Unit - I

1 Foundations of Human-Computer Interaction

1.1 What is HCI

Q.1 What is HCI ? Explain goals of HCI.

Ans. : • Human-computer interaction is a discipline concerned with the design, implementation and evaluation of interactive computing systems for human use and with the study of major phenomenon surrounding them.

- HCI is study of people, computer technology and the ways these influence each other. We study HCI to determine how we can make this computer technology more usable by people.
- Human : Individual user, a group of users working together, a sequence of users in an organization.
- Computer : Desktop computer, large-scale computer system, Pocket PC, embedded system, software.
- User interface : Parts of the computer that the user contacts with
- Interaction : Usually involve a dialog with feedback & control throughout performing a task.

HCI Goals

- At physical level, HCI concerns the selection of the most appropriate input devices and output devices for a particular interface or task.

- Determine the best style of interaction, such as direct manipulation, natural language (speech, written input), WIMP (windows, icons, menus, pointers), etc.
- The goals of HCI are to produce usable and safe systems, as well as functional systems. In order to produce computer systems with good usability, developers must attempt to :
  1. Understand the factors that determine how people use technology
  2. Develop tools and techniques to enable building suitable systems
  3. Achieve efficient, effective, and safe interaction
  4. Put people first
- Safety : Protecting the user from dangerous conditions and undesirable situations
- Users : Nuclear energy plant or bomb-disposal – operators. It should interact with computer-based systems remotely. Also used in medical equipment in intensive care unit (ICU)
- Data : Prevent user from making serious errors by reducing risk of wrong keys/buttons being mistakenly activated.
- Provide user with means of recovering errors
- Ensure privacy (protect personal information such as habits and address) & security (protect sensitive information such as passwords, VISA card numbers)
- Usability is one of the key concepts in HCI. It is concerned with making systems easy to learn and use. Usable system is :
  1. Easy to learn
  2. Easy to remember how to use
  3. Effective to use
  4. Efficient to use

  5. Safe to use
  6. Enjoyable to use

Q.2 Why HCI is important ?

Ans. : • HCI has become much more important in recent years as computers and embedded devices have become common place in almost all facets of our lives.

- HCI has expanded rapidly and steadily for three decades, attracting professionals from many other disciplines and incorporating diverse concepts and approaches.
- HCI researches the design and use of computer technology, focusing particularly on the interfaces between people (users) and computers.
- HCI is study of design, implementation and evaluation.
- Interaction is a concept to be distinguished from another similar term, interface. Roughly speaking, interaction refers to an abstract model by which humans interact with the computing device for a given task, and an interface is a choice of technical realization.
- Usable and efficient interaction with the computing device in turn translates to higher productivity.
- The spreadsheet interface made business computing a huge success. The internet phenomenon could not have happened without the web-browser interface.
- Smart phones, with their touch-oriented interfaces, have nearly replaced the previous generation of feature phones.
- Body-based and action-oriented interfaces are now introducing new ways to play and enjoy computer games.

Q.3 List the factors affecting human computer interface.

Ans. : • There are a large number of factors which should be considered in the analysis and design of a system using HCI principles. The main factors are listed in the table below :

1. **Organisation Factors :** Training, job design, politics, roles, work organisation
2. **Environmental Factors :** Noise, heating, lighting, ventilation,
3. **The User :** Cognitive processes and capabilities, Motivation, enjoyment, satisfaction, personality, experience
4. **Comfort Factors :** Seating, equipment, layout.
5. **User Interface :** Input devices, output devices, dialogue structures, use of colour, icons, commands, navigation, graphics, natural language, user support, multimedia
6. **Task Factors :** Easy, complex, novel, task allocation, monitoring, skills
7. **Constraints :** Cost, timescales, budgets, staff, equipment, buildings
8. **System Functionality :** Hardware, software, application
9. **Productivity Factors :** Increase output, increase quality, decrease costs, decrease errors, increase innovation

Q.4 Explain disciplines contributing to human computer interaction.

Ans. : Disciplines Contribute to HCI :

1. **Computer Science :** Develop programming languages, system architectures, etc. of the computing systems
2. **Engineering :** Provide faster and cheaper equipment
3. **Linguistics, Artificial Intelligence :** Speech synthesis and recognition, natural language processing, etc.
4. **Psychology :** Provide information about human mental capabilities (e.g., memory, decision making)
5. **Ergonomics (Human Factors) :** Provide information about human physical capabilities

6. **Graphic Design :** Art of combining text and graphics and communicating an effective message in design of posters, brochures, signs, logos & other type of visual communications
7. **Product Design :** Process of planning the product's specification
8. **Industrial Design :** Applied art whereby aesthetics and usability of products may be improved. Aspects include overall shape of the object, colors, textures, sounds

Q.5 Explain any two of the following HCI principles in brief : i) Know of user ii) Understand the task iii) Reduce memory load iv) Strive for consistency v) Prevent errors / Reversal of Action.

☞ **[SPPU : March-19, Marks 4]**

Ans. : • HCI principles are as follows :

1. **Know Thy User :** This principle simply states that the interaction and interface should cater to the needs and capabilities of the target user of the system in design. HCI designers and implementers proceed without a full understanding of the user.
2. **Understand the Task :** Task refers to the job to be accomplished by the user through the use of the interactive system. In fact, understanding the task at hand is closely related to the interaction modeling and user analysis.
3. **Reduce Memory Load :** Designing interaction with as little memory load as possible is a principle that also has a theoretical basis. Humans are certainly more efficient in carrying out tasks that require less memory burden, long or short term. Keeping the user's short-term memory load light is of particular importance with regard to the interface's role as a quick and easy guidance to the completion of the task.
4. **Strive for Consistency :** In the longer term, one way to unburden the memory load is to keep consistency. This applies to both within an application and across different applications and both the interaction model and interface implementation

5. **Remind Users and Refresh their Memory :** Any significant task will involve the use of memory, so another good strategy is to employ interfaces that give continuous reminders of important information and thereby refresh the user's memory. The human memory dissipates information quite quickly, and this is especially true when switching tasks in multitasking situations.

6. **Prevent Errors/Reversal of Action :** While supporting a quick completion of the task is important, error free operation is equally important. As such, the interaction and interface should be designed to avoid confusion and mental overload.

1.2 Basic Human Abilities

Q.6 List human input-output channels and discuss briefly about it.

Ans. : • Human interaction with the outside world occurs through information being received and sent is called input-output channel.

- Human input-output channels vision, hearing, touch, movement etc.
- Human vision is a highly complex activity with a range of physical and perceptual limitations, yet it is the primary source of information for the average person.
- Vision begins with light. The eye is a mechanism for receiving light and transforming it into electrical energy. Light is reflected from objects in the world and their image is focussed upside down on the back of the eye.
- Hearing : The sense of hearing is often considered secondary to sight, but we tend to underestimate the amount of information that we receive through our ears. The human ear can hear frequencies from about 20 Hz to 15 kHz.

- Touch provides us with vital information about our environment. It tells us when we touch something hot or cold, and can therefore act as a warning. It also provides us with feedback when we attempt to lift an object, for example.
- Movement : A simple action such as hitting a button in response to a question involves a number of processing stages

Q.7 Explain role of senses which plays an important role in HCI ?

Ans. : • There are five senses : sight, sound, touch, taste and smell.

- Sight is the predominant sense for the majority of people, and most interactive systems consequently use the visual channel as their primary means of presentation, through graphics, text, video and animation.
- However, sound is also an important channel, keeping us aware of our surroundings, monitoring people and events around us, reacting to sudden noises, providing clues and cues that switch our attention from one thing to another. It can also have an emotional effect on us, particularly in the case of music. Music is almost completely an auditory experience, yet is able to alter moods, conjure up visual images, evoke atmospheres or scenes in the mind of the listener.
- Touch, too, provides important information : tactile feedback forms an intrinsic part of the operation of many common tools – cars, musical instruments, pens, anything that requires holding or moving. It can form a sensuous bond between individuals, communicating a wealth of non-verbal information.
- Taste and smell are often less appreciated but they also provide useful information in daily life: checking if food is bad, detecting early signs of fire, noticing that manure has been spread in a field, pleasure

Q.8 What is human memory ? Explain types of memory.

Ans. : • Memory is a vital part of how we perceive the world around us. Human beings have both short term and long term memory capacities and we can create better designs by understanding how memory works and how we can work with that capacity rather than against it.

- Memory is a collection of systems for the storage and recall of information (personal experiences, emotions, facts, procedures, skills and habits).
- Fig. Q.8.1 shows structure of memory.

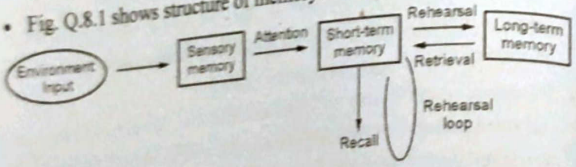


Fig. Q.8.1 Structure of memory

- There are three types of memory or memory function : ***sensory buffers, short-term memory or working memory, and long-term memory.***
- **Sensory memory** is the shortest-term element of memory. It is the ability to retain impressions of sensory information after the original stimuli have ended. It acts as a kind of buffer for stimuli received through the five senses of sight, hearing, smell, taste and touch, which are retained accurately. Short-term memory can be accessed rapidly, in the order of 70 ms.
- **Short-term memory** acts as a kind of "scratch-pad" for temporary recall of the information which is being processed at any point in time

- **Long-term memory** is planned for storage of information over a long period of time. There are two types of long-term memory: episodic memory and semantic memory.

Q.9 Explain difference between short term memory and long term memory.

Ans. :

Short term memory	Long term memory
Capacity is limited	Capacity is more
Information is stored for shorter time	Information is stored for longer time
Information is usually stored in short-term memory in terms of the physical qualities of the experience, such as what we see, do, taste, touch or hear	In long-term memory, information is primarily stored in terms of its meaning or semantic codes
STM is stored and retrieved sequentially	LTM is stored and retrieved by association
Short-term memory is utilized to retain information	Long-term memory is utilized more or less at all times

Q.10 Suggest ideas for an interface which uses the properties of sound effectively.

Ans. : • Speech sounds can obviously be used to convey information. This is useful not only for the visually impaired but also for any application where the user's attention has to be divided (for example, power plant control, flight control, etc.).

- Uses of non-speech sounds include the following :
  1. **Attention :** To attract the user's attention to a critical situation or to the end of a process, for example.
  2. **Status information :** Continuous background sounds can be used to convey status information. For example, monitoring the progress of a process without the need for visual attention.

3. **Confirmation :** Sound associated with an action to confirm that the action has been carried out. For example, associating a sound with deleting a file.
4. **Navigation :** Using changing sound to indicate where the user is in a system. For example, what about sound to support navigation in hypertext ?

Q.11 Write a long term memory model script for case given below. An owner went to veterinary hospital along with dog.

Ans. : Script for a visit to the vet

Entry conditions :	dog ill vet open owner has money	**Roles :**	vet examines diagnoses treats owner brings dog in pays takes dog out
Result :	dog better owner poorer vet richer	**Scenes :**	arriving at reception waiting in room examination paying
Props :	examination table medicine instruments	**Tracks :**	dog needs medicine dog needs operation

Q.12 Design and explain an experiment to investigate the decay aspect of human short term memory.

Ans. : • The student should first choose an aspect to investigate : for example, digit span, recency effect, decay.

