Human-Computer Interaction

(Code : 314445)

Semester V- Information Technology

(Savitribai Phule Pune University) (SPPU)

Strictly as per the New Credit System Syllabus (2015 Course)
Savitribai Phule Pune University w.e.f. academic year 2017-2018

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Sanjay R. Mate, Dr. K. S. Wagh

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Preface

Dear Students,

We are extremely happy to present the book of **"Human-Computer Interaction"** for you. We have divided the subject into small chapters so that the topics can be arranged and understood properly. The topics within the chapters have been arranged in a proper sequence to ensure smooth flow of the subject.

We are thankful to Late Shri. Pradeep Lunawat and Shri. Sachin Shah for the encouragement and support that they have extended. We are also thankful to the staff members of Tech Max Publications and others for their efforts to make this book as good as it is. We have jointly made every possible efforts to eliminate all the errors in this book. However if you find any, please let us know, because that will help us to improve further.

We are also thankful to our family members and friends for their patience and encouragement.

- Authors

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Syllabus

Savitribai Phule Pune University

Fourth Year of Information Technology (2015 Course)

Course Code : 314445

Course Name : Human-Computer Interaction

Teaching Scheme : TH : 03 Hours/Week	Credits : 03	Examination Scheme : In-Sem (Paper) : 30 Marks /19 End-Sem (Paper) : 70 Marks /60

Prerequisites :

1. Problem Solving and Object Oriented Technologies.

Course Objectives :

1. To introduce to the field of human-computer-interaction study.
2. To gain an understanding of the human part of human-computer-interactions.
3. To learn to do design and evaluate effective human-computer-interactions.
4. To study HCI models and theories.
5. To understand HCI design processes.
6. To apply HCI to real life use cases.

Course Outcomes :

1. To explain importance of HCI study and principles of user-centred design (UCD) approach.
2. To develop understanding of human factors in HCI design.
3. To develop understanding of models, paradigms and context of interactions.
4. To design effective user-interfaces following a structured and organized UCD process.
5. To evaluate usability of a user-interface design.
6. To apply cognitive models for predicting human-computer-interactions.

Course Contents

UNIT I : INTRODUCTION **06 Hours**

What is HCI?, Disciplines involved in HCI, Why HCI study is important? The psychology of everyday things, Principles of HCI, User-centred Design. **(Refer chapter 1)**

UNIT II : UNDERSTANDING THE HUMAN **06 Hours**

Input-output channels, Human memory, Thinking: Reasoning and Problem Solving, Human emotions, Individual differences, Psychology and Design. **(Refer chapter 2)**

UNIT III : UNDERSTANDING THE INTERACTION **06 Hours**

Models of interaction, Ergonomics, Interaction styles, WIMP Interface, Interactivity, Context of interaction, User experience, Paradigms of Interactions. **(Refer chapter 3)**

UNIT IV : HCI - DESIGN PROCESS **06 Hours**

What is interaction design?, The software design process, User focus, Scenarios, Navigation Design, Screen Design, Prototyping techniques, Wire-Framing, Understanding the UI Layer and Its Execution Framework, Model-View-Controller(MVC) Framework. **(Refer chapter 4)**

UNIT V : HCI - DESIGN RULES , GUIDELINES AND EVALUATION TECHNIQUES **06 Hours**

Principles that support usability, Design standards, Design Guidelines, Golden rules and heuristics, Using toolkits, User interface management system (UIMS), Goals of evaluation, Evaluation Criteria, Evaluation through expert analysis, Evaluation through user participation, Choosing an Evaluation Method.

(Refer chapter 5)

UNIT VI : HCI MODELS AND THEORIES **06 Hours**

Goal and task hierarchy model, Linguistic model, Physical and device models, Cognitive architectures, Hierarchical task analysis (HTA), Uses of task analysis, Diagrammatic dialog design notations, Computer mediated communication, Ubiquitous Computing, Finding things on web Future of HCI.

(Refer chapter 6)

❑❑❑

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UNIT I

CHAPTER 1

Introduction to HCI

Syllabus Topics

- What is HCI ?
- Disciplines involved in HCI
- Why HCI study is important?
- The psychology of Everyday Things
- Principles of HCI
- User-centred Design.

Syllabus Topic : What is HCI ?

1.1 What is HCI?

1.1.1 Introduction to HCI

- The activity performed among man-made-machine, i.e. computer and a human beings in an interactive session wise manner.
- Particularly human-computer-interaction can be partitioned into three distinct items for better understanding.
- The human computer interaction foundation can be observed with the help of:
  - (a) Human's psychological nature and physiological activity
  - (b) Computer Input and Output Channels (e.g.: visual, auditory, haptic, movement along with their characteristics), Computational power and memory
  - (c) Models of interaction, Interaction styles and design
- Model Human Processor' by Card, Moran and Newell in 1983 which describes about a simplified approach of a human processing towards interaction with computer systems.
- Model Human Processor' described with the help of three subsystems
  - (a) Perceptual System (Operating sensory stimulus)
  - (b) Motor System (Action control)
  - (c) Cognitive System (Approach of processes to establish connection between two)
- Each of these subsystems has its own memory and processor, complexity of them varies as per the task assigned to it. The model represents patterns of behaviour of a system under any condition.

1.1.2 The Human

- The human has the capacity to observe, think, sense, and react to objects surrounded to him. Human is a vital source of interaction with computer based on his features and every human is distinct and different. Few qualities of the human are mentioned below:
  - **(a) Vision:** Human eye, visual perception, perceiving size and depth, perceiving brightness, perceiving colour.
  - **(b) Reading**
  - (c) **Hearing:** The human ear (Outer ear, middle ear, inner ear), Processing Sound,

(d) **Touch (haptic perception)**

(e) **Movement** Sensory Memory, Short term memory, Long term memory.

(f) **Thinking** : Reasoning (deductive reasoning, inductive reasoning, inductive reasoning) and Problem Solving (Gestalt Theory, problem space theory)

(g) **Emotion**

(h) **Individual Differences**

1.1.3 The Computer

- The computer is a machine which works on request and responds mechanically as per instruction given by the user.
- Many time users pass information on computer and further require it to edit, update, modify, delete, retrieve and so on it is part of interaction between user and computer.
- In a few cases, the computer needs information from users; it collects in the form of request while it provides information as an output in the form of response to user queries.
- A computer system may be any personal computer, laptop, personal digital assistant (PDAs).

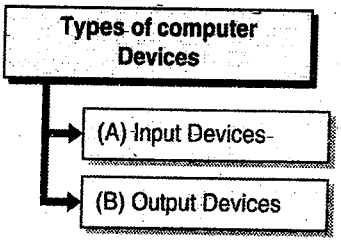


Fig. 1.1.1 : Types of Computer Devices

➜ (A) Input Devices

- Earlier days batch processing approach used for interaction, it is highly time consuming process. The reader has to read all punched cards and it took few hours to read and return those cards. Bach processing was efficient for printing pay checks.
- Faster is better in interaction approach left batch processing unused in recent days. Recently IP addresses based devices associated with computer helped to rapid interaction between user and computer.
- Automation taking place new form of interaction between computer system and human.
- The keyboard is one of the input devices of the computer. It helps in interaction between user and computer. The QWERTY keyboard is more users friendly and popular as compared to Chord and DVORAK keyboard.
- A bad design of the keyboard may lead to Repetitive Strain Injury (RSI) to the operator's fingers. Bespoke key layout is also used which help to reduce the strain of finger movements.
- ATM, Calculator, Phone and computer keyboard (QWERTY type keyboard) has not same arrangement of numerical key. Key arrangements vary from device to device depending on the scenario.
- The mouse is an input device for computer, Douglas C. Engelbart developed mouse in 1964. Pointer of mouse called 'cursor'. Single and double click events used for selection. Scrolling key is also available. Mechanical mouse is not used, it replaced by optical or infrared based mouse which are more sensitive and accuracy is at the pick.
- 3D mouse is also becoming popular, but practically it is difficult to shake the mouse in the air for a long.
- As per HCI, interaction is concerned a user should use mouse pad with wrist supporter which will ease in long duration session.
- Touchpad is another input device for computer in recent days, firstly used in Apple Power book Portable computer. It is 50-75mm square having touch sensation. It is easily operated with the help of finger stroke ouch sensation accelerate cursor movements.
- Trackballs and thumbnails are the effective input source, it helps to reduce Repetitive Strain Injury (RSI) factor for the keyboard suffering user.
- Few other input devices which deals with more accurate positioning and drawing like stylus, light pen, digitizing tablet which is mostly used with PDAs.
- Some special eye glasses or one head mounted box on eyes based technique like Eye gaze also provide an input to the computer.

