a significant delay between the input command to move the insertion point down one line and the actual movement of the cursor on screen, it is quite possible that the user will "overshoot" the target when repeatedly pressing the down-arrow key to move down a few lines on the screen.
- Reversibility of all actions, so that users are encouraged to explore without severe penalties : Single step undo commands in most word-processors allow the user to recover from the last action performed.
- One problem with this is that the user must recognize the error before doing any other action. More sophisticated undo facilities allow the user to retrace back more than one command at a time.
- Syntactic correctness of all actions, so that every operation is a legal operation WYSYWYG : word-processors usually provide menus and buttons which the user uses to articulate many commands.
- These interaction mechanisms serve to constrain the input language to only allow legal input from the user.
- Replacement of complex command languages with actions to manipulate directly the visible objects : The case for word processors is similar to that described above for syntactic correctness. In addition, operations on portions of text are achieved many times by allowing the user to directly highlight the text with a mouse (or arrow keys).
- Subsequent action on that text, such as moving it or copying it to somewhere else, can then is achieved more directly by allowing the user to "drag" the selected via the mouse to its new location.

❑ Advantages of direct manipulation :

- Visually presents task concepts
- Allows easy learning
- Allows easy retention
- Allows errors to be avoided
- Encourages exploration
- Affords high subjective satisfaction.

❑ Disadvantages of direct manipulation :

- May be hard to program
- May require graphics display and pointing devices
- Not suitable for small graphic displays

Greater design complexity

- Lack of experimentally-derived design guidelines
- Inconsistencies in technique and terminology.

3.4 Web User Interface

- It is essentially the design of navigation and presentation of information. It is about content, not data.
- Web design refers to the design of websites that are displayed on the internet. It usually refers to the user experience aspects of website development rather than software development.
- Two of the most common methods for designing websites that work well both on desktop and mobile are responsive and adaptive design.
- In the context of websites, a web interface is a page that users interact with when a site is fully downloaded on a web browser. A website is a collection of code, but this code is not suitable for user interaction.
- Proper interface design is largely a matter of properly balancing the structure and relationships of menus, content and other linked documents or graphics. The design goal is to build a hierarchy of menus and pages that feels natural, is well structured, is easy to use and is truthful.
- Web interface design is also more difficult because the main issues concern information architecture and task flow, neither of which is easy to standardize.
- Web interface design is difficult for a number of reasons.
  1. First, its underlying design language, HTML, was never intended for creating screens to be used by the general population. HTML was limited in objects and interaction styles and did not provide a means for presenting information in the most effective way for people.
  2. Browser navigation retreated to the pre-GUIera. This era was characterized by a "command" field whose contents had to be learned and a navigational organization.

3.4.1 Popularity of the Web

- 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.
- Web usage has reflected this popularity. The number of Internet hosts has risen dramatically.
- Key Features :
  1. Web provides a hypertext structure among the documents that it stores.
  2. The documents contain links i.e. references to other documents or resources. The structures of links can be arbitrarily complex and the set of resources that can be added is unlimited.

3.4.2 Characteristics of the Web

GUI versus Web Page Design

GUI	Web
Interface oriented towards functionality and application domain.	Interface oriented towards navigation in contents.
Moderate risk in deployment, software testing.	Low risk in deployment, user testing.
Response time with GUI system are fairly stable. if not nearly instantaneous.	Web response time can be variable and often slow.
GUI systems are about well-defined applications and data, about transactions and processes.	The Web is about information and navigation, an environment where people move back and forth in an unstructured way among many pages of information.
In a GUI environment the user's conceptual space is controlled by the program and application.	A Web user's space is infinite and generally unorganized.
Elements for GUIs are various kinds of windows, menus, controls, toolbars, messages and data.	Web systems possess two components : The browser and page.
GUI users navigate through structured menus, lists, trees, dialogs and wizards.	Web users control their own navigation through links, bookmarks and typed URLs.