- Example solution : STM decay
- Subjects ideally selected to represent population, more probably undergraduate students (try to get a range of academic subjects).
- Sample size : 10+

- Experiment split subjects into two groups. Each subject studies list of 15-20 words
- Subject has to recall list either (a) immediately or (b) after 20 second delay. Measure the number of the words remembered correctly.
- A within-groups design can be used to avoid individual bias or group variation
- Independent variable -- delay in recall
- Dependent variable -- number correctly recalled.
- Group (b) should be given a task to do during the delay period in order to avoid rehearsal. If possible this task should occupy a different channel to minimise interference, e.g. a visual recognition task.
- Hypothesis Those in (b) will perform worse than those in (a) since STM will decay.
- Analysis : graphs to see decay and perform T test
- Short-term memory can be accessed rapidly, in the order of 70 ms. However, it also decays rapidly, meaning that information can only be held there temporarily, in the order of 200 ms.
- Short-term memory also has a limited capacity. There are two basic methods for measuring memory capacity. The first involves determining the length of a sequence which can be remembered in order. The second allows items to be freely recalled in any order. Using the first measure, the average person can remember 7 ± 2 digits.

Q.13 A semantic network is used in modeling the organization of knowledge in memory. Produce a semantic network to train memory for gaining knowledge about all living things.

Ans. : • Semantic memory is structured in some way to allow access to information, representation of relationships between pieces of information, and inference.

- One model for the way in which semantic memory is structured is as a network. Items are associated to each other in classes, and may inherit attributes from parent classes. This model is known as a semantic network.
- Semantic memory typically refers to memory for word meanings, facts, concepts, and general world knowledge.
- For example, you know that a panther is a jungle cat, is more like a tiger than a corgi, and you know better than to try to pet one.
- Two common types of semantic information are conceptual and propositional knowledge. A concept is a mental representation of something, such as a panther, and knowledge of its similarity to other concepts.
- A proposition is a mental representation of conceptual relations that may be evaluated to have a truth value, for example, that a panther is a jungle cat, or has four legs and knowledge that panthers do not have gills.
- Fig. Q.13.1 shows long-term memory may store information in a semantic network.

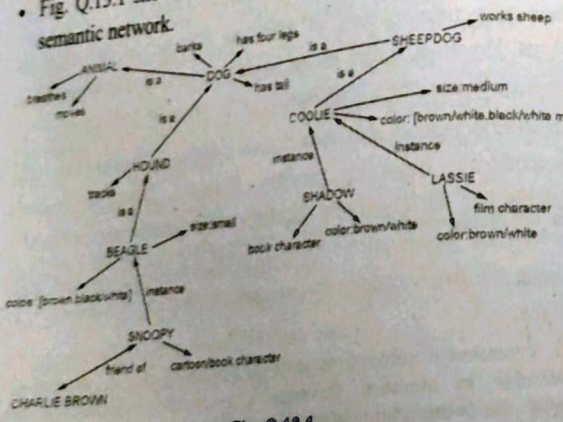


Fig. Q.13.1

- Specific breed attributes may be stored with each given breed, yet general dog information is stored at a higher level. This allows us to generalize about specific cases.
- For instance, we may not have been told that the sheepdog shadow has four legs and a tail, but we can infer this information from our general knowledge about sheepdogs and dogs in general.
- Note also that there are connections within the network which link into other domains of knowledge, for example cartoon characters. This illustrates how our knowledge is organized by association.

Q.14 What is ergonomics ?

Ans. : • Ergonomics means literally the study or measurement of work. In this context, the term work signifies purposeful human function.

- Ergonomics is the science of designing user interaction with equipment and workplaces to fit the user.
- Proper ergonomic design is necessary to prevent repetitive strain injuries, which can develop over time and can lead to long-term disability.
- Ergonomics is employed to fulfill the two goals of health and productivity. It is relevant in the design of such things as safe furniture and easy-to-use interfaces to machines.
- Ergonomics is concerned with the 'fit' between people and their technological tools and environments
- As well as addressing physical issues in the layout and arrangement of the machine interface, ergonomics is concerned with the design of the work environment itself.
- All users should be comfortably able to see critical displays. For long periods of use, the user should be seated for comfort and stability.

- Seating should provide back support. If required to stand, the user should have room to move around in order to reach all the controls.
- Human factors issues arise in simple systems and consumer products as well.
- Some examples include cellular telephones and other hand held devices that continue to shrink yet grow more complex, millions of VCRs blinking "12:00" across the world because very few people can figure out how to program them, or alarm clocks that allow sleepy users to inadvertently turn off the alarm when they mean to hit 'snooze'.
- A user-centered design (UCD), also known as a systems approach or the usability engineering life cycle aims to improve the user-system.
- Ergonomics has a close relationship to human psychology in that it is also concerned with the perceptual limitations of humans. For example, the use of color in displays is an ergonomics issue.
- Ergonomics examines not only the passive ambient situation but also the unique advantages of the human operator and the contributions that can be made if a work situation is designed to permit and encourage the person to make the best use of his or her abilities.
- Human abilities may be characterized not only with reference to the generic human operator but also with respect to those more particular abilities that are called upon in specific situations where high performance is essential.
- For example, an automobile manufacturer will consider the range of physical size and strength of the population of drivers who are expected to use a particular model to ensure that the seats are comfortable, that the controls are readily identifiable and within

reach, that there is clear visibility to the front and the rear, and that the internal instruments are easy to read.

- Ease of entry and egress will also be taken into account.

Q.15 Discuss about entity Human based on following factors : i) Memory ii) Attention iii) Psychology iv) Ergonomics.

Ans. : i) Memory : Refer Q.8

ii) Attention : Attention is used for passing information from sensory memory into short-term memory.

iii) Psychology : Psychological theory has led to the development of analytic and predictive models of user behavior. Psychology also provides a range of empirical techniques which we can employ to evaluate our designs and our systems.

iv) Ergonomics : Ergonomics is traditionally the study of the physical characteristics of the interaction: how the controls are designed, the physical environment in which the interaction takes place, and the layout and physical qualities of the screen

1.3 Computers

Q.16 What is the myth of the infinitely fast machine ?

Ans. : • The adverse effects of slow processing are made worse because the designers labor under the myth of the infinitely fast machine. That is, they design and document their systems as if response will be immediate.

- Rather than blithely hoping that the eventual machine will be 'fast enough', the designer ought to plan explicitly for slow responses where these are possible.
- A good example, where buffering is clear and audible (if not visible) to the user, is telephones.
- Even if the user gets ahead of the telephone when entering a number, the tones can be heard as they are sent over the line. Now

this is probably an accident of the design rather than deliberate policy, as there are so many other problems with telephones as interfaces. However, this type of serendipitous feedback should be emulated in other areas.

Q.17 Explain limitations on interactive performance.

Ans. : • Computation bound : Computation takes ages, causing frustration for the user

- Storage channel bound : Bottleneck in transference of data from disk to memory
- Graphics bound : Common bottleneck: updating displays requires a lot of effort - sometimes helped by adding a graphics coprocessor optimized to take on the burden
- Network capacity : Many computers networked i.e. shared resources and files, access to printers etc. But interactive performance can be reduced by slow network speed

Q.18 Discuss about following computer factors.
i) Speed ii) Interface iii) Widgets

☞ [SPPU : March-19, In Sem, Marks 6]

Ans. : i) Speed : It refers to the speed of your computer's CPU. Hardware makers measure a CPU's clock speed using a unit called gigahertz. A CPU running at 3GHz processes data faster than one running at 1GHz. The speed at which data flows from the CPU to applications also affects the computer's speed.

ii) Interface : graphical interface may involve a set of actions that the user can invoke by use of the mouse and the designer must decide whether to present each action as a 'button' on the screen, which is always visible, or hide all of the actions in a menu which must be explicitly invoked before an action can be chosen.

iii) Widgets : elements of the WIMP interfaces are called widgets and they comprise the toolkit for interaction between user and system. Widgets embody both input and output languages, so we consider

them as interaction objects. The appropriate choice of widgets and wording in menus and buttons will help you know how to use them for a particular selection or action.

1.4 Methods for Evaluation of Interfaces with users

Q.19 What are the goals of Evaluation ? Discuss about DECIDE Evaluation framework. ☞ [SPPU : March-19, In Sem, Marks 6]

Ans. : Goals of Evaluation :

1. To assess the extent and accessibility of the system's functionality,
2. To assess users' experience of the interaction,
3. To identify any specific problems with the system

DECIDE Evaluation framework :

- DECIDE is a framework that is used to guide evaluation
  1. Determine the goals the evaluation addresses.
  2. Explore the specific questions to be answered.
  3. Choose the evaluation paradigm and techniques to answer the questions.
  4. Identify the practical issues.
  5. Decide how to deal with the ethical issues.
  6. Evaluate, interpret and present the data

Q.20 What is observation ?

Ans. : • Observation is a useful data gathering technique at any stage during product development. It helps designers understand the users' context, tasks, and goals.

- Observation conducted later in development, e.g. in evaluation, may be used to investigate how well the developing prototype supports these tasks and goals

- Users may be observed directly by the investigator as they perform their activities, or indirectly through records of the activity that are studied afterwards.
- Observation may also take place in the field, or in a controlled environment. In the former case, individuals are observed as they go about their day-to-day tasks in the natural setting.
- In the latter case, individuals are observed performing specified tasks within a controlled environment such as a usability laboratory.

Q.21 What is evaluation ? List the goal of evaluation.

Ans. : • Evaluation role is to access designs and test systems to ensure that they actually behave as we expect and meet user requirements.

- Ideally, evaluation should occur throughout the design life cycle, with the results of the evaluation feeding back into modifications to the design.

Evaluation has three main goals :

1. To assess the extent and accessibility of the system's functionality
2. To assess users' experience of the interaction
3. To indentify any specific problems with the system.

Q.22 Explain cognitive walkthrough.

Ans. : • Heuristic evaluation can be carried out on a design specification so it is useful for evaluating early design. But it can also be used on prototypes, storyboards and fully running systems. It is a flexible, relatively cheap approach. Hence it is often considered a *discount usability* technique.

- The general idea behind heuristic evaluation is that several evaluators independently review a system to come up with probable usability problems.

- Each evaluator assesses the system and notes violations of any of heuristics that would indicate a probable usability problem.
- The evaluator also assesses the severity of each usability problem, based on four factors : how common is the problem, how easy is it for the user to overcome, will it be a one-off problem or a persistent one and how seriously will the problem be perceived ? These can be combined into an overall severity rating on a scale of 0-4 :

  0 = I don't agree that this is a usability problem at all

  1 = Cosmetic problem only : need not be fixed unless extra time is available on project

  2 = Minor usability problem : fixing this should be given low priority

  3 = Major usability problem : important to fix, so should be given high priority

  4 = Usability catastrophe : imperative to fix this before product can be released (Nielsen)

- Nielsen recommends the use of ten heuristics given below as providing the most effective coverage of the most common usability problems,

1. **Visibility of system status** : Always keep users informed about what is going on, through appropriate feedback within reasonable time.
2. **Match between system and the real world** : The system should speak the user's language, with words, phrases and concepts familiar to the user, rather than system-oriented terms.
3. **User control and freedom** : Users often choose system functions by mistake and need a clearly marked 'emergency exit' to leave the unwanted state without having to go through an extended dialog. Support undo and redo.
4. **Consistency and standards** : Users should not have to wonder

whether words, situations or actions mean the same thing in different contexts.