(B) Output Devices

Q. What are the reasons behind black border and stretched pixels on monitor screen?

(different types of display screen, 3D visualizations, printer, scanner, optical character recognition)

- Computer Monitor is mainly considered in case of display devices rather than ATM, Car and Mobile Screen.
- Monitor used for computer as display device has travelled a long journey of monochrome, black and white – gray scale, colored screen as well as CRT, FT, LCD, LED, HD, 4K UHD on the basis of technology and pixel quality.
- Screen display quality is all about maximum number of pixels per inch i.e. pixel density.
- Generally, computer display is about 4:3 aspect ratio, 1024 pixels across by 768 down. On other hand horizontal 3840 pixels by max vertical 2160 pixels resolution with 16:9 aspect ratio found in few recent monitor
- It happens as the screen has good resolution (i.e. LCD, LED monitor) and computer system provides less resolution quoted than monitor specification in such scenario black screen black color border appears on screen.
- **For example:** Screen has 1200 X 900 resolution setting along with 96 pixels density and computer provide 800 X 600 resolution.
- Two pixels get squashed to one or one get into two due to inappropriate computer systems supplied resolution than the projector resolution and pixel density. Further, it leads in forming thick or thin line of pixel line which gets disappeared from the screen.
- Anti-aliasing is useful to get more accurate display in such scenario.

1. Cathode Ray Tube

Q. Explain working of the CRT? Enlist disadvantages and precaution for computer monitor user in perspective of HCI.

- Cathode Ray Tube (CRT) technology based monitor is more popular since late 90s. Now a day a flat LCD screen is mostly used as a computer monitor. CRT and LCD both work on the same technique.
- Electrons were emitted by an electron gun which is focused and directed by magnetic fields. Beam reaches on phosphor coated screen which turn into a set of pixels.
- The electron beam traverse from right to left side of the screen starting from top left of the screen and flicked back to rescan for the next line and repeating same from top to bottom.
- This action is quite faster approx. 30 times per second(30Hz) per frame, higher scan rate is used to reduce flickering of the screen used to display. Use of high persistent phosphor also practiced to reduce flickering.
- Interlacing is an approach used to reduce flicker in which firstly all off lines are scanned later even lines.

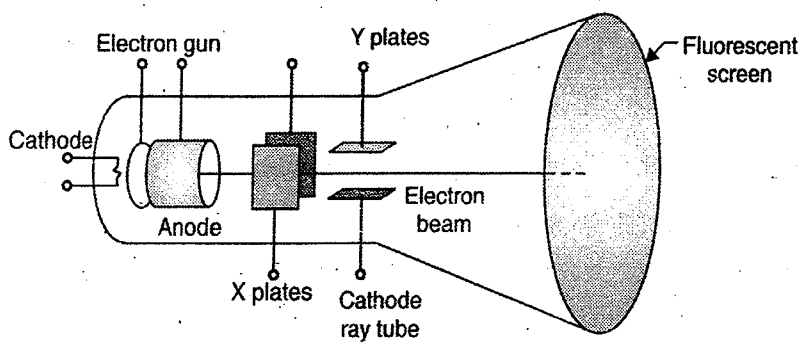


Fig. 1.1.2 : Cathode Ray tube

Disadvantages

(a) X-rays emission (Mostly absorbed by screen)

(b) Use of phosphor lead to ultraviolet and infrared radiation

(c) Emission of radio frequency

(d) Emission of ultrasound (16KHz)

(e) Conducive material Enfield with induced current due electromagnetic field

Precaution

(a) Avoid close sitting from the screen

(b) Avoid use of small fonts

(c) Avoid continuous monitoring activity (continuous stare at the screen)

(d) Avoid excessive brightness or contrast screen

(e) Avoid direct sunlight or windows facing monitor screen arrangement

2. LCD

Q. Why eyestrain occurs with monitor use? How LCD is useful in HCI ?

- Liquid Crystal Display (LCD) monitor is more popular due to flat screen, lighter in weight, less consumption of power.
- LCD monitor was formed by the sandwich of liquid crystal between the two glass plate, i.e. transparent and polarized plate on top, reflective plate at bottom.
- In LCD, a beam of light is passed from the top plate, it gets polarized i.e. get oscillated in one direction. Beam later passes through crystal which makes cells, white by reflecting off the bottom plate. Post is applying voltage to crystallize with the help of conducting glass plate crystal get twisted.
- Slow response of crystal of even though refresh time is required at usual rates leads to the very negligible flicker of the screen.
- Emission of light at low intensity, negligible flickering helped to reduce monitor user's eyestrain.

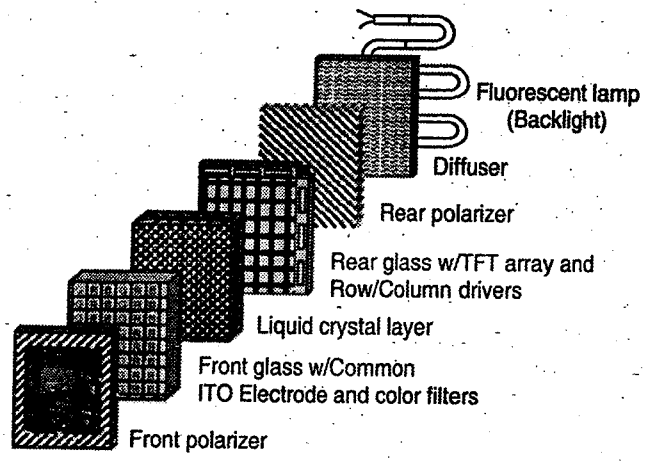


Fig.1.1.3 : Liquid crystal display layer structure

Advantages

(a) Less consumption of electricity

(b) No eyestrain compared to CRT

(c) Flat screen, light in weight and compact in size

(d) Very less flickering on screen

Design goals for display screen in concern with HCI are as follows

(a) Less flickering screen

(b) Good pixel dense

(c) Less power consumption

(d) Appropriate aspect ratio

(e) Installation of display device should be in an appropriate manner so that entire screen can be monitored easily.

(f) There should be adequate distance and height (mostly for desktop computer) of the screen for all types of user.

3. Other Display

- Gas plasma display screen are recent popular high end display unit with high resolutions, approx. 4096 X 3120 pixels. It has some issues like low contrast and low brightness.
- Some large display uses HDTV (High Definition Television) wide screen having an aspect ratio of 16:9 whereas 4:3 observed in monitor and TV.

- LCD screens or projector also used in room meeting or conferences, buta shadow of presenter is an unavoidable issue faced by user and other audience in a conference.
- 3D display glasses were used for observing special effects made in some animated or recorded records.

Input and Output Device

➔ (SPPU - Dec. 2017)

> Q. 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 specification, assuming the new system will be a replacement of old paper-based system. What assumption you need to make about its user?
>
> SPPU - Dec. 2017, 5 Marks

- Paper and sound, both are input as well as an output source for interaction.
- The sound is output of the speakers while for device like microphone and mike sound is input.
- Sound is used to alarm for a different indication like different beeps patterns from CPU inform about its CPU status, some text to speech tool also used as interaction among computer and user like pdf has Read out loud option.
- It is also used to pass information in form instruction with the help of speech to text tool like siri application of iPhone or some cloud based API.
- Paper used for printing text, images with an output device like a printer. While Optical Character Recognition (OCR) technology uses paper as input for devices like a scanner.
- The idea behind a paperless or digitized work is about eliminating paper based work, all transactions of data through digitized form, but it doesn't appear in true manner as a record keeping activity required paper or hard copy in the draft.
- Few software for handling meeting or calendar are used to replace dairy or paper-based system.
- An appointment scheduler software should consider some assumption like:
  - (a) Appointment scheduler will be more user friendly if it syncs with Google calendar, Outlook or iCal it will keep notifying as per settings
  - (b) Allow users to sign up and apply for an appointment online
  - (c) Appointment timeline
  - (d) Accept online appointments
  - (e) Display time available for booking or update notifications about scheduled or rescheduled appointment
  - (f) Use an online booking calendar for events, conferences or workshops for better interaction
  - (g) Post meeting evaluation
  - (h) Review or Feedback Form
- A task which can be organized ~~and~~ managed by software are as below:
  - (a) Appointment scheduler
  - (b) Meeting invitation
  - (c) Meeting scheduler
  - (d) Calendar bookings on weekly-monthly- Tri monthly etc.
  - (e) Update notification for books, events participants

– Few of appointment scheduler software screenshot for better understanding purpose:

(a) Weekly planner

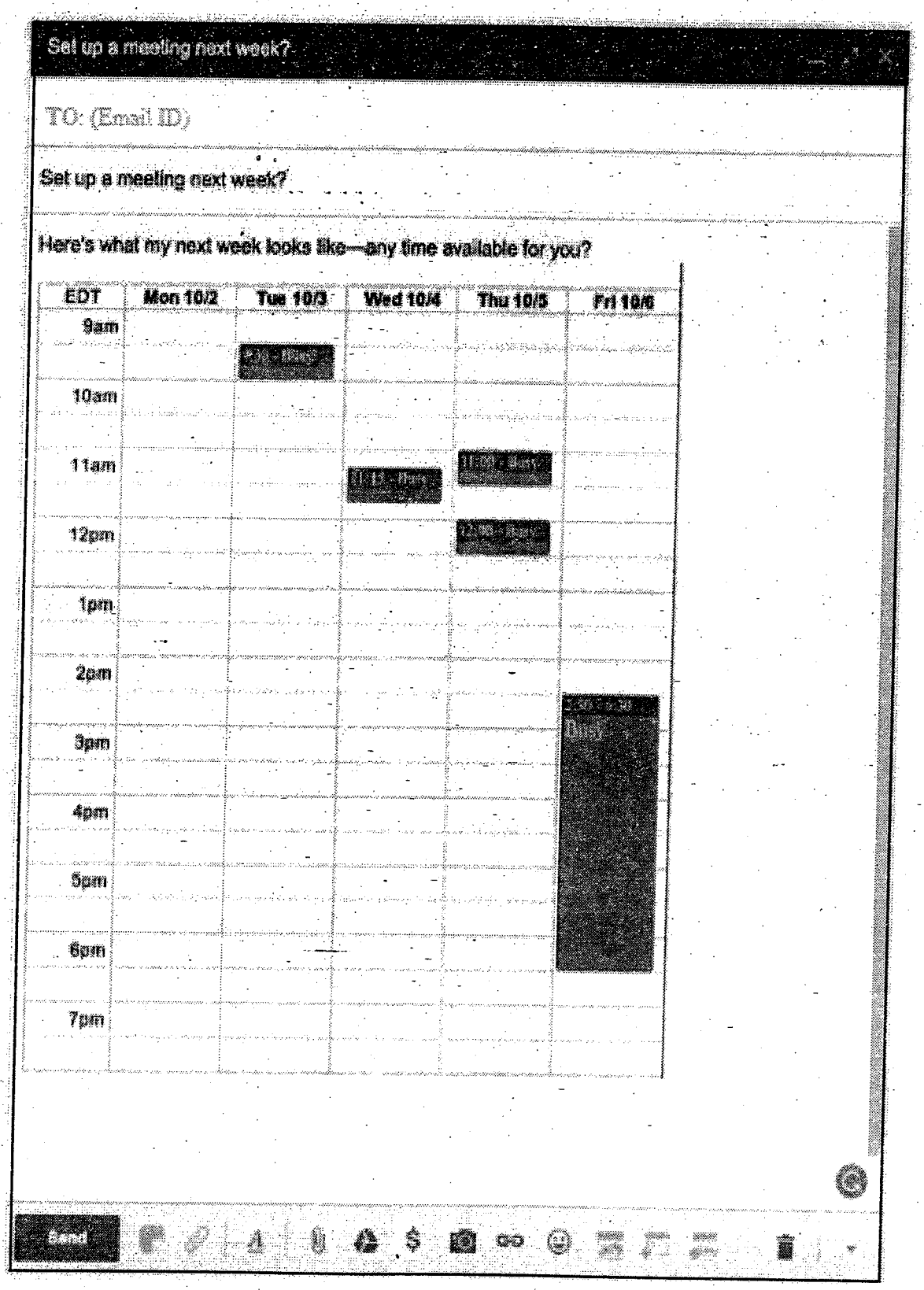


Fig. 1.1.4 :An Appointment Schedule: Weekly planner

(b) Google Calendar: Calendar utility provided by Google works efficiently and popular in user for an interaction tool for meeting, conference or appointment scheduler etc.

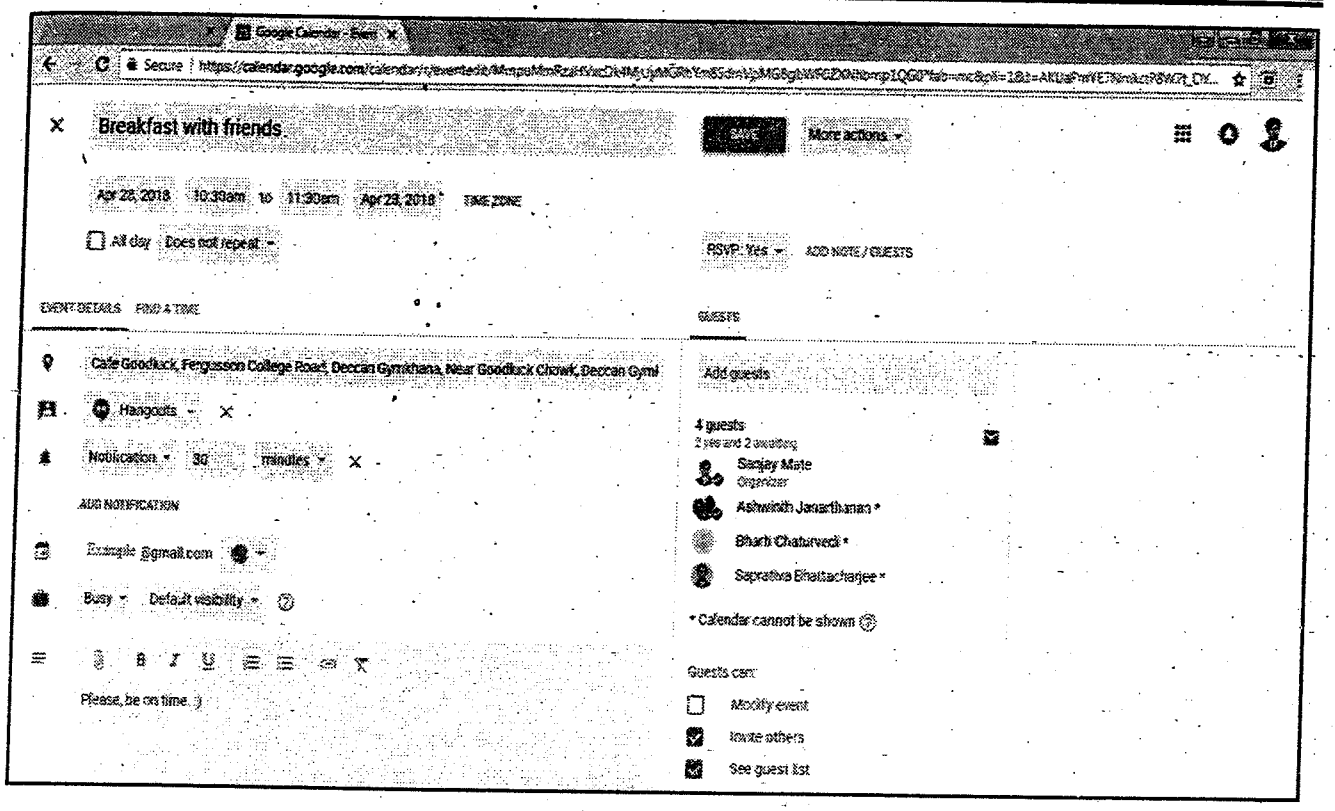


Fig. 1.1.5 : A Google Calendar: Event organization page

- Scheduling of a task provides start date and time, event end date and time, all day or repetitive task, With event details user can mention location, invite chat group or email, notification can be scheduled, invitation details can be sent with draft email. Post sending request guest can reply either as Yes , No or Maybe.