GUI	Web
Unlimited capability proportional to sophistication of hardware and software.	Limited by constraints imposed by the hardware, browser, software, client support and user willingness to allow features because of response time, security and privacy concerns.

3.5 Merging of Graphical Business Systems and the Web

3.5.1 Characteristics of an Intranet versus the Internet

1. **Users** : Intranets users are organization employees and know a lot about its organization, structure of organization, its product etc. Customers use Internet sites and others who know much less about the organization and often care less about it.
2. **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.
3. **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.
4. **Amount of information** : An intranet site will be much larger than an organization's Internet site.

3.5.2 Extranets

- An extranet is a private network similar to an intranet, but typically open to external parties, such as business partners, suppliers, key customers, etc.
- The main purpose of an extranet is to allow users to exchange data and applications and share information.
- An extranet can be a useful tool for the following business needs :

a) Using online ordering, electronic order tracking and inventory management internally or externally, with selected partners.

b) Working flexibly to meet the demands of larger companies, by adopting new technologies and enabling the exchange of business information and transactions.

c) Facilitating a cheap and efficient way for businesses to connect with their trading partners and suppliers and allowing them access to the information they need 24 hours a day.

d) Automating the trading tasks between you and your trading partners, in order to strengthen business relationships and integrate your business firmly within their supply chain.

3.6 Principles of User Interface Design

- The principles of user interface design are intended to improve the quality of user interface design.
- It should be useful, accomplishing some business objectives faster and more efficiently than the previously used method or tool did. It must also be easy to learn, for people want to do, not learn to do.

❑ Principles for the xerox star

- The xerox 'star' was a commercial version of the prototypical xerox alto - if one thousand fully working systems, used internally at 'PARC' day-in-day-out over seven years, can be said to be prototypical.
- While the system itself is an interesting development in computer science, the interface and the mode of user interaction is truly visionary and lead to five key principles for enhancing the user experience :

1. The illusion of manipulable objects. Displayed objects that are selectable and manipulable must be created.
2. Visual order and viewer focus.
3. Consistency : Screen elements should not appear consistent with each other unless they behave consistently with each other. Elements that behave the same should look the same.
4. A match with the medium. The interface must also reflect the capabilities of the device on which it will be displayed.
5. Interfaces exist to allow interaction between humans and the digital world. They help us clarify, manage expectations and access services.

❑ General Principles :

a. **Equitable use :** The design in useful and marketable to people with diverse abilities.

b. **Flexibility in use :** The design accommodates a wide range of individual preferences and abilities.

c. **Simple and intuitive to use :** Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills or current concentration level.

d. **Perceptible information :** The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

e. **Tolerance for error :** The design minimizes hazards and the adverse consequences of accidental or unintended actions.

f. **Low physical effort :** The design can be used efficiently and comfortably and with a minimum of fatigue.

g. **Size and space approach and use :** Appropriate size and space is provided for approach, reach, manipulation and use regardless of user's body size, posture or mobility.

3.7 Usability Engineering

- Usability engineering is a professional discipline that focuses on improving the usability of interactive systems. It draws on theories from computer science and psychology to define problems that occur during the use of such a system. Usability engineering involves the testing of designs at various stages of the development process, with users or with usability experts.
- Usability engineering is used to determine to what degree a product or prototype will be user-friendly. It often pertains to the field of software development.
- To be tested, usability is expressed in terms of :
  1. **Learnability :** Time and effort to reach a specified level of user performance (ease of learning)
  2. **Throughput :** For tasks accomplished by experienced users, the speed of task execution and the errors made (ease of use)
  3. **Flexibility :** Multiplicity of ways the user and system exchange information and the extend to which the system can accommodate changes beyond those initially specified
  4. **Attitude :** The positive attitude created in users by the system.
- "Usability data" is any information that is useful in measuring (or identifying potential issues affecting) the usability attributes of a system under evaluation.
- Usability can be improved by means of,
  1. User-centred Design
  2. Heuristic Testing

3. Usability Evaluation
4. Prototyping
5. Task Analysis
6. Collaborative Walk-through.

❑ Problems with usability engineering :

- The problem with this sort of usability specification is that it may miss the point.
- Usability engineering must start from the very beginning of the design process to ensure that account is taken of these issues.
- Also, it is not clear that what is specified in the usability specification actually relates to genuine usability.