5. **Error prevention** : Make it difficult to make errors.
6. **Recognition rather than recall** : Make objects, actions and options visible. The user should not have to remember information from one part of the dialog to another.
7. **Flexibility and efficiency of use** : Allow users to tailor frequent actions.
8. **Aesthetic and minimalist design** : Dialogs should not contain information that is irrelevant or rarely needed.
9. **Help users recognize, diagnose and recover from errors** : Error messages should be expressed in plain language (no codes), precisely indicate the problem and constructively suggest a solution.
10. **Help and documentation** : Few systems can be used with no instructions so it may be necessary to provide help and documentation.

Q.23 Explain Nielsen's ten heuristics.

Ans. : Nielsen's ten heuristics are :

1. **Visibility of system status :** The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.
2. **Match between system and the real world :** The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.
3. **User control and freedom :** Users often choose system functions by mistake and will need a clearly marked "emergency exit" to

leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

4. **Consistency and standards :** Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.
5. **Error prevention :** Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.
6. **Recognition rather than recall :** Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another
7. **Flexibility and efficiency of use :** Accelerators unseen by the novice user, may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.
8. **Aesthetic and minimalist design :** Dialogues should not contain information which is irrelevant or rarely needed
9. **Help users recognize, diagnose, and recover from errors :** Error messages should be expressed in plain language, precisely indicate the problem, and constructively suggest a solution.
10. **Help and documentation :** Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation.

Q.24 Explain advantages and disadvantages of Cognitive Walkthrough.

Ans. : Advantages :

- Permits early evaluation of designs at the prototyping stage or without a mockup.

- Helps the designer assess how the features of their design fit together to support users' work.
- Provides useful feedback about action sequences.
- Assists designer by providing reasons for trouble areas.
- Provides indications of the users' mental
- Processes, which helps build a successful interface that accommodates users.

Disadvantages :

- Relies on analysis rather on user testing.
- Provides a detailed examination of a particular task rather than an overview of the interface.
- Provides no quantitative data.

Q.25 Explain advantages and disadvantages of Heuristic Evaluation

Ans. : Advantages :

- Relatively inexpensive and fast
- Performed at any phase of product development
- Identifies many problems
- Achieves substantially better performance by aggregating the evaluation from several evaluators
- Provides an overview of the complete design
- Pays direct attention to particular aspects of a design and associated problems
- Does not attempt to trace specific
- User behavior, rather it critiques the attribute of an interface itself

Disadvantages :

- Relies on analysis rather on user testing
- Relies on the judgment of the evaluator and his/her level of expertise

Q.26 What influence does the social environment in which you work have on your interaction with the computer ? What effect does the organization to which you belong have on the interaction ?

Ans. : • The particular influences will vary from environment to environment, but consider some of the following :

1. **Work context :** Is the work place shared ? Are the machines shared ?
2. **Peer pressure :** Is there pressure to compete or impress ?
3. **Management pressure :** Is there pressure to achieve ? Is the interaction carried out in the presence of management ?
4. **Motivation :** What motivates the interaction ? Does this encourage or discourage experimentation ?
5. **Organizational goals :** What is the objective of the organization? How does this affect the interaction ?
6. **Organizational decision making :** Who determines the systems that you use ? Do you have any choice or influence ? Does this influence the way you interact with the system ?

- In each case consider what influence there may be on the interaction. It may be helpful to consider other possible environments in order to identify how the interaction would differ under these different circumstances.

Q.27 What is constructive interaction ?

Ans. : • The constructive interaction is a method based on the observation of a user during his service experience.

- The user is asked to think out loud while performing a given set of tasks, so that the evaluators could listen to and record his thoughts.
- If this kind of evaluation takes place with two users interacting with the system simultaneously, the inspectors could obtain a more natural way of thinking aloud and more effective results.

Q.28 Explain two distinct evaluation styles of usability with their advantages and disadvantages.

Ans. : • Two distinct evaluation styles are laboratory studies and field studies.

- **Laboratory studies :**
  - Users are taken out of their normal work environment to take part in controlled tests, often in a specialist usability laboratory
  - A well-equipped usability laboratory may contain sophisticated audio/visual recording and analysis facilities, two-way mirrors, instrumented computers and the like, which cannot be replicated in the work environment.
  - **Advantages :**
    1. Specialist equipment available
    2. Uninterrupted environment
  - **Disadvantages :**
    1. Lack of context
    2. Difficult to observe several users cooperating
- **Field studies :**
  - It takes the designer or evaluator out into the user's work environment in order to observe the system in action
  - On balance, field observation is to be preferred to laboratory studies as it allows us to study the interaction as it occurs in actual use
  - **Advantages :**
    1. Natural environment
    2. Context retained
    3. Longitudinal studies possible
  - **Disadvantages :**
    1. Distractions problem
    2. Noise is more

Q.29 Define Feedback.

Ans. : The system should always keep users informed about what is going on through appropriate feedback within reasonable time. System feedback should be expressed in the users' language to guide and provide effective feedback. It must be provided in case of system failure.

Q.30 Explain interviews and questionnaires of query techniques.

Ans. : 1. Interviews :

- Interviewing users about their experience with an interactive system provides a direct and structured way of gathering information.
- Effective for high level evaluation - preferences, impressions, attitudes.
- Often structured in a top down style, starting with general questions about the task, and moving on to more leading questions.
- It must be well planned in advance, with central questions prepared. This may be important to ensure consistency between interviews from different interviewees, and by different interviewers.
- It is crucial that the designer of the system being evaluated does not conduct the interview! They will be unable to avoid giving off 'body language' signals which are likely to bias responses.
- Advantages
  1. Level of questioning can be varied to suit the context.
  2. Interesting issues can be probed as they arise.
- Disadvantages
  1. Depending on degree of structure, encoding of results may be problematic.
  2. Personality and style of the interviewer may affect response.

2. Questionnaires

- A questionnaire is a method for the elicitation, and recording, and collecting of information.
- Design of the questionnaire is crucial. This requires that the following must be clearly established.
- Advantages
  1. Reach a wider subject group.
  2. Takes less time to administer.
  3. Can be rigorously analysed.
  4. Can be administered throughout the design process.
- Disadvantages
  1. Less flexible than interview - questions fixed in advance.
  2. Likely to be less probing.

Q.31 What is introspection ? explain.

Ans. : • Introspection is when you think about your emotions, motivations, thoughts, and behaviors.

- It's also a great way to develop a higher awareness of not only yourself and how you tick, but also how you perceive the world around you. Everyone is introspective in day-to-day life without even realizing it.
- Introspection is frequently used in the counseling process. During counseling, clients are encouraged by their therapists to examine their own beliefs, feelings, thoughts, and behaviors to find out who they are and how or why they are reacting to what they're going through.
- Introspection can benefit people that do it on a regular basis who 'check-in' with themselves on how they feel about something.
- Introspection can be done in a variety of ways. You have freedom of choice. Whether it's going to talk therapy, journaling, or just thinking by yourself - do whatever works best for you.
- The process can change and grow for you as time goes on.

Q.32 The cognitive walkthrough is a formalized way of imagining peopel's thoughts and actions when they use an interface for the first time. During a cognitive walkthrough the evaluator needs to ask four questions as below.

i) Is the effect of the action the same as the user's goal at that point ?

ii) Will users see that the action is available ?

iii) Once users have found the correct action, will they know it is the one thy need ?

iv) After the action is taken, will users understand the feedback they get ?

Given below is an action sequence for creating a customized voicemail message on an iPhone.

1) Tap Voicemail
2) Tap Greeting
3) Tap Custom
4) Tap Record and speak your greeting.
5) When you finish, tap Stop.
6) To listen to your greeting, tap Play.
7) To re-record, repeat steps 4 and 5.
8) Tap Save.

Imagine an iPhone interface and create a report of the cognitive walkthrough for the above mentioned task in context with the review questions.

Ans. : • Formalized way of imagining people's thoughts and actions when they use an interface for the first time.

- First select a task that the design is intended to support.
- Then try to tell a believable story about each action a user has to take to do the task.
- To make the story believable, you have to motivate each of the user's actions, relying on the user's general knowledge and on the prompts and feedback provided by the interface. If you can't tell a believable story about an action, then you've located a problem with the interface.
- Question assumptions about what the users will be thinking
- Identify controls that may be missing or hard to find
- Note inadequate feedback.
- Suggest difficulties with labels and prompts.

- Vocabulary Problem : On a piece of paper write the name you would give to a program that tells about interesting activities occurring in some major metropolitan area.
- Focus most clearly on problems that users will have when they first use an interface, without training.
- Not a technique for evaluating the system over time (e.g., how quickly a user moves from beginner to intermediate).
- Most effective if designers can really create a mental picture of the actual environment of use.
- Prior to doing a walkthrough, you need four things :
  1. You need a description of a prototype of the interface. It doesn't have to be complete, but it should be fairly detailed. Things like exactly what words are in a menu can make a big difference.
  2. You need a task description (for a representative task).
  3. You need a complete, written list of the actions needed to complete the task.
  4. You need an idea of who the users will be and what kind of experience they'll bring to the job.

1.5 Choosing an Evaluation Method

Q.33 List the factors that distinguishing evaluation techniques.

Ans. : • There are eight factors that distinguish different evaluation techniques and therefore help us to make an appropriate choice.

- These are :
  1. The stage in the cycle at which the evaluation is carried out
  2. The style of evaluation
  3. The level of subjectivity or objectivity of the technique
  4. The type of measures provided
  5. The information provided
  6. The immediacy of the response

  7. The level of interference implied
  8. The resources required.

Q.34 Design an experiment to test whether adding color coding to an interface will improve accuracy. Identify your hypothesis, participant group, dependent and independent variables, experimental design, task and analysis approach.

Ans. : • The following is only an example of the type of experiment that might be devised.

1. **Participants :** Taken from user population.
2. **Hypothesis :** Color coding will make selection more accurate.
3. **IV (Independent Variable) :** Color coding.
4. **DV (Dependent Variable) :** Accuracy measured as number of errors.
5. **Design :** Between-groups to ensure no transfer of learning (or within-groups with appropriate safeguards if participants are scarce).
6. **Task :** The interfaces are identical in each of the conditions, except that, in the second, color is added to indicate related menu items. Participants are presented with a screen of menu choices (ordered randomly) and verbally told what they have to select. Selection must be done within a strict time limit when the screen clears. Failure to select the correct item is deemed an error. Each presentation places items in new positions. Participants perform in one of the two conditions.
7. **Analysis :** t test.

END ...

Unit - II

2 The Design Process

2.1 : Interaction Design Basics

Q.1 What is interaction ? Explain general interaction framework with diagram.