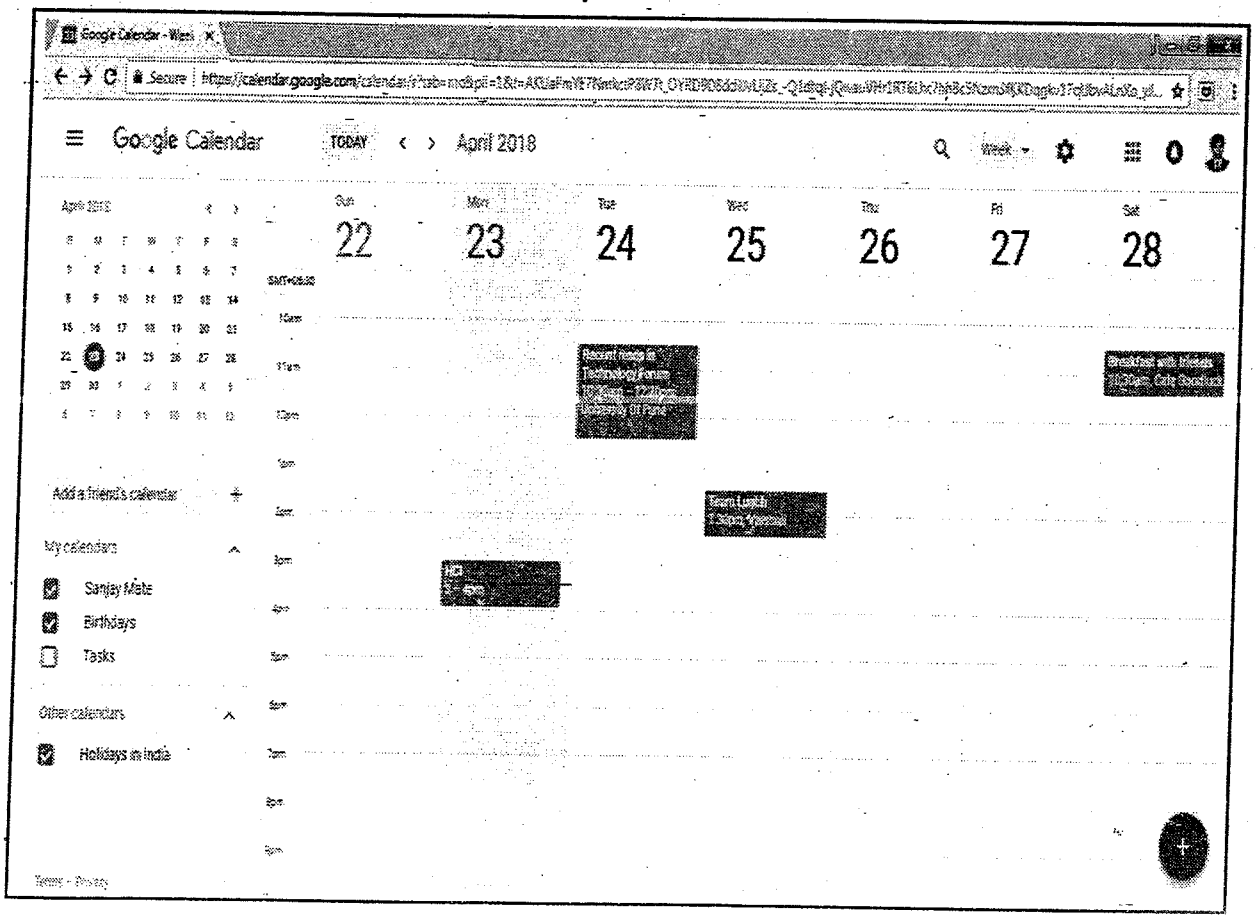


Fig. 1.1.6 : Google Calendar: A Weekly Summary

Memory

- Memory talks about RAM – Short term memory (STM), Disks and Long term memory (LTM), storage, compression, capacity and speed.
- Memory keyword refers to a component within our computer which allows us to access data which is stored for a short term.
- Few of such components known as DRAM or dynamic random-access memory (RAM).
- The computer performs various operations by accessing data which are stored in its short-term memory.
- For example editing a document, surfing via web browser, installing any application depends on the memory of your computer system.
- Like items which frequently required place on the desk, but there is limitation of space to put things on desk, similarly in case of memory of the computer.
- Storage is another component of data which can be accessed from memory on a long term basis, usually it comes from magnetic disks like HDD, DVD, Blu-ray disk, pen drive or any portable storage devices.
- Usually a hard disk drive is used as a prime long term memory (LTM) in the computer.
- It consists of a disk platter, many disk together creates a disk cylinder.
- Each disk has a track, tracks has small, virtually separated memory storage compartment known as a sector.
- Read/Write head assembly is attached to a rotatory position assembly which is helpful to change R/W head position from one track to another while disk were rotating.
- Generally, such six disk cylinder observed in SATA HDD technology.

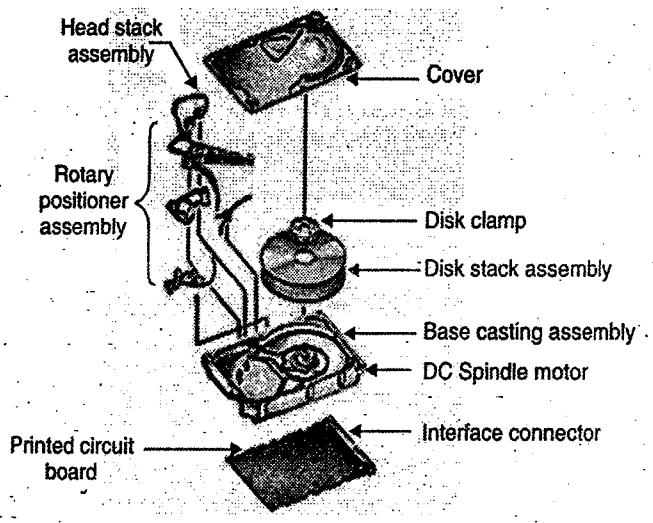


Fig. 1.1.7 : Illustration of Hard Disc Drive (HDD) components

- In storage device, average seek time or average access time is nothing but the amount of time taken by device takes to attain a position for read/write heads over a spot in the medium.
- Measurement is an average taken as access times get varied as per distance between the heads original location and head designated location.
- In case of storage devices seek times is counted in Milliseconds. In case of memory devices, seek times are counted in Nanoseconds.
- In case of a disk drive the seek time affected due to a combination of 2 things: Revolutions per minute (RPM)and time required for head movement among the tracks.
- Different device along with their access time mentioned below:

Table 1.1.1 : Memory Devices and access time

Device	Access Time
Static RAM	5-15 Nano Seconds
Dynamic RAM	50-70 Nano Seconds
ROM	55-250 Nano Seconds
Hard disk drives	6-12 Milliseconds
CD-ROM drives	80-800 Milliseconds
Tape Drives	10-500 Seconds

- File Compression or data compression technology used to shrink the size of a file; it gives more free data on disk for storage.
- Different disks, including hard disks, floppy disks (not used now-a-days), or some individual files might be get compressed with a ratio of 3:1..
- A mathematical algorithm is used to squeeze he data into small unit of memory storage, i.e. chunks by removal of less important information.
- Data in reinserted just before file returned to its original size.
- Data transfer rate is the speed of data transfer from one device to another.
- The data transfer rate varies from a few KB to MB or GB. Generally HDD gets 15MBps to 80MBps or sometime little more, comparably CD-ROMs get low data transfer rate.

1.1.4 Models of Interaction

➔ (SPPU - Aug. 2017)

Q. Explain Donald Norman's seven stages of interaction? (in brief in Chapter 3)

SPPU - Aug. 2017 (In sem), 5 Marks

- Interaction models help us to know the interaction takes place in human and the computer with help of Interaction Design, Interaction Styles, Interaction design process.
- Social and organizational interaction context are also equally affecting factor for system and user.
- Norman model suggests 7 stages of interaction as mentioned below:
  - (a) Establishing the goal.
  - (b) Forming the intention.
  - (c) Specifying the action sequence.
  - (d) Executing the action.
  - (e) Perceiving the system state.
  - (f) Interpreting the system state.
  - (g) Evaluating the system state with respect to the goals and intentions.

- Evolution of HCI interface :

Table 1.1.2 : Evolution of HCI Interface

Year	Level of Interface	Interface media or devices
1950s	Hardware	Switch Panels
1960s-70s	Programming	COBOL, FORTRAN
1980s	Dialogue level	GUIs, Multimedia
1990s	A networked system	Groupware
2000s	Network and digital media	RF tag, Bluetooth technology, mobile devices, consumer electronics, interactive screens, embedded technology, information appliances

Syllabus Topic : Disciplines Involved in HCI

1.2 Disciplines Involved in HCI

Q. Explain disciplines contributing of Human Computer Interface.

- Psychology – understanding the user
- Sociology – groupware
- Art – aesthetic appeal
- Design – user interface layout
- Engineering/Computer Science – faster machines – faster systems – means of building better interfaces
- Linguistics – language for commands
- Anthropology – user body shape
- Ergonomics – equipment design
- AI – help facilities – modelling the user
- Philosophy – creating consistency