3.8 Design Rationale

- Design rationale is about explaining why a product has been designed the way it has.
- For each decision made there must a set of reasons why that particular decision was made. Design rationale is about recording those decisions and the reasons why they were made.
- A design rationale is a useful design tool because it explicitly lays out the reasoning behind a design process and it forces designers to be explicit about what they are doing and why they are doing it.
- In particular a design rationale can be used after a product has been completed in order to analyse why a product was a success or failure.
- If a similar product is being designed subsequently then its designers can refer to a design rationale to discover why earlier products were designed the way they were, and with the benefit of hindsight judge whether the earlier design decisions were successful and warrant repeating.
- Design rationales are particularly helpful in interactive system design because, there is rarely one objectively correct solution to any problem, and some solutions may contradict one another, or require trade-offs.
- Design rationales require the designer to be explicit about how contradictions were resolved and trade-offs were made.
- Furthermore the design space may be very large and therefore it is not obvious that a designer will even consider the best solution, never mind choose it.

- A design rationale makes it clear which options from the design space were considered and why. If an apparently better solution were later discovered then it is obvious whether that solution had been considered and discarded for some reason, or not considered at all.
- Usability is very context dependent; what is good for one user may be dreadful for another. If subsequent designs are made where the context of use does not change then a design rationale can be reused without modification. If however the context does change then new design decisions can be made for this new context, but in the light of the decisions made for the older context.
- It is beneficial to have access to the design rationale for several reasons :
  1. In an explicit form, a design rationale provides a communication mechanism among the members of a design team.
  2. Accumulated knowledge in the form of design rationales for a set of products can be reused to transfer what has worked in one situation to another situation which has similar needs.
  3. The effort required to produce a design rationale forces the designer to deliberate more carefully about design decisions.

3.8.1 Benefits of Design Rationale

- Communication throughout life cycle
- Reuse of design knowledge across products
- Enforces design discipline
- Presents arguments for design trade-offs
- Organizes potentially large design space
- Capturing contextual information.

3.8.2 Process - Oriented Design Rationale

- Process - oriented design rationale is interested in recording an historically accurate description of a design team making some decision on a particular issue for the design.
- In this sense, process - oriented design rationale becomes an activity concurrent with the rest of the design process.
- It preserves order of deliberation and decision making.
- Design rationale is based on Rittels Issue Based Information System (IBIS).
- IBIS is best known for its use in dialogue mapping, a collaborative approach to tackling wicked problems but it has a range of other applications as well.

- IBIS consists of three main elements :
  1. Issues (or questions) : These are issues that need to be addressed.
  2. Positions (or ideas) : These are responses to questions. Typically the set of ideas that respond to an issue represents the spectrum of perspectives on the issue.
  3. Arguments : These can be Pros (arguments supporting) or Cons (arguments against) an issue. The complete set of arguments that respond to an idea represents the multiplicity of viewpoints on it.
- Fig. 3.8.1 shows IBIS elements.