Ans. : • Interaction : The communication between the user and the system

- Domain : Area of expertise and knowledge in real-world activity
- Tasks : Operations to manipulate the concepts of a domain
- Goal : Desired output from a performed task
- Intention : Specific action required to meet goal.
- Task Analysis : Identification of problem space for the user in terms of the domain, goals intentions and tasks.
- Fig. Q.1.1 shows general interaction framework. Interaction framework has 4 parts : User, Input, System and Output

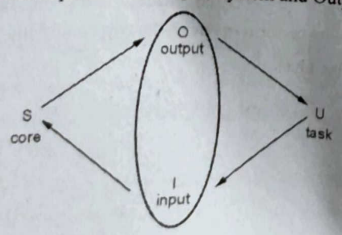


Fig. Q.1.1 : General interaction framework

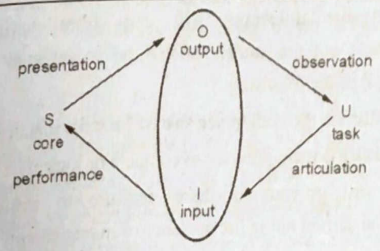


Fig. Q.1.2 : Translation between components

- Each has its own unique language. Interaction necessitates translation between languages
- Problems in interaction occur when translation between one language and the next is difficult, or impossible.
  1. User intentions translated into actions at the interface.
  2. Translated into alterations of system state,
  3. Which in turn are reflected in the output display
  4. Which is interpreted by the user.
- Some systems are harder to use than others
- Gulf of Execution - User's formulation of actions may be different to those actions allowed by the system
- Gulf of Evaluation - User's expectation of the changed system state may be different to the actual presentation of this state

Q.2 What influence does the social environment in which you work have on your interaction with the computer ? What effect does the organization (commercial or academic) to which you belong have on the interaction ?

Ans. : • The aim is to get the student to explore the social and environmental influences which effect interaction, often without the user being aware of them.

- The particular influences will vary from environment to environment but the student should be encouraged to consider some or all of the following.
- Work context is the work place shared ? are the machines shared?
- Peer pressure is there pressure to compete or impress ?
- Management pressure is there pressure to achieve? Is the interaction carried out in the presence of management?
- Motivation mean what motivates the interaction? Does this encourage or discourage experimentation?
- Organizational goals : what is the objective of the organization ? (profit ? education ? etc.) How does this effect the interaction ?
- Organizational decision making - who determines the systems that you use ?
- Do you have any choice or influence ? Does this influence the way you interact with the system ?
- In each case the student should discuss what influence this may have on the interaction. It may be helpful to consider other possible environments in order to identify how the interaction would differ under these different circumstances.
- For example, if the student currently shares a machine with colleagues, would his/her interaction practice change if she/he was given a private machine ?

Q.3 There are four main translations involved in the interaction framework viz. articulation, performance, presentation and observation.

i) **The compact disk player has a button for power off. However its remote control does not have a power off button.**

ii) **It is difficult in a command line interface to determine the result of copying and moving files in a hierarchical file system.**

iii) **User is unable to figure out which switches from the bank to turn on to lit the front portion of a classroom.**

iv) **The user is unable to know whether the voice recorder is in playing or recording state.**

Specify in each of the above four cases which of the interaction framework translations are in effective.

Ans. :

i) **Performance :** Performance is the interface's translation of the input language into stimuli to the system. This translation is determined by the designer or programmer (not the user).

ii) **Presentation :** Presentation is the translation of the system's new state into the output language of the interface. This translation is determined by the designer or programmer.

iii) **Articulation :** Articulation is the user's translation of their task into the input language.

iv) **Observation :** Observation is the translation of the output language into personal understanding. This translation is done by the user.

Q.4 Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks. What are implications of this for interaction design ?

Ans. : • It suggests that in situations of stress, people will be less able to cope with complex problem solving or managing difficult interfaces, whereas if people are relaxed they will be more forgiving of limitations in the design.

- This does not give us an excuse to design bad interfaces but does suggest that if we build interfaces that promote positive responses - for example by using aesthetics or reward - then they are likely be more successful.
- Positive affect is associated with other characteristics of people who tend to be happier, like optimism, extraversion, and success
- Positive affect can be developed and cultivated. While affectivity is somewhat inborn, meaning that some people are simply born with a greater propensity for being in a good mood as part of their personality, there are many things you can do to get into the habit if

experiencing positive affect more often in your life, and making your good moods even better.

Q.5 What is design ? What is the golden rule of design ? Illustrate the process of interaction design.

Ans. : • 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 :

1. **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.

Interaction design process :

- Fig. Q.5.1 shows Interaction design process.

(Refer Fig. Q.5.1 on next page)

- **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.

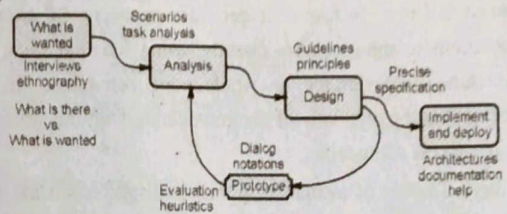


Fig. Q.5.1

- **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.

2.2 Interaction Styles

Q.6 Describe briefly four different interaction styles used to accommodate the dialog between user and computer.

Ans. : These are the commonest interaction styles :

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.
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.

Q.7 Enlist different interaction styles and describe different interaction styles used to accommodate the dialog between user and computer.

Ans. : • Interaction can be seen as a dialog between the computer and the user.

- Different interaction 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.

- **Command line interface :** Interaction between user and computer where user input series of command lines into program.
- **Menus :** Series of drop down menu that logically grouped where user is presented with choice of already implemented commands. In this style, user's selection (by point and click) is required.
- **Natural language :** Series of plain-text instruction given to computer by user. Problem with this style lies in ambiguity of natural language. Computers have difficulty understanding preciously what is being said and meant.
- **Question/answer and query dialog :** Composed of series of questions and user is presented with an selection of choices or an input field. Prefect example of this style of interaction would be Web questionnaires/surveys.
- Form-filling interfaces are used primarily for data entry but can also be useful in data retrieval applications. The user is presented with a display resembling a paper form, with slots to fill in.
- 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.
- 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.

- 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.
- 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.

Q.8 What is WIMP ? Explain elements of WIMP interfaces.

Ans. : • 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.
- Windows can contain text, graphics, menus, toolbars, etc. It can be moved, resized, closed, minimized, maximized.

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.
- A well-designed icon improves the user experience. An icon difficult to understand, vague but results in frustrating user experiences.

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. Pointer

- 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).

Q.9 What is the difference between menu bar and toolbar ? Many times users face problems in understanding/learning toolbar icons, how to resolve this issue ?

Ans. : • 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.

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

2.3 HCI in the Software Process

Q.10 What is prototype ? Explain different types of rapid prototyping techniques. ☞ [SPPU : March-19, In Sem, Marks 6]

Ans. : • A **prototype** is an example that serves as a basis for future models. Prototyping gives designers an opportunity to research new alternatives and test the existing design to confirm a product's functionality prior to production.

- Prototyping is an example of what is known as a hill-climbing approach.

- **Rapid prototyping** is an instructional design approach that combines the design, developmental, and evaluation phases. It is a non-linear approach that produces a sample working model that is a scaled-down representative version of the whole course.
- Three main approach of prototyping are throw-away, incremental and evolutionary.

Types of rapid prototyping :

- Storyboard, paper prototype, wireframes and mock up review form are the types of rapid prototyping.

1. **Storyboard :** It is a graphical depiction of the outward appearance of the intended system, without any accompanying system functionality. Storyboards do not require much in terms of computing power to construct.
   - Storyboarding allows you to check your design is on target with expectations before investing time in developing.
   - Modern graphical drawing packages now make it possible to create storyboards with the aid of a computer instead of by hand.
2. **Paper prototype :** Easy and fast to do. It helps you think of specifics. Usually good as a first round prototype. It can still do usability testing, even with paper.
3. **Wireframe :** Wireframes are the first stage of the design process and help us to understand the key user journeys, information structuring, modes of interaction and functionality.

- Wireframes or 'page schematic' are a basic outline or skeleton of your key website pages, drawn to show the elements of a page, their relationships, position, and their relative importance.
- They indicate the information types present, navigation, signposting, branding and content areas. They are black and white schematics presented either in PowerPoint or as a clickable web prototype.

4. **Mock-up** is a scale or full-size model of a design or device, used for design evaluation, promotion. A mockup is a prototype

if it provides at least part of the functionality of a system and enables testing of a design. Mock-ups are used by designers mainly to acquire feedback from users.

Q.11 What is throw-away prototyping ?

Ans. : • A prototype which is usually a practical implementation of the system is produced to help discover requirements problems and then discarded. The system is then developed using some other development process

- Fig. Q.11.1 shows Throw-away prototyping within requirements specification.

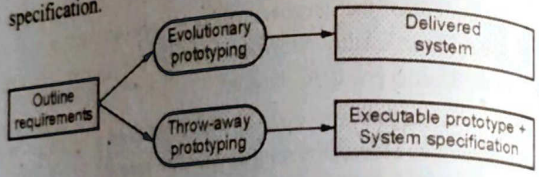


Fig. Q.11.1 : Throw-away prototyping within requirements specification

- The prototype is built and tested. The design knowledge gained from this exercise is used to build the final product, but the actual prototype is discarded.
- Used to reduce requirements risk.
- The prototype is developed from an initial specification, delivered for experiment then discarded.
- The throw-away prototype should NOT be considered as a final system
  a. Some system characteristics may have been left out
  b. There is no specification for long-term maintenance
  c. The system will be poorly structured and difficult to maintain

Q.12 Explain evolutionary prototyping.

Ans. : • An approach to system development where an initial prototype is produced and refined through a number of stages to the final system.

- It must be used for systems where the specification cannot be developed in advance e.g. AI and user interface systems.
- Based on techniques which allow rapid system iterations.
- Verification is impossible as there is no specification. Validation means demonstrating the adequacy of the system evolutionary prototyping
- Fig. Q.12.1 shows evolutionary prototype.

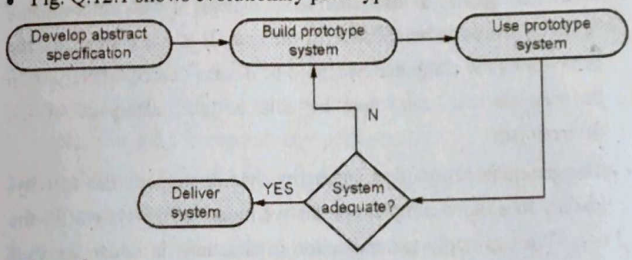


Fig. Q.12.1 : Evolutionary prototype

- Specification, design and implementation are inter-twined. The system is developed as a series of increments that are delivered to the customer.
- User interfaces are usually developed using a GUI development toolkit.

Advantages :

- Accelerated delivery of the system : Rapid delivery and deployment are sometimes more important than functionality or long-term software maintainability

- User engagement with the system : Not only is the system more likely to meet user requirements, they are more likely to commit to the use of the system

2.4 : HCI Design Principle

Q.13 Define the following : Learnability, Predictability, Generalizability and Consistency.

Ans. : • Learnability concerns the features of the interactive system that allow novice users to understand how to use it initially and then how to attain a maximal level of performance.

- Predictability is a user-centered concept; it is deterministic behavior from the perspective of the user. It is not enough for the behavior of the computer system to be determined completely from its state, as the user must be able to take advantage of the determinism.
- The generalizability of an interactive system supports this activity, leading to a more complete predictive model of the system for the user. We can apply generalization to situations in which the user wants to apply knowledge that helps achieve one particular goal to another situation where the goal is in some way similar. Generalizability can be seen as a form of consistency.
- Consistency relates to the likeness in behavior arising from similar situations or similar task objectives. Consistency is probably the most widely mentioned principle in the literature on user interface design.

Q.14 Explain different stages in the design.

Ans. : • **Concept Design :** Every possible approaches are sketched out. The validity of each sketches is verified following the usability requirements and the goals agreed. At the end, the best approach is selected.