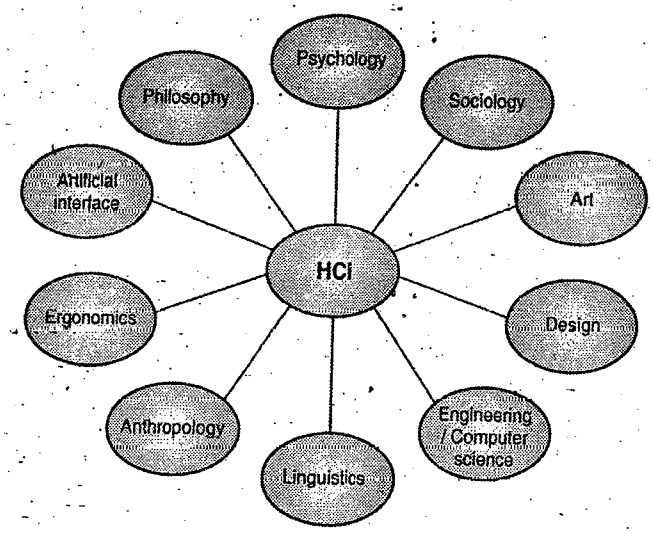


Fig. 1.2.1 : HCI Discipline

(A) Psychology

- It understands about human mental status and behaviour in interaction system.
- The psychology approach of HCI is initially for laboratory based experiments and research.
- The psychology behind HCI is initially about a user behavioural approach for software design and programming, motivate and guide system development.
- Psychologist analyzed human user requirement and guided for development of software and computer applications. Few popular theories of Psychology are as:
  1. Marr's Theory of Vision
  2. Gesalt Laws of Perception ,
  3. Model Human Processor by Card, Moran and Newell
  4. Keystroke Level Model by Card, Moran and Newell
  5. GOMS (Goal, Operators, Methods and Selection)

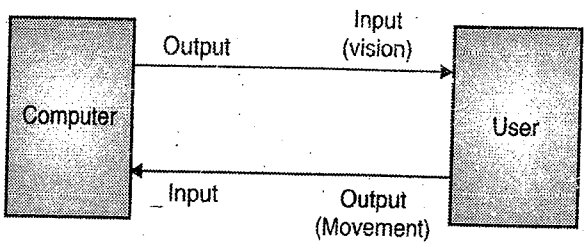


Fig. 1.2.2 : Psychological User Model

(B) Sociology

- It is about human responses on social context like attitude and behaviour gets effected due to influence someone or someone's attitude and behaviour get impacted by a member of the group,
- Sometime a member in a group or team impact on overall team activity.

(C) Art

- Design may imply Art but it is not required that art should also implies design similarly science and design too.
- A User Experience (UX) looks forward with high design and outcomes while HCI focus scientifically on outcomes.

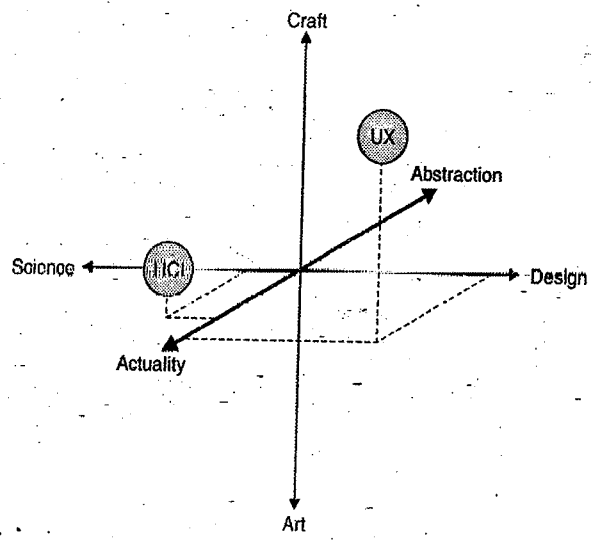


Fig. 1.2.3 : HCI relation to Art, Craft, Design, Science and HCI –UX cardinality

(D) Design

- A user design should more users friendly. It should contain appropriate symbol, color combination, logo, navigation button or bar, relevance of information is also more important for tooltip for the new user or visitor in case of web design or installation guide or an application based software.
- A user should easily traverse among different section or modules of the application or tool. A helpful layout should be availed as per requirement. Stakeholder feedback must have to be considered for better improvement in design and interaction between user and computer system.

(E) Engineering/Computer Science

- Faster is better in perception of interaction.
- User Interface Management System (UIMS) and User Interface Development Environment (UIDE) are helpful platform in computer science for interface of user with computer based applications or software.
- Hardware design and maintenance is also managed by a systematic approach by interaction guidance available in HCI.

For examples

- The user should use rubber hand gloves for handling cables inside the CPU cabinet which will saves from minor currents as well.
- Power Off and On key should not glow for long once used or it should be arranged in a way that users will not be disturbed.

(F) Linguistics

- Slob(1977) discussed characteristic for language; Language should possess certain qualities like Clear, quick and easy, expressive, processible.
- In addition to the design rules, Slob (1977) discussed about natural pressures which can change natural languages are:
  1. Gradual evolutionary processes
  2. Contact with other languages
  3. Realization
  4. Individual development

(G) Anthropology

- Anthropology is a branch of science and it deal with societies and culture.
- It is the study of human behaviour, development and societies.
- It is about understanding the social context importance.
- The information base about socio-cultural and historical circumstances of daily user's required technology can be designed in a better manner.

(H) Ergonomics

→ (SPPU - Aug. 2017)

Q. What is Ergonomics?

SPPU - Aug. 2017 (In Sem) 5 Marks

- It is suitability between technology and environments. It ensures that information and environment suits each other.
- It monitors performed activity of the user and demands of the user. Ergonomics can be studied in details with such as,

(a) Physical Ergonomics

- It is generally about human anatomical process.
- It describes about how a human (user) prefer his sitting arrangements i.e. physically interaction with computer like appropriate use of chair height, wrist rest, neutral wrist position, height of keyboard from the ground, angle of sight within monitor screen and eyes, distance between user and monitor , sitting posture for back, footrest etc.

(b) Cognitive Ergonomics

Mental process like reasoning, memory and motor response.

(c) Organizational Ergonomics

Socio technical systems in policies and work design in teamwork, community ergonomics.

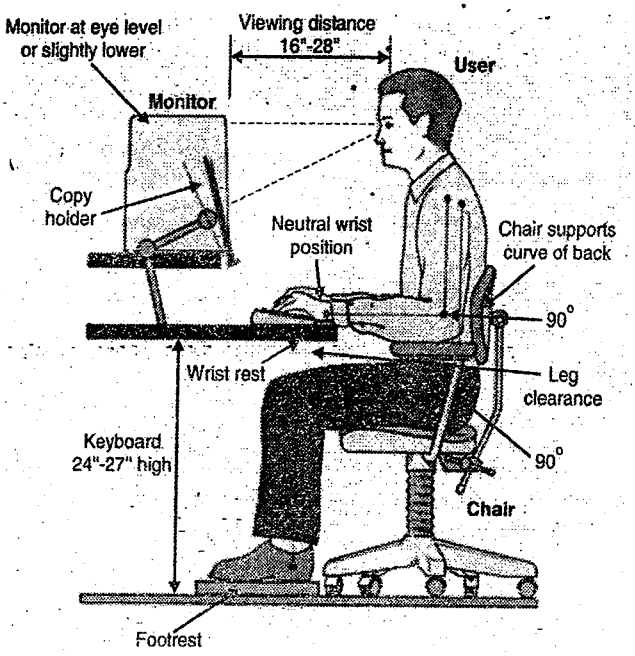


Fig.1.2.4 : Discipline of HCI: Physical Ergonomics

- ISO 9241 : Ergonomics of Human Computer (System) Interaction, adopt a traditional usability category means of specific measures, Example:

Usability Objective	Effectiveness Measures	Efficiency Measures	Satisfaction Measures
Task suitability	Goal achieved (In %)	Task Completion time	A scale based ratings for satisfaction
Appropriate for experienced users	How many functionalities used effectively	Expert user's efficiency	A scale based rating for easy learning
Learnability	Functions learned (in %)	The time required to learn criteria	Scale based rating for easy learning
Error Tolerance	Error correction (in %)	Error correction time	A scale based rating for error handling

(I) Artificial Intelligence

- Artificial intelligence improved user and computer interface in many new approaches which providing multiple data which were remaining unused before AI come into the picture.
- Human interaction with machine learning is increasingly going up day-by-day.AI usage begins with the help of NLP, Neuron technology, augmented reality, biometric readers for finger, palms, eye retina, face as well as voice as a command or instruction. Software development, MOOCs, robotics is a domain where AI is use is increasing in rapid approach.

(J) Philosophy

- Philosophy in a technology is about revealing, analyzing and discussing the human, ethical, political and social-cultural implications of these changes.
- Now a days computer programmer and computer users are treated as a separate group in view of philosophy in HCI.
- HCI philosophy acts as designer ,consultant and participative role for user overall development and providing an appropriate decision making environment for design solution for exiting as well as upcoming resources.