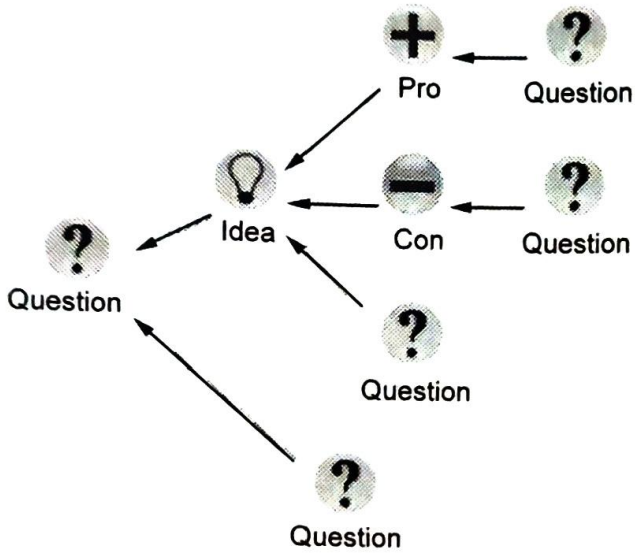

Fig. 3.8.1 : IBIS elements

- Issues can be raised a new or can arise from other issues, positions or arguments. In other words, any IBIS element can be questioned. In Compendium notation : a question node can connect to any other IBIS node.
- Ideas can only respond to questions, i.e. in Compendium "light bulb" nodes can only link to question nodes. The arrow pointing from the idea to the question depicts the "responds to" relationship.
- Arguments can only be associated with ideas - i.e. in Compendium and nodes can only link to "light bulb" nodes (with arrows pointing to the latter).

3.8.3 Design Space Analysis

- Design space analysis is an approach to representing design rationale. It uses a semiformal notation, called QOC (Questions, Options, and Criteria), to represent the design space around an artifact.

- The main constituents of QOC are questions identifying key design issues, options providing possible answers to the questions and criteria for assessing and comparing the options.
- Fig. 3.8.2 shows design space analysis.

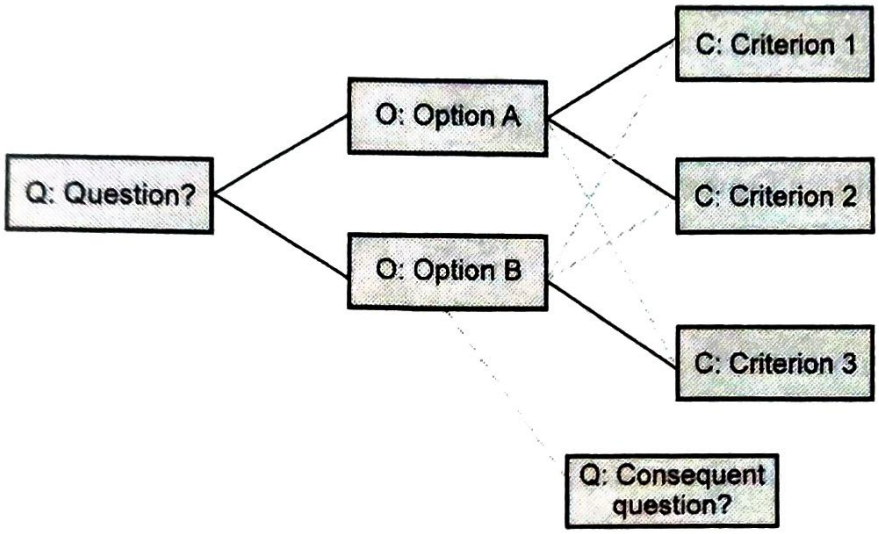

Fig. 3.8.2 : QOC design space analysis

- A design space analysis does not produce a record of the design process but is instead a coproduct of design and has to be constructed alongside the artifact itself.
- The key to an effective design space analysis using the QOC notation is deciding the right questions to use to structure the space and the correct criteria to judge the options.
- The initial questions raised must be sufficiently general that they cover a large enough portion of the possible design space, but specific enough that a range of options can be clearly identified. It can be difficult to decide the right set of criteria with which to assess the options.
- Another structure-oriented technique, called **Decision Representation Language** (DRL), developed by Lee and Lai, structures the design space in a similar fashion to QOC.
- The goal of DRL is foremost to provide a vocabulary for representing the qualitative aspects of decision making such as the issues raised, pro and con arguments advanced, and dependency relations among alternatives and constraints, that typically appear in a decision making process.
- Once we have a language for representing these basic elements of decision making, it becomes possible to provide services that use this language to support decision making.