- **Interaction Design :** In this step, the structure of the UI must be set by naming interaction flows. Method : e.g. Affinity diagramming, each action can be written on a Post-It note, and organised in clusters. The Post-It notes are then rearranged to simplify user tasks.
- **Screen Design :** Creating rough designs of the screens' structure. These layouts are linked together and usability test is performed with a user.
- **Testing :** A user is asked to follow a realistic scenario/tasks on the sketched out prototype.

Q.15 Write in details all principles to support usability.

☞ [SPPU : March-19, In Sem, Marks-6]

Ans. : • The principles are divided into three main categories :

1. **Learnability :** The ease with which new users can begin effective interaction and achieve maximal performance.
2. **Flexibility :** The multiplicity of ways in which the user and system exchange information.
3. **Robustness :** The level of support provided to the user in determining successful achievement and assessment of goals.

- The consistency, it can take many forms, because it is usually referred to in relation to some other feature of the interaction between user and system. There are consistency related to the following principles :
- Familiarity - consistency with respect to prior real-world experience.
- Generalizability - consistency with respect to experience with the same system or set of applications on the same platform.
- In addition, we could interpret some other principles as contributors to consistency :

- Affordance - consistency with understood intrinsic properties of an object, so a soft button on the screen should allow us to always 'push' on it to select some action :
- Predictability - consistency of system response with user's expectation, given the user has some information about past interaction history.
- Substitutivity - consistent permission from system to allow use of equivalent values for input and output.
- Commensurate effort - consistency of effort with respect to doing and undoing tasks.
- Response time stability - consistency of system response for similar actions.
- Some other principles for consistency from the text and elsewhere :
- Consistency can be relative to the form of input/output expressions relative to the user's conceptual model of the system. An example in the text involves using keys whose relative positions are similar to commands for the systems (any set of four typewriter keys that form a diagonal to indicate up, down, left and right information for an input command).
- Consistency can be with respect to social or cultural conventions (e.g., using red to indicate stop or hot, green for go, blue for cool).

2.5 Design Standard and Guidelines

Q.16 What is the definition of usability as per ISO 9241 standard ? Effective applications are both consistent within themselves and consistent with one another. Discuss that in context of Microsoft Office products.

Ans. : • **Usability :** The effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments.

- **Effectiveness :** The accuracy and completeness with which specified users can achieve specified goals in particular environments.
- **Efficiency :** The resources expended in relation to the accuracy and completeness of goals achieved.
- **Satisfaction :** The comfort and acceptability of the work system to its users and other people affected by its use.
- The strength of a standard lies in its ability to force large communities to abide, the so-called authority.
- The authority of a standard (or a guideline, for that matter) can only be determined from its use in practice.
- Some software products become de facto standards long before any formal standards document is published, for example, the X windowing system).
- Usability test of Microsoft word :

Task 1 : Create New Document

Task 2 : Save Document under Custom Title

Task 3 : Choose Custom Font

Task 4 : Paragraph Formatting

Task 5 : Creating Table of Contents

Task 6 : Add Page Numbers

Task 7 : Upload/Format Image

Q.17 Explain basic categories of the Smith and Mosier guidelines. Also explain guidelines for data entry.

Ans. : Basic categories of the Smith and Mosier guidelines are as follows :

1. Data entry
2. Data display
3. Sequence control
4. User guidance

5. Data transmission
6. Data protection

- Smith and Mosier (1986) guidelines for data entry :

1. Consistency of data-entry transactions : Similar sequences of actions should be used under all conditions.
2. Minimal input actions by user : Greater productivity, fewer chances for error.
3. Minimal memory load on users : Should not be required to memorize lengthy lists of commands,
4. Compatibility of data entry with data display.
5. Flexibility for user control of data entry.

2.6 Golden Rules and Heuristics

Q.18 Write and explain Shneiderman's eight golden rules of interface design. ☞ [SPPU : March-19, In Sem, Marks 4]

Ans. : Shneiderman's 8 golden rules are as follows :

1. **Strive for consistency :** Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout.
2. **Enable frequent users to use shortcuts :** As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.
3. **Offer informative feedback :** For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

4. **Design dialog to yield closure :** Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.
5. **Offer simple error handling :** As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.
6. **Permit easy reversal of actions :** This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.
7. **Support internal locus of control :** Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.
8. **Reduce short-term memory load :** The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

Q.19 Brief about Norman's seven principles for transforming difficult tasks into simple ones. ☞ [SPPU : March-19, In Sem, Marks 4]

Ans. : Norman's 7 principles are as follows :

1. Use both knowledge in the world and knowledge in the head.
2. Simplify the structure of tasks.
3. Make things visible : bridge the gulfs of execution and evaluation.

4. Get the mappings right.
5. Exploit the power of constraints, both natural and artificial.
6. Design for error.
7. When all else fails, standardize.

2.7 HCI Patterns

Q.20 Explain characterized features of patterns and Pattern languages .

- They capture design practice and embody knowledge about successful solutions.
- They capture the essential common properties of good design
- They represent design knowledge at varying levels, ranging from social and organizational issues through conceptual design to detailed widget design.
- They are not neutral but embody values within their rationale.
- The concept of a pattern language is generative and can therefore assist in the development of complete designs.
- They are generally intuitive and readable and can therefore be used for communication between all stakeholders.

2.8 Direct Manipulation

Q.21 What is Direct Manipulation (DM) ?

- 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.

- 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

Q.22 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.

Ans. : • **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.

2.9 Universal Design

Q.23 What is universal design ?

Ans. : The design and composition of an environment so that it may be accessed, understood and used

a) To the greatest possible extent

b) In the most independent and natural manner possible

c) In the widest possible range of situations

d) Without the need for adaptation, modification

- Universal Design should incorporate a two level approach :

1. **User-aware design :** Pushing the boundaries of 'mainstream' products, services and environments to include as many people as possible.
2. **Customisable design :** Design to minimize the difficulties of adaptation to particular users

Q.24 Explain universal design principle.

Ans. : Universal design principles are as follows :

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

2.10 User Centered Design

Q.25 What is user-centered design ? Explain Normans seven principles of design for the designer.

Ans. : • **User-Centered Design** (UCD) is a broad term to describe design processes in which end-users influence how a design takes shape. It is both a broad philosophy and variety of methods.

- Norman (1988) suggested that the following seven principles of design are essential for facilitating the designer's task :

1. Use both knowledge in the world and knowledge in the head. By building conceptual models, write manuals that are easily understood and that are written before the design is implemented.
2. Simplify the structure of tasks. Make sure not to overload the short-term memory, or the long term memory of the user.
3. Make things visible : Bridge the gulfs of execution and evaluation
4. Get the mappings right. One way to make things understandable is to use graphics.

5. Exploit the power of constraints, both natural and artificial, in order to give the user the feel that there is one thing to do.
6. Design for error. Plan for any possible error that can be made, this way the user will be allowed the option of recovery from any possible error made.
7. When all else fails, standardize. Create an international standard if something cannot be designed without arbitrary mappings

Q.26 List advantages and disadvantages of user centered design.

Ans. : Advantages :

1. The collaborative process generated more creative design solutions to problems.
2. Products require less redesign and integrate into the environment more quickly.
3. Users develop a sense of ownership for the product.
4. More satisfaction to the user.

Disadvantages:

1. It is more costly and time consuming.
2. May be difficult to translate some types of data into design.
3. May require the involvement of additional design team members and widerange of stakeholders.

Q.27 Why empathy is important for human centered design ?

Ans. : • Empathy is one way of thinking about the difference between art and design.

- If art is about exploring the possibility of human imagination and expressing this through physical media, design is about exploring the possibility of human imagination and connecting this to the reality of people's lives.

- Design is about being helpful and useful as well as being provocative and surprising. Design makes "the art of the possible" a collective endeavor.
- Empathy is the center piece of a human-cantered design process. The Empathize mode is the work you do to understand people within the context of your design challenge.
- It is your effort to understand the way they do things and why, their physical and emotional needs, how they think about world, and what is meaningful to them.
- As a design thinker, the problems you are trying to solve are rarely your own, they are those of a particular group of people; in order to design for them, you must gain empathy for who they are and what is important to them.
- User-centered design is an iterative design process in which designers focus on the users and their needs in each phase of the design process. UCD calls for involving users throughout the design process via a variety of research and design techniques so as to create highly usable and accessible products for them.

Q.28 A software for handling meetings (diary or calendar) electronically needs to be developed. Identify any frequent task that will be performed on this system and specify its usability specifications assuming the new system will be a replacement of the old paper - based system. What assumptions you need to make about its user ?

Ans. : • Scheduling a meeting that involves diverse commitments and people from different background and with different preferences is a difficult task. A tool for scheduling a meeting provides a mechanism for better time planning and utilization.

- Fig. Q.28.1 shows outline sketch of electronic calendar.

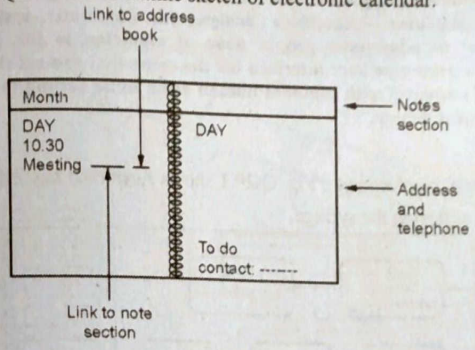


Fig. Q.28.1

- **Assumptions are as follows :**
  1. Identify needs and establishing requirement.
  2. Develop alternative designs that meets those requirements.
  3. Building interactive versions so that they can be communicated
  4. Evaluating design.
- While designing , make sections for month, time, day and other. We can also add section number and notes.
- We can also add hyperlinks to make it easier for navigations. We also requires address, email and phone numbers.
- Search facility is also added for searching particular name or phone number.
- We can keep maps, appointments, small notes.
- One more parameter is thinking about interface and look. The exact steps to produce product will vary from designer to designer and product to product.

Q.29 Understanding users and their behavior is an important factor influencing user - interface design. An automatic syringe is designed to administer proper dose of medicine to the patient. Create a prototype user interface for the same that can set the dose (4 digit numeric) with minimal human error while setting the dose. Justify your design.

Ans. :

User interface prototype : Fig. Q.29.1 shows functional block diagram process of dosing the syringe.