Syllabus Topic : Why HCI Study is Important

1.3 Is HCI study Important?

- In early period computers were expensive device or machine and mostly used for research and industry. Recently, literacy definition is changed as those who know to use a computer are literate one. Now-a-days computer users and software programmers are two different user groups in the computer system. HCI comes into the picture where necessity comes up with knowing user interest and requirement, behaviour on social context.
- HCI is highly important as we interface with many computerized machines on a daily basis like ATM machines , local train or express train ticket vending machines, image (retina or face) based unlocking system and hot drinks dispensing machines, etc. User gives command by voice, biometric, touch and keystroke based instruction, interaction of users with the system is increased a lot. With the use of

artificial intelligence interaction of user and computer or computerized system will grow rapidly in nearby future.

- As per daily needs of interacting with various systems we need to improve design, safety for user by considering social context, physiological, psychological behaviour of users.
- HCI is important to:
  - Recognize the User Goal
  - Understanding the Problem (Design Research)
  - Modeling Users (Persons and Goals)
  - Setting The Vision
  - Design Product
  - Teamwork

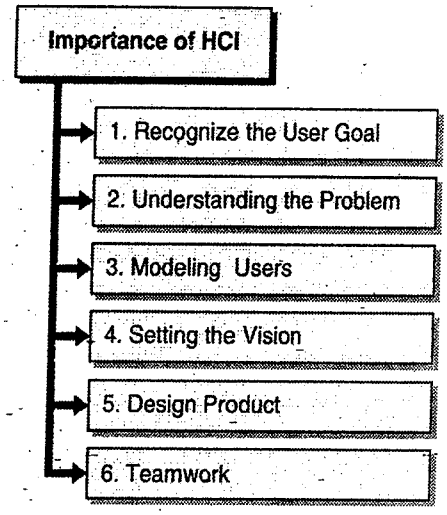


Fig. 1.3.1 : Importance of HCI

1. Recognize the User Goal

- Developer and designer should keep in mind that all users are not same, their privileges change over time. Goals are different from the overall functionality of task to do.
- Business goals, user's goal and/ or personal goals may get varied as per environment of the company, depending on whether it is product based, service based company.
- The designer should think about designing goals and need to think differently about achieving goals.
- The designer should follow some design principal of goal:
- User interfaces should be based on the user mental model rather than implementation models.
- User mental model should get reflected in goal directed interaction.
- Interaction design is not like a guesswork

2. Understanding the Problem

- A designer has to choose among an available quantitative data or qualitative data. Both data have own strength and weakness.
- Qualitative data give behaviours, social context of user and system. It helps to make a decision making design.
- Quantitative data lead to guesswork, user observation or ethnographic readings which can be used to make some decision segment or pattern.

3. Modelling Users

- Like a car manufacturing company design a car, but few users wants a stylish looking car with maximum interior features, few want safe and comfort and few want reliable but should travel with a number of people, luggage, etc., similarly a model for a user has to be made keeping different user group should be satisfied with maximum requirements completion.
- HCI is useful in modelling a user with the help information it carries about the user's Psychology, Philosophy, Sociology, Ergonomics of user etc.
- Some models which help in HCI are Physical model, Artifact model, Work flow model etc.
- Modelling users mainly deal with
  - Determining user requirement
  - Communication with stakeholder
  - Build consensus and commitment to design
  - Measure of design effectiveness

4. Setting the Vision

- As per business perspective HCI set the vision with centre designed approach with the core experience vision.
- Few visions centred method based framework as well as structured scenario based design method also suggested to set vision.

- Tools are used which are helpful to design vision to help of conveying vision of the future.
- Value scenario, interaction scenario and activity scenario are considered in Structured Scenario Based Design Method (SSBDM).
- Human Centred Deign (HCD) was used to address the issues in the design of services, products and systems based scenario.

5. Design Product

- Generally design of product is user centred a more user friendly design is more important than other issues.
- More interactive designs are considered as good design and become popular compare to others design like :
  - The peanut shape of the TV remote is preferred as better design than a rectangular shape TV remote.
  - An appropriate Font Face, Size, Text Effects, Color, Text Highlight, Alignment, proper Capitalization of an Alphabets, Numbering, Line and Paragraph Spacing, Shading, Indent, Sort, Style, Editing (Find, Replace, Select), Picture, ClipArt, Shape, Smart Ai, Chart, Links, Header and Footer , Symbols, Tables, Page Setup (margin, Orientation, Size, Columns, Breaks, Line Number, Hyphenation), Page Background-color-border, Theme etc. should be considered in case of display of text on website page or software or tool, any installation manual etc.
- Combining necessary graphical and textual representation improves GUI while the unnecessary use of an Image, .gif file, Flash screen, the use of horizontal or vertical sections in between the text lead to bad design.

6. Teamwork

- The team is a collective representation of members from distinct portfolio. In team its more 'we' than 'me' or 'we did this' than 'I did this'.

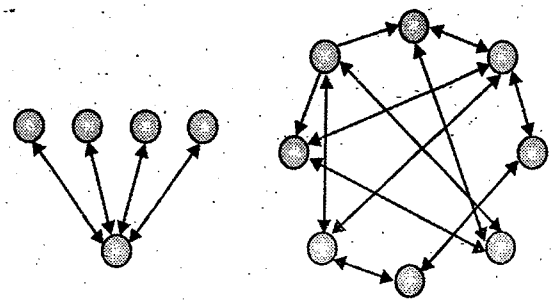


Fig. 1.3.2: Representation of Group, Teamwork

- A group has the same purpose to work, but each user has its own linking and ideology to group lead or representative at the individual level.
- In a Team each member has coordination with other members of a team; together they work for achieving some task.
- James: Everyone should be quick to listen, slow to speak and slow to become angry.

Syllabus Topic : The Psychology of Everyday Things

1.4 The Psychology of Everyday Things

(SPPU - Aug. 2017)

Q. Explain everyday design things with example?
SPPU – Aug. 2017 (In Sem), 5 Marks

- Everyday things are required with good design, essential characteristic of good design is understanding i.e. What does it mean? And Discoverability i.e. looking for probability of performing acting in How? What? Ways it can be achieved.
- One famous example of doors good design known as 'Norman Dorrs' where a user is confused with operating the door at the entrance and exits.
- Some door required to Pull for entrance and push for exist and some door required Push for entrance and Pull for exist, it means it operate in either direction.
- Some door function in both the ways Push-Pull in either side. Some door doesn't help on Pull or Push they required to slide.

- Again, few sliding door slides from left to right and few from right to left while some door slides from middle to either side.
- Even though, instruction return on the door like a push or pull, but some design of door handles makes confusion in such small things to open and close door.
- Some other design issues in similar example category like microwave oven, coffee vending machine, washer dryer machine, etc., devices from the same manufacturer have a different operating process.
- All such devices are not used with all of its functionality. Most of the user, uses few functions and keep self restricted unnecessarily from many other functions.
- Generally approx. 100 of recipes availed in the auto function mode in microwave oven, approx 15+ function in the washer dryer machine, approx. 10 functions on coffee machine, but very few user usability is more than a half of function available with devices.
- All such devices come up with a user manual or an instruction set and purpose behind it to help user to utilize all functions of the device. Rarely, users prefer to read (most of the time they found it as confusing) and all purposes behind design get lost.

1.4.1 The Complexity Of Modern Devices

- The trend for the field of design is raising up in recent days with stream of specialty. Everything around us is designed purposely to make user friendly objects for interaction or user interface with easily interactive and attractive manner.
- Products or objects are designed to increase its understanding and usability. It should maintain interaction quality along with the motive of engineering, ergonomics. Generally design areas are observed in three specials are:

  (a) **Industrial Design:** It is mad with the purpose to improve interaction between user and manufacturer by providing better service with the development of new concepts and specification.

  (b) **Interaction Design:** It is made with the purpose to improve interaction of user with technology. The design is based on social culture, psychology, ergonomics.

  (c) **Experience Design:** It is made with the purpose to improve quality in design of product, processes, overall environment considering review, feedback.

- Good design lad more useful, precise products while bad design makes a product with restricted use or unusable.
- Engineer think logically, technically and these qualities reflect in the design.
- Machines has intelligence, no emotions hence act equally as per set instruction assigned I its to-do list.
- Human having emotions and sometimes it makes deficiency in interaction. To get design more interactive and useful users should read manual or instruction set provided along with products or software service agreement.