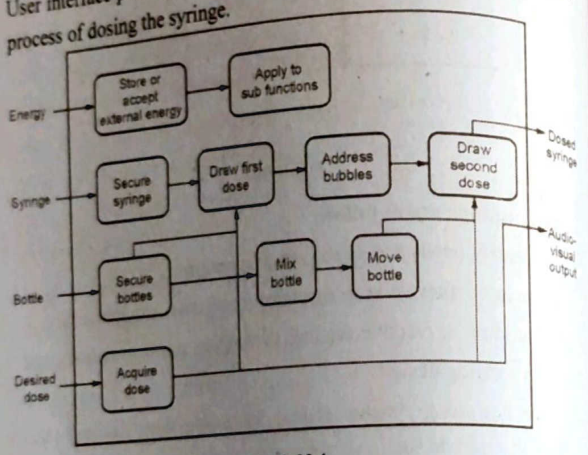
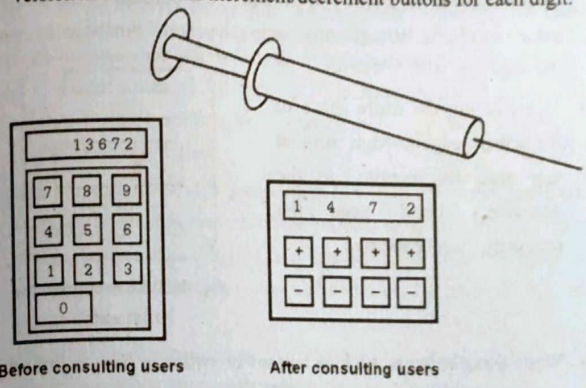


Fig. Q.29.1

- Many designers will build a system that they find easy and pleasant to use, and they find it incomprehensible that anyone else could have trouble with it. Simply sitting someone down with an early version of an interface is enormously valuable.
- Where possible, the eventual users should be involved in the design process. They have vital knowledge and will soon find flaws.
- A mechanical syringe was once being developed and a prototype was demonstrated to hospital staff. Happily they quickly noticed the potentially fatal flaw in its interface

- The doses were entered via a numeric keypad: an accidental key press and the dose could be out by a factor of 10! The production version had individual increment/decrement buttons for each digit.



Before consulting users **After consulting users**

Fig. Q.29.2 : Prototype

- People are complicated, so you won't get it right first time. Programming an interface can be a very difficult and time-consuming business.
- So, the result becomes precious and the builder will want to defend it and minimize changes.
- Making early prototypes less precious and easier to throw away is crucial.

Q.30 Create a prototype user-interface for a digital wrist watch. How will you make sure that user using analogue wrist watch will have no problem using new design ?

Ans. : • A wristwatch is designed to be worn around the wrist, attached by a watch strap or other type of bracelet.

- To help designers prototype user interfaces, it serve as a good starting point for conceptualizing and arranging UI elements.

- When you begin to design your screens, the first principle that's important to remember is that you don't have the affordance of the screen size, which forces you to focus your purpose of the screens more carefully, emphasizing only the core functionality and message you wish to deliver.
- You can use the entire space of the screen, edge-to-edge, without any need for margins, as the wearable's bezel adds the necessary visual padding.

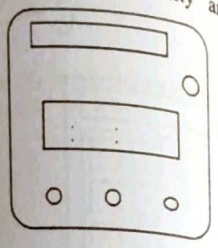


Fig. Q.30.1 : Prototype for wrist watch

- When using controls, such as buttons or switches, look to limit the number of elements stacked horizontally (side-by-side) to three at the most, in order to avoid hampering the tap-target of each element.
- Less-frequently used buttons should be placed in the contextual menu, instead of cluttering the active screen interface.
- Circular icons have the advantage of having the "ability to have more points adjacent to your finger at the same distance when touching the screen. With squares, the path to the next item would be variable and there would be a smaller limit to the number of items you could fit around a touch point."
- When designing your icons, you will design them as square images and then the system itself masks the icons to create the circular shape automatically.
- Human User Interface Guide promotes a strong distinction in contrast between text and background, while avoiding bright colors. You should make use of one primary (key) color that symbolizes your app's branding, which would feature prominently

in distinct labeling, such as for titles or to discern important information.

Q.31 How to get to know the system users ? Explain various methods adopted in user - centered design. What are the people directly or indirectly affected by a student registration system ?

Ans. : • User Centered Design (UCD) is an approach to interactive system development that focuses specifically on making systems or applications easy to use

- The purpose of User Centred Design (UCD) is to involve end users in the development process of the product or system in a way that the prototypes and designs, and finally the products or systems would meet the needs and requirements of the users as well as possible.
- Usability can be defined as the measure of the quality of a user's experience when interacting with a product or service
- Usability is recognized as one of the most important characteristics of systems and products. Usable systems are easy to learn, efficient to use, not error prone, and satisfactory in use.

1. With close user involvement, products are more likely to meet users' expectations and requirements. This leads to increased sales and lower costs incurred by customer services.
2. Systems designers tailor products for people in specific contexts and with specific tasks, thereby reducing the chances of situations with a high risk of human error arising. UCD leads to safer products.
3. Putting designers in close contact with users means a deeper sense of empathy emerges. This is essential in creating ethical designs that respect privacy and the quality of life.
4. By focusing on all users of a product, designers can recognize the diversity of cultures and human values through UCD - a step in the right direction towards creating sustainable businesses.

- People directly or indirectly affected by a student registration system are university, college, teacher, student, parents, timetable scheduler etc.

2.11 GOMS

Q.32 What is GOMS ? List and explain elements of GOMS.

Ans. :

- The GOMS is an acronym for goals, operators, methods and selection. GOMS is a task analysis technique.
- GOMS is family of user interface modeling techniques.
- The GOMS model has four components : goals, operators, methods and selection rules.

1. **Goals -** Tasks are deconstructed as a set of goals and subgoals. GOMS the goals are taken to represent a 'memory point' for the user
2. **Operators -** Tasks can only be carried out by undertaking specific actions. Example : To decide which search engine to use.
3. **Methods -** It represent ways of achieving a goal. Example : drag mouse over field.
4. **Selection Rules -** The method that the user chooses is determined by selection rules

Q.33 Create a GOMS description of the task of photocopying a paper from a journal. Discuss the issue of closure in terms of your GOMS description.

Ans. : • One possible GOMS description of the goal hierarchy for this task is given below. Answers will vary depending on assumptions about the photocopier used as the model for the exercise.

- In this example, we will assume that the article is to be copied one page at a time and that a cover over the imaging surface of the copier has to be in place before the actual copy can be made.

Goal : PHOTOCOPY-PAPER

Goal : LOCATE-ARTICLE

Goal : PHOTOCOPY-PAGE repeat until no more pages

[**Select Goal :** SELECT-PAGE --> CHOOSE-PAGE-TO-COPY]

Goal : ORIENT-PAGE

OPEN -COVER

POSITION-PAGE

CLOSE-COVER

PRESS-BUTTON

Goal : VERIFY-COPY

LOCATE-OUT-TRAY

EXAMINE-COPY

Goal : COLLECT-COPY

LOCATE-OUT-TRAY

REMOVE-COPY (outer goal satisfied!)

Goal : RETRIEVE-JOURNAL

OPEN-COVER

REMOVE-JOURNAL

CLOSE-COVER

Selection rules exist **if a spoiled copy was printed. Consider the following :**

Rule 1 : SELECT-PAGE **if last page was copied successfully or start of article.**

Note : The goal SELECT-PAGE is only valid if we are at the start of the article or the last copy was successful. If the last copy was spoiled

the we must recopy the current page, so only a re-orientation would be required.

Goal : PHOTOCOPY-PAPER

Goal : LOCATE-ARTICLE

Goal : PHOTOCOPY-PAGE repeat until no more pages

[**Select Goal :** SELECT-PAGE --> CHOOSE-PAGE-TO-COPY]

Goal : ORIENT-PAGE

OPEN -COVER

POSITION-PAGE

CLOSE-COVER

PRESS-BUTTON

Goal : VERIFY-COPY

LOCATE-OUT-TRAY

EXAMINE-COPY

Goal : RETRIEVE-JOURNAL

OPEN-COVER

REMOVE-JOURNAL

CLOSE-COVER

Goal : COLLECT-COPY

LOCATE-OUT-TRAY

REMOVE-COPY (outer goal satisfied!)

- Closure to Outer Goal, must force user to collect copy last

Q.34 Explain advantages and disadvantages of GOMS.

Ans. : Advantages :

1. Easy to construct a simple GOMS model and saves time
2. Helps discover usability problems.
3. Gives several qualitative and quantitative measures.
4. Less work than usability study.

Disadvantages :

1. Only work for goal directed tasks.
2. Not for the novice user
3. Not ideal for leading edge technology systems
4. Not as easy as heuristics analysis, guidelines.

Q.35 Goals are accomplished by methods consisting of operators which are identified by selection rules. Illustrate this for following goals.

i) To delete a sentence in a graphical text editor.

ii) To close window in a graphical text editor.

Ans. : i) to delete a sentence in a graphical text editor :

GOAL : DELETE SENTENCE IN A GRAPHICAL TEXT EDITOR

Method_for_goal: MENU-METHOD-DELETE SENTENCE

Step 1 : HIGHLIGHT SENTENCE

Step 2 : OPEN MENU

Step 3 : SELECT DELETE-COMMAND

Step 4 : Accomplish_goal MENU-METHOD-DELETE SENTENCE

Method_for_goal: DEL-KEY-METHOD-DELETE SENTENCE

Step 1 : POSITION-CURSOR AT END

Step 2 : PRESS DELETE FOR EACH LETTER

Step 3 : Accomplish_goal DEL-KEY-METHOD-DELETE SENTENCE

Selection_rules_for_goal : DELETE SENTENCE

If [long sentence] Then Accomplish_goal: MENU-METHOD-DELETE SENTENCE

If [short sentence] Then Accomplish_goal: DEL-KEY-METHOD-DELETE SENTENCE

ii) to close window in a graphical text editor

When we have a window interface that can be closed in either of the two methods: by selecting the 'close' option from the file menu or by selecting the Ctrl key and the F4 key together.

Model the task of "closing the window in a graphical text editor".

Here, we have the high level goal of "close window" which can be achieved with either of the two methods: "use menu option" and "use Ctrl+F4 keys".

- This is unlike the previous example where we had only one method for each goal.

- We use the "Select" construct to model such situations (next slide)

Goal : Close window

- [Select Goal : Use menu method

Operator : Move mouse to file menu

Operator : Pull down file menu

Operator : Click over close option

Goal : Use Ctrl+F4 method

Operator : Press Ctrl and F4 keys together]

The select construct implies that "selection rules" are there to determine a method among the alternatives for a particular usage context.

- Example selection rules for the window closing task can be

Rule 1: Select "use menu method" unless another rule applies

Rule 2 : If the application is GAME, select "use Ctrl+F4 method"

The rules state that, if the window appears as an interface for a game application, it should be closed using the Ctrl+F4 keys. Otherwise, it should be closed using the close menu option.

Q.36 What is cognitive complexity theory ?

Ans. : • Cognitive complexity theory, introduced by Kieras and Polson, begins with the fundamental premises of goal breakdown from GOMS and enriches the model to offer added predictive power.

- CCT has two parallel descriptions : one of the user's goals and the other of the computer system (called the device in CCT). For the system grammar, CCT apply *generalized transition networks*, a form *of state transition network*.
- The description of the user's goals is based on a GOMS-like goal hierarchy, but is expressed primarily using *production* rules.
- The production rules are a sequence of rules :
  if condition then action
- Where, *condition* is a statement about the contents of working memory. If the condition is true then the production rule is said to fire. An *action* may consist of one or more elementary actions, which may be either changes to the working memory, or external actions such as keystrokes.
- As an example, consider an editing task using the UNIX vi text editor. The task is to insert a space where one has been missed out in the text. The fragment of the associated CCT production rules can be as below.

```
(SELECT-INSERT-SPACE
IF (AND (TEST-GOAL perform unit task)
 (TEST-TEXT task is insert space)
 (NOT (TEST-GOAL insert space))
 (NOT (TEST-NOTE executing insert space)))
THEN ( (ADD-GOAL insert space)
 (ADD-NOTE executing insert space)
 (LOOK-TEXT task is at %LINE %COL) ))
 (INSERT-SPACE-DONE
IF (AND (TEST-GOAL perform unit task)
 (TEST-NOTE executing insert space)
 (NOT (TEST-GOAL insert space)) )
```

```
THEN ( (DELETE-NOTE executing insert space)
 (DELETE-GOAL perform unit task)
 (UNBIND %LINE %COL) ))
 (INSERT-SPACE-1
IF (AND (TEST-GOAL insert space)
 (NOT (TEST-GOAL move cursor))
 (NOT (TEST-CURSOR %LINE %COL)))
THEN ( (ADD-GOAL move cursor to %LINE %COL) ))
 (INSERT-SPACE-2
IF (AND (TEST-GOAL insert space)
 (TEST-CURSOR %LINE %COL))
THEN ( (DO-KEYSTROKE 'I')
 (DO-KEYSTROKE SPACE)
 (DO-KEYSTROKE ESC)
 (DELETE-GOAL insert space))
```

- To see how these rules work, imagine that the user has just seen the typing mistake and thus the contents of working memory (w.m.) are,

```
(GOAL perform unit task)
(TEXT task is insert space)
(TEXT task is at 5 23)
(CURSOR 8 7)
```

- TEXT uses the text of the document that is being edited and CURSOR refers to the placing cursor on the screen. The position (5, 23) is the line and column of the typing error where the space is required. However, the present cursor location is at line 8 and column 7.
- So, the rule fires and its action is performed. This action has no external effect in terms of keystrokes, but adds extra information to working memory.
- The rules in CCT must not represent error-free performance. They can be utilized to explain error phenomena, even if they cannot predict them. The CCT rules are closely related to GOMS-like goal hierarchies; the rules may be generated from such a hierarchy, or

alternatively, it may analyze the production rules to obtain the goal tree.

- In fact, the CCT rules can characterize more difficult plans than the simple sequential hierarchies of GOMS. However, one should regard CCT as an engineering tool giving one a rough measure of learnability and difficulty combined with a detailed description of user behavior.

END ...

Unit - III

3 Implementation

3.1 Implementation Tools

Q.1 What is windowing system ? Discuss role of windowing system.

Ans. : • A windowing system is a system for sharing a computer's graphical display presentation resources among multiple applications at the same time.

- A windowing system provides "low-level" input, output and window management capabilities to the operating system.
- A windowing system uses a window manager to keep track of where each window is located on the display screen and its size and status. A windowing system doesn't just manage the windows but also other forms of graphical user interface entities.
- The X Window System is a cross-platform windowing system that uses the client/server model to distribute services in a network so that applications can run in a remote computer.
- Users of workstations or terminals using the X Window System don't need to know where the application is located.
- Windowing system provides supports for :
  1. Input and output devices thru operating system.
  2. High-level abstractions of graphical primitives.
  3. Window management.

Q.2 Discuss about the client-server architecture of windowing system with suitable figure and explain its working.

☞ [SPPU : March-19, In Sem, Marks 6]

Ans. : • Classic example of a window system based on the client-server architecture is the industry-standard X-Window System.

- Fig. Q.2.1 shows client-server architecture of windowing system.

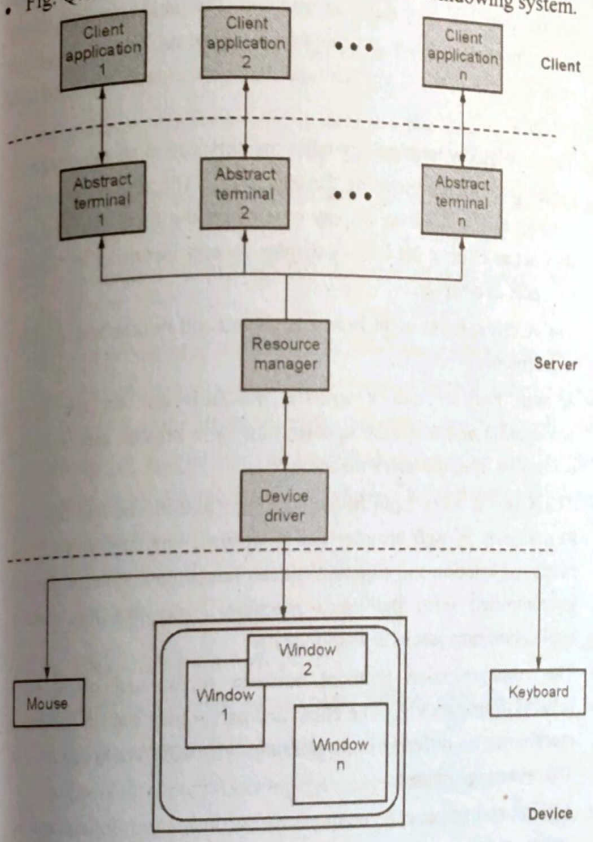


Fig. Q.2.1

- An X server program runs on a computer with a graphical display and communicates with various client programs. The server accepts requests for graphical output (windows) and sends back user input (keyboard, mouse).
- In X Window, the server runs on the user's computer, while the clients may run on a different machine. This is the reverse of the common configuration of client-server systems, where the client runs on the user's computer and the server runs on a remote computer.
- The X Window terminology takes the perspective of the program, rather than the end-user or the hardware : The remote programs connect to the X server display running on the local machine and thus act as clients; the local X display accepts incoming traffic and thus acts as a server.
- The X server takes input from a keyboard and mouse and displays to a screen.
- A web browser and a terminal emulator run on the user's workstation and a system updater runs on a remote server but is controlled from the user's machine.
- The X server takes input from a keyboard and mouse and displays to a screen. A web browser and a terminal emulator run on the user's workstation and a system updater runs on a remote server but is controlled from the user's machine. Note that the remote application runs just as it would locally.
- The communication protocol between server and client runs network-transparently : The client and server may run on the same machine or on different ones, possibly with different architectures and operating systems.
- A client and server can communicate securely over the Internet by tunneling the connection over an encrypted connection.

3.2 Technology and Change Designing the Web

Q.3 What is navigation design ? Explain its local structure.

Ans. : Navigation Design : Imagine yourself using a word processor. You interact at several levels :

- **Widgets** help you know how to use them for a particular selection or action.
- **Screens or windows** - To understand the logical grouping of buttons.
- **Navigation within the application** - To understand where you are in the interaction.
- **Environment** - You swap between applications, perhaps cut and paste.
- In the web we have less control of how people enter a site and on a physical device we have the same layout of buttons and displays no matter what the internal state (although we may treat them differently). Just in case you haven't already got the idea, the place to start when considering the structure of an application is to think about actual use :
  1) Who is going to use the application ?
  2) How do they think about it ?
  3) What will they do with it ?
- This can then drive the second task - thinking about structure.
- We will consider two main kinds of issue :
  1) Local structure : Looking from one screen or page out
  2) Global structure : Structure of site, movement between screens.

Local Structure

- Much of interaction involves goal-seeking behavior. In an ideal world if users had perfect knowledge of what they wanted and how the system worked they could simply take the shortest path to what they want.
- At each point in the interaction they can make some assessment of whether they are getting closer to their (often partially formed) goal.
- To do this goal seeking, each state of the system or each screen needs to give the user enough knowledge of what to do to get closer to their goal. To get you started, here are four things to look for when looking at a single web page, screen or state of a device.
  1. Knowing where you are
  2. Knowing what you can do
  3. Knowing where you are going - or what will happen
  4. Knowing where you've been - or what you've done
- The screen, web page or device displays should make clear *where you are* in terms of the interaction or state of the system. Some websites show 'bread crumbs' at the top of the screen, the path of titles showing where the page is in the site. Trade-off between appearance and ease of use may mean that this is the right thing to do, but you should take care before confusing the user needlessly.
- You need to know *where you are going* when you click a button or *what will happen*. It is better if users do not have to use this 'try it and see' interaction. Icons are typically not self-explanatory and should always be accompanied by labels or at the very least tooltips or some similar technique.
- Special care has to be taken if the same command or button press means something different in different contexts. System needs to give some *feedback* to say what has happened.

Q.4 Write short note on wider still.

Ans. : • Each sits amongst other devices and applications and this in turn has to be reflected within our design.

- This has several implications :
  1. **Style issues :** We should normally conform to platform standards, such as positions for menus on a PC application, to ensure consistency between applications. For example, on our proposed personal movie player we should make use of standard fast-forward, play and pause icons.
  2. **Functional issues :** On a PC application we need to be able to interact with files, read standard formats and be able to handle cut and paste.
  3. **Navigation issues :** We may need to support linkages between applications, for example allowing the embedding of data from one application in another, or, in a mail system, being able to double click an attachment icon and have the right application launched for the attachment.

Q.5 While design screen, which of the appropriate appearance are considered ?

Ans. : Presenting information :

- The way of presenting information on screen depends on the kind of information : text, numbers, maps, tables.
- Technology available to present it : character display, line drawing, graphics, virtual reality; and, most important of all, on the purpose for which it is being used.

Aesthetics and utility

- Remember that a pretty interface is not necessarily a good interface. Ideally, as with any well-designed item, an interface should be aesthetically pleasing.
- The conflict between aesthetics and utility can also be seen in many 'well designed' posters and multimedia systems.

- In particular, the backdrop behind text must have low contrast in order to leave the text readable; this is often not the case and graphic designers may include excessively complex and strong backgrounds because they look good. The results are impressive, perhaps even award winning, but completely unusable.

Making a mess of it : Color and 3D :

- The increasing use of 3D effects in interfaces has posed a whole new set of problems for text and numerical information.

Localization / Internationalization

- The process of making software suitable for different languages and cultures is called localization or internationalization.

Q.6 Write short note on wire-framing.

Ans. : • The interaction modeling and interface options can be put together concretely using the so-called wire-framing process.

- Wire-framing originated from making rough specifications for website page design and resembles scenarios or storyboards.
- Usually, wire-frames look like page schematics or screen blueprints, which serve as a visual guide that represents the skeletal framework of a website or interface. It depicts the page layout or arrangement of the UI objects and how they respond to each other.
- Wireframes can be pencil drawings or sketches on a whiteboard or they can be produced by means of a broad array of free or commercial software applications.

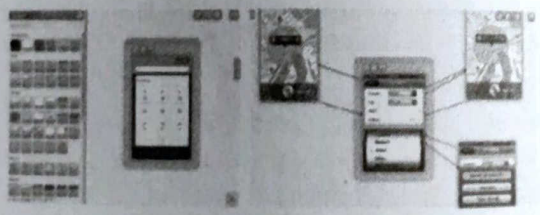


Fig. Q.6.1 : An example of a wire-framing tool

- Fig. Q.6.1 shows such a wire-framing tool. Wireframes produced by these toolscan be simulated to show interface behavior and depending on the tools, the interface logic can be exported for actual code implementation (but usually not).
- Note that there are tools that allow the user to visually specify UI elements and their configuration and then automatically generate code. Regardless of which type of tool is used, it is important that the design and implementation stages be separated.
- Through wire-framing, the developer can specify and flesh out the kinds of information displayed, the range of functions available and their priorities, alternative sand interaction flow.

3.3 Designing for Portable Devices

Q.7 How does making a call differs when using :
i) Cell phone
ii) Smart phone ?
Consider the kinds of user, type of activity and context of use.