Syllabus Topic : Principles of HCI

1.5 Principles of HCI

1.5.1 Shneiderman's 8 Golden Rule

➔ **(SPPU - Aug. 2017, Dec. 2017)**

Q. Explain Principles of Human Computer Interaction ?

SPPU - Aug. 2017 (In Sem), 5 Marks

Q. Explain Shneiderman's eight golden rule of interface design with suitable example.

SPPU - Dec. 2017, 8 Marks

Q. Explain any 2 of the following Principles in brief

i. Know the User

ii. Understand the task

iii. Reduce memory load

iv. Strive for consistency

v. Prevent errors/reversal of action

SPPU - Aug. 2017 (In Sem), Dec. 2017, 5 Marks

- Ban Shneiderman provide general guideline for computer software or user interface developer (1987) also known as Shneiderman's 8 Golden Rule :

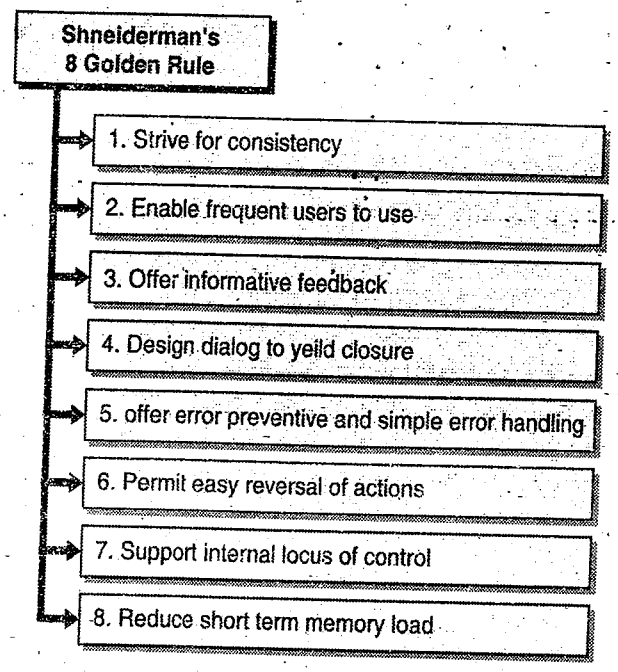


Fig. 1.5.1 : Shneiderman's 8 Golden Rule

➜ **1. Strive for consistency**

Consistency is observed in sequence of an action, terminologies, layout and command used etc.

➜ **2. Enable frequent users to use shortcuts**

Use of macro for repeatedly required context, key sequence for specific functions, abbreviation and short cut for more familiar and frequently used operation.

➜ **3. Offer informative feedback**

Availability of feedback for each user action with an appropriate feedback platform.

➜ **4. Design dialog to yield closure**

User knows at what time task is completed.

➜ **5. Offer error prevention and simple error handling**

It is to awake user from getting introduce to error. It informs user if step leading to an error, bug or fault are followed by user with the help of informative instructions or cue, hint messages so mistakes can be avoided at early stages.

➜ **6. Permit easy reversal of actions**

User got encouraged to exploration. User become more flexible with the environment by acknowledgement of user can be returned to previous position sage as per required.

➜ **7. Support internal locus of control**

Control helps user activity in control, which keep responding to his action.

➜ **8. Reduce short term memory load**

With the help of multiple panel in a window or panel with multiple page display. Time for learning action sequence.

1.5.2 Don Norman's Principle of Design

- Don Norman's Principle of Design in HCI

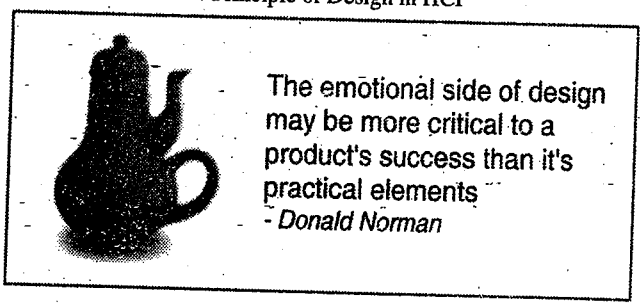


Fig. 1.5.2 :Example of Design : A Tea Pot

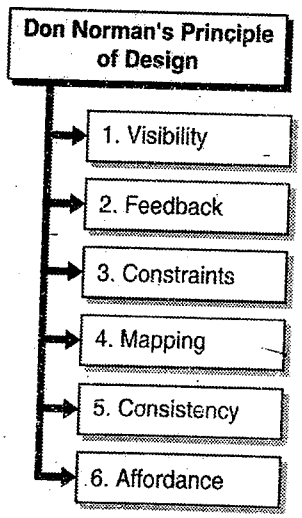


Fig. 1.5.3 : Don Norman's principle of design

➜ **1. Visibility**

More visible more user friendly. Hidden or semi hidden, overlapping based, icon based design lead to out of sight and reduce usability.

➜ **2. Feedback**

Interaction design, interaction audio, interaction tactile , verbal and so on feedback mechanism, used to collect stakeholder approach towards design.

➜ **3. Constrains**

Constraints should be applied to a various user types as they may lead to error sometimes. Constraints to user are helpful for design purpose and it can be achieved with the help of multiple ways.

➜ **4. Mapping**

It is relationship among controls and effects like top-bottom buttons, left – right side indicators, jump to particular page from a series of pages, directly to homepage of website or information uploading websites WebPages or software tool without losing data. etc

➜ **5. Consistency**

Interface of design remain consistent to lead to a good design. Relevant and relevance information should remain in a consistent it help to improve usability, user friendly quality of design.

➜ **6. Affordance**

It is act of providing cue or basic idea to perform task. Give a journey of features and advantages of design with small video or animated clips or design with help of arrows and pop-up messages. It helps to inexperienced user.

1.5.3 Nielson's 10 Heuristics

➜ **(SPPU - Dec. 2017, May 2018)**

Q. Explain Nielson's 10 heuristics.

SPPU -Dec. 2017,May 2018, 8 Marks

– Jakob Nielson together with Rolf Molich(1994) gives some design interface guideline , popular as Nielson's Usability Heuristics:

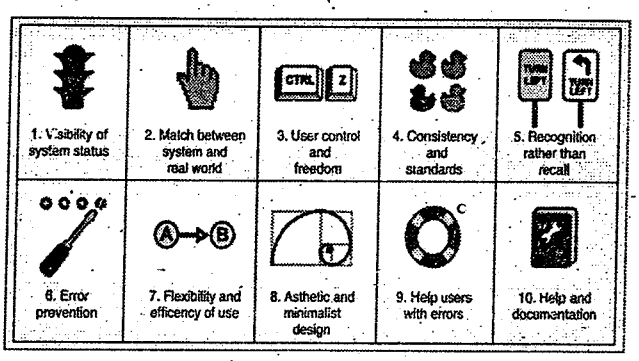


Fig. 1.5.4 :Nelson's Usability Heuristic

1. Visibility of System Status

System should be informing about performance to user and act on user feedback within specific time bound.

2. Match Between System and Real World

System should be design in a fashion where it ensemble with users language, words, concepts etc. which lead to a proper logically ordered design.

3. User control and Freedom

- User require necessary exist option at most of critical time, as user come to know proceeding ahead may lead to an error , user check for available exist which may protect from near future error in a task.
- Some options undo , redo are useful but these not help when data submitted and processed in such case design should provide exist from last saved data or current window without losing previous data. its better to exist without losing a data than to face a system's kill process.

4. Consistency and Standard

- A same word stands for a different meaning and in some cases different words are leading to a same meaning.
- Design should maintain synchronization among design with consistency and without tampering standards.

5. Error Prevention

An error should prevented from occurrence, user should be intimated before the proceed action which may turn into an error.

6. Recognize Rather Than Recall

- Design should be highly interactive so a user can easily find options and objects, option with symbolic appearances help more better way.
- Instruction set should be highlighted , design should made user to remember less information while interacting.

7. Flexibility and Efficiency of Use

- System has to interact with both experienced and inexperienced user.
- It should be efficient for experienced while flexible for inexperienced users.

8. Aesthetic and Minimalist Design

- Relevant dialog should be there, unnecessary information from dialogue lead to disturbances in useful information.
- Design should be more comfortable to view, read, search and other activities where users are involved.

9. Help Users Recognize, diagnose and recover from error

- Error, warning, exception, message should be pop-up or display with efficient information. It should not cover all script of code or operating system bug report etc. unless it is required.
- Even if large information provided it should remain hidden , if user need then user should avail it from same dialog box with the help of hitting any extra key.
- Exception, informative, successful, warning, error messages dialog box should represent adequate data.

10. Help and Documentation

- Help is useful to user who is inexperience with interaction to design. Help utility work like guide at tourist place.
- Documentation is not really getting importance what it deserve but it may lead to consume user time in exploring things without proper interaction with documentation.
- A properly documented things gives a user maximum usability, robustness, flexibility among interaction design.