Ans. : • Cellphones have been around for some time. At first, its only function was to provide people with a means to call and be called anytime without being connected to any line. It eventually evolved and added more features like text messaging. Before the advent of the smartphone, people were often carrying two devices, a cellphone and a Personal Digital Assistant. The PDA is a digital organizer where users can get a calendar where they can input tasks and appointments and a contact list among other things. The smartphone combined these two devices into one.

- Getting a proper comparison between these two is not that easy as there is no clear line between a smartphone and an ordinary cellphone with extra features. But as we see today, smartphones have more things in common to computers rather than cellphones. A compact or full keyboard often comes as standard in

smartphones as it is necessary for quickly typing messages and emails.

- Smartphones utilize an operating system that is identifiable and is often used on other phones. It provides a stable platform where users can install third party applications. These applications extend the capability of the phone and can often be bought from online stores provided by the OS maker. Smartphones are also expected to have a mail client that can connect to a mail server and extract messages.
- This touch screen cellphones and messaging phones with full screen QWERTY keyboards. As the technology develops more in the future, there would be no reason why cellphones would not have the same functionality as smartphones. At this point in time all phones would be smartphones.

1. Smartphones have more advanced capabilities compared to cellphones.
2. A smartphone is both a PDA and a cellphone.
3. Today's smartphones have more in common with computers than cellphones.
4. Smartphones usually have a touch screen and a full QWERTY keyboard while cellphones come with a regular small screen and a number pad.
5. A smartphone uses an operating system that allows third party applications to run on it.

Q.8 When systems are not designed to match the way people actually work, then users end up having to do 'work arounds'. Discuss.

Ans. : • Integrated student records systems are becoming popular in universities.

- They bring the benefits of integrating examination systems with enrolment and finance systems so all data can be maintained together and cross-checked.
- All very useful and time saving in theory.
- However, one commonly used system only holds a single overall mark per module for each student, whereas many modules on engineering courses have multiple elements of assessment.
- Knowing a student's mark on each part of the assessment is often useful to academics making decisions in examination boards as it provides a more detailed picture of performance.
- In many cases staff are therefore supplementing the official records system with their own unofficial spreadsheets to provide this information - making additional work for staff and increased opportunity for error.

Q.9 What are the problems faced by designer in physical design ?

Ans. : Designers are faced with many constraints :

1. **Ergonomic :** You cannot physically push buttons if they are too small or too close.
2. **Physical :** The size or nature of the device may force certain positions or styles of control, for example, a dial like the one on the washing machine would not fit on the MiniDisc controller; high-voltage switches cannot be as small as low-voltage ones.
3. **Legal and safety :** Cooker controls must be far enough from the pans that you do not burn yourself, but also high enough to prevent small children turning them on.
4. **Context and environment :** The microwave's controls are smooth to make them easy to clean in the kitchen.
5. **Aesthetic :** The controls must look good.
6. **Economic :** It must not cost too much.

3.4 Handling Errors and Designing Help

Q.10 Describe two programming paradigms which can be used to organize the flow of control within the application.

☞ [SPPU : March-19, In Sem, Marks 6]

Ans. : • Two programming paradigms are read evaluation loop and notification based.

1. Read evaluation loop :

- Programming on the Macintosh is used this method.
- The server sends user inputs as structured events to the client application. As far as the server is concerned, the only importance of the event is the client to which it must be directed.
- The client application is programmed to read any event passed to it and determine all of the application-specific behavior that results as a response to it.
- The logical flow of the client application is shown in Fig. Q.10.1.

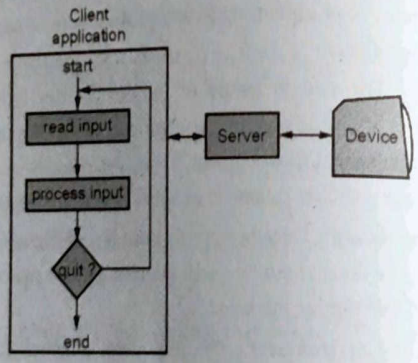


Fig. Q.10.1

- The application has complete control over the processing of events that it receives. The programmer must execute this control over every possible event that the client will receive.

2. Notification based :

- It is main control loop for the event processing does not reside within the application.
- Centralized notifier receives events from the window system and filters them to the application program in a way declared by the program.
- Fig. Q.10.2 shows notification-based programming paradigm.

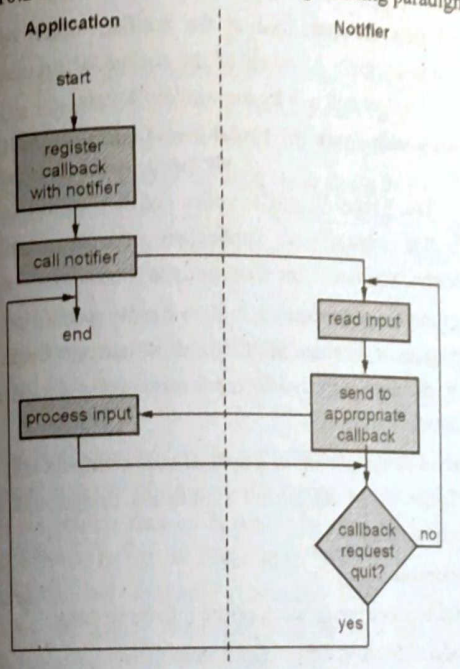


Fig. Q.10.2

- The application program informs the notifier what events are of interest to it and for each event declares one of its own procedures as a callback before turning control over to the notifier.

- When the notifier receives an event from the window system, it sees if that event was identified by the application program and if so, passes the event and control over to the callback procedure that was registered for the event.
- After processing, the callback procedure returns control to the notifier, either telling it to continue receiving events or requesting termination.
- Control flow is centralized in the notifier, which relieves the application program of much of the tedium of processing every possible event passed to it by the window system.

Q.11 Discuss with figure the Model-View-Controller (MVC) triad in small talk. [SPPU : March-19, In Sem, Marks-4]

Ans. : • The Model-View-Controller (MVC) is an architectural pattern that separates an application into three main logical components: the model, the view, and the controller.

- Each of these components are built to handle specific development aspects of an application. MVC is one of the most frequently used industry-standard web development framework to create scalable and extensible projects.
- A standard design pattern of graphical user interfaces that is used at many levels, including overall application design and individual visual components.

MVC Components :

- Interface architecture is decomposed into three parts :
  1. Model : Manages data and its manipulation
  2. View : Manages the presentation of the data
  3. Controller : Manages user interaction
- Fig. Q.11.1 shows MVC architecture.

- Model is decoupled by View. View and Controller know all about model. In practice, View and Controller are often coupled. View knows to send events to Controller.

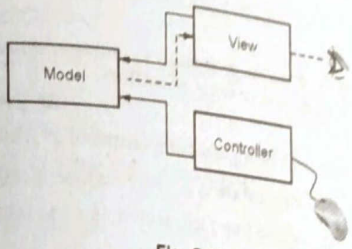


Fig. Q.11.1

- Controller knows about view modern widget toolkits use MVC throughout. Simple widgets (e.g., buttons, checkboxes, scrollbars) usually contain a default model within themselves.
- Model : Model component corresponds to all the data-related logic that the user works with. This can represent either the data that is being transferred between the View and Controller components or any other business logic-related data.
- **View :** The View component is used for all the UI logic of the application. For example, the Customer view will include all the UI components such as text boxes, dropdowns, etc. that the final user interacts with.
- **Controller :** Controllers act as an interface between Model and View components to process all the business logic and incoming requests, manipulate data using the model component and interact with the Views to render the final output.
- For example, the customer controller will handle all the interactions and inputs from the customer view and update the database using the customer model. The same controller will be used to view the customer data.

3.5 Prototyping and UI Software

Q.12 Present a graphical interpretation of section model of the logical components of a UIMS.

☞ [SPPU : March-19, In Sem, Marks 4]

Ans. : • The logical components of a UIMS were identified as :

1. **Presentation :** The component responsible for the appearance of the interface, including what output and input is available to the user.
2. **Dialog control :** The component which regulates the communication between the presentation and the application.
3. **Application interface :** The view of the application semantics that is provided as the interface.

- Fig. Q.12.1 shows Seeheim model of the logical components.

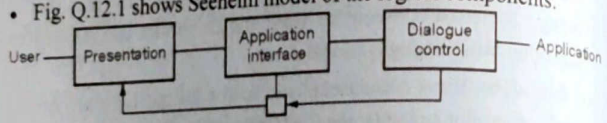


Fig. Q.12.1 : Seeheim model of the logical components

- The Seeheim workshop proposed a new model, which can be characterized by two principles :
  1. The application program shall be separated from the user interface;
  2. The user interface shall be decomposed into three components : the presentation component, the dialogue component and the application interface component.
- The three components of the Seeheim model were interpreted for some time as the lexical, syntactic and semantic components of a language analyzer.
- In effect, the presentation handles low-level aspects comparable to tokens, while the dialogue component ensures that proper

commands are specified by a set of tokens, and the application interface describes the semantics of the application.

- This interpretation has been the motivation for using language description techniques to build user interfaces : we will describe a number of UIMSs which use such techniques.

Q.13 Explain advantages of constructing user interfaces with a UIMS.

Ans. : 1. UIMS improves the efficiency with which user interface designers can use their skills.

2. UIMS speeds the incremental process of creating a user interface.
3. UIMS makes it possible to create prototypes that can be discussed with the end user.
4. UIMS can adapt to different user profiles.
5. UIMS makes the integration of new application functionalities easier.
6. UIMS allows the application to be portable, while the user interface can be tailored to the particular environment.
7. UIMS can ease the debugging of interactive applications.

Q.14 List and explain various implementation techniques used for dialog modeling in UIMS.

Ans. : 1. Menu networks : The communication between application and presentation is modeled as a network of menus and submenus. To control the dialog, the programmer must simply encode the levels of menus and the connections between one menu and the next submenu or an action.

2. **Grammar notations :** The dialog between application and presentation can be treated as a grammar of actions and responses, and, therefore, described by means of a formal context-free grammar notation.
3. **State transition diagrams :** State transition diagrams can be used as a graphical means of expressing dialog.

4. **Event languages :** Event languages are similar to grammar notations, except that they can be modified to express directionality and support some semantic feedback.
5. **Constraints :** Constraints systems are a special subset of declarative languages. Constraints can be used to make explicit the connection between independent information of the presentation and the application.

Q.15 Describe the techniques used in dialog modeling in UIMS.

Ans. : 1. Menu networks :

- The communication between application and presentation is modeled as a network of menus and submenus.
- The menu is used to embody all possible user inputs at any one point in time. Links between menu items and the next displayed menu model the application response to previous input.
- The menu can be represented as graphical items or buttons that the user can select with a pointing device.

2. Grammar notations :

- The dialog between application and presentation can be treated as a grammar of actions and responses. It is described by means of a formal context-free grammar notation i.e. BNF.
- Suitable for describing command-based interfaces, but not suitable more graphically-based interaction techniques.
- It is difficult to model communication of values across the dialog controller and that is necessary to maintain any semantic feedback from application to presentation.

3. State transition diagrams : State transition diagrams can be used as a graphical means of expressing dialog.
4. Event languages : Event languages are similar to grammar notations, except that they can be modified to express directionality and support some semantic feedback.

5. Declarative languages describe what should result from the communication between application and presentation, not how it should happen in terms of event sequencing.
6. Constraints : Constraints can be used to make explicit the connection between independent information of the presentation and the application.

END ...