1.5.4 Few Other Characteristics and Principles

- Few characteristic of good design are as mentioned below:
  1. Innovative
  2. Aesthetic
  3. Unobtrusive
  4. Long lasting
  5. Environment friendly
- Makes a product understandable
  1. Makes a product useful
  2. Good design is through down to the last detail
  3. Good design is as little as possible
- Design Principle to Reduce Cognitive Load
  1. Avoid unnecessary element.
  2. Leverage common design patterns
  3. Eliminate unnecessary task
  4. Minimize choices
  5. Display choices as a group
  6. Strive for readability
  7. Use iconography with caution

Syllabus Topic : User-Centred Design

1.6 User-centred Design

- A good design is a bridge between technology aspirant users and understanding human psychology, user's communication in case of success, partially successful and unsuccessful interaction due to design.
- Better user centred design correlate user capabilities and solution and usability provided by design.
- Like if we used the keyword 'attached' or 'enclosed' etc. in body of email and no file is attached to the body of an email, as we try to send an email a pop-up notify to the user informing you not attached anything in the mail, do you want to continue ?

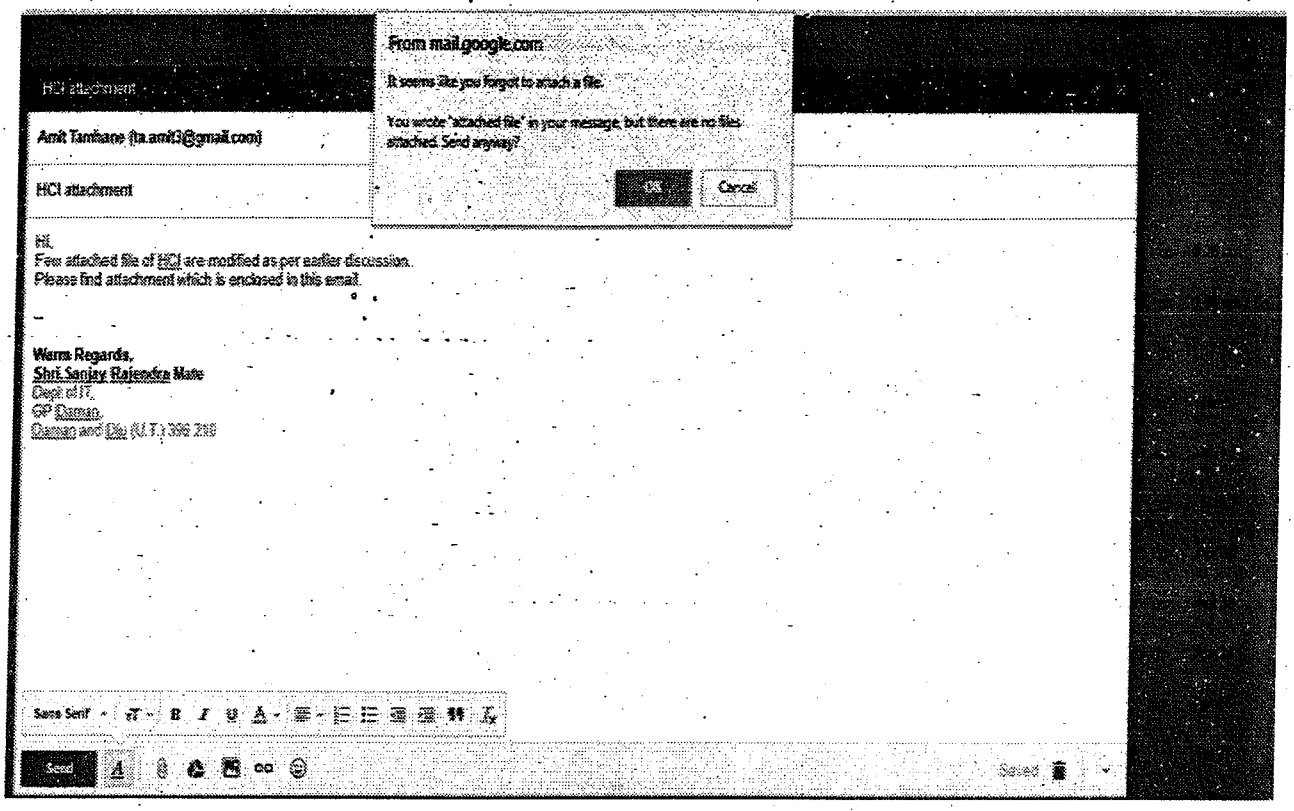


Fig.1.6.1 :User centred Design Google –Mail Service Feature(with Intelligence)

- This is highly supportive and helpful and user centred design. Sometimes a user without any intension proceed some activity which leads to an error or mistake and user centred design helps user and improve usability, flexibility of design.
- Few software or products goes costlier due to inappropriate design, usability reasons like:
  - (a) User requested change post project goes live
  - (b) User in confused about SRS satisfactorily completed or not
  - (c) All stakeholder reviews should be taken in consideration at the time of designing.
- For better user centred design
  - (a) Understand user which helps to design task centred system design
  - (b) Use of low or medium fidelity protocol
  - (c) User involvement at each stage of process of design
  - (d) Perform usability test with users
  - (e) Collection of data can be achieved by interviewing stakeholders, subject matter expert discussion, literature survey etc.
  - (f) Data analysis can be in a better way with Requirement Analysis, User Analysis, Task Analysis, Functional Analysis.
  - (g) Prototyping: It helps it provide a better system to user as the involvement of user is active. User understand system from the initial stage of system development.
  - (h) By evaluating from expert user, user leads to better usability, function ability and acceptability.

□□□

UNIT II

CHAPTER 2

Understanding the Human

Syllabus Topics

- Input-Output Channels
- Human Memory
- Thinking: Reasoning and Problem Solving
- Human Emotions
- Individual Differences
- Psychology and Design

2.1 Introduction

- Recently, automated drives and robots were used to interact and operate with devices. Research and studies becoming popular nowadays in a field of Robotics, along with Machine Learning, Artificial Intelligence, NLP based interaction, design and engineering.
- In this chapter, we will see Input – Output Channel, Memory, Thinking, Emotion, Psychology and Design with aspects of human as an interesting object with devices.
- Here, we will discuss How a human adopts skills? How to remember things? How body revokes information from memory, if can't then what is reason behind it? What is mean by emotions? What exactly happens in reasoning and thinking abilities to human? How human organs work as an input system for the body ?

Syllabus Topic : Input Output Channels

2.2 Input Output Channels

→ **(SPPU - Aug. 2017)**

Q. List human input output channel and describe it briefly. **SPPU – Aug. 2017 (In Sem.), 2 Marks**

Q. Explain the role of senses, which plays an important role in HCI.

- A computer gives some output which is accepted by human as a part of an input in the interaction.
- While human provides instruction to computer or devices which are recognized as an input for it in the interaction i.e. users' output becomes computer input.
- Mechanism of providing input and output with the help of some media will be changing as per device like sound from the speaker is an output while sound received from in mile or microphone is an input to the system.

- Input for human are mainly controlled of effectors were used to provide output.
- Major five senses of human sight (eye), hearing(ear), haptic (touch), smell(nose) from interaction purpose sight, hearing and touch are important.
- Few scents (fragrance) based technology are in demand in communication technology from users of web surfing, gaming, music and movies, etc. As if A Paper scent is one of the devices which instant dispense, scented perfume strips. Scent and taste both not much significantly used in interaction.
- Fingers, eyes, head, vocal system, limbs these are effectors in the interaction. Fingers were mainly used to provide input via keyboard and mouse, eyes to observe computer output as well as input wherever retina used as biometric credentials. Some use of voice, head and body position in HCI.
- Hearing is helpful to come to know about system functioning status via beeps from the CPU. Various beeps patterns are used to show the status of working, error message of the system. Apart of this hearing is used to know about press of keys on keyboards.
- Hearing is used in entertainment, communication via internet based calls, recording etc.

2.3 Visual Channel

2.3.1 Vision

The Eye is one of the prime source of information for human. Human vision is made up of many sequential actions based process, it is a less complex activity too.

(A) Eye

- Human vision can be grouped into two for better understanding; first the physical reception stimulus from the outer environment, second visual system and physical properties of the eye along with many universal properties of functioning eye.
- Many things can be visually perceived while few things cannot be visually perceived by the human eye.
- Light is an important aspect of the human eye. Eye mechanism begins with light only.
- The eye receives light and transform it into electrical energy, that is reflected or emitted from an object in the environment.
- With light-based reflection of an object in the human eye is focused upside down on the back of the eye. It gets transformed into an electrical signal by the receipt or in the eye. These electrical signals produced by receptor are passed to the brain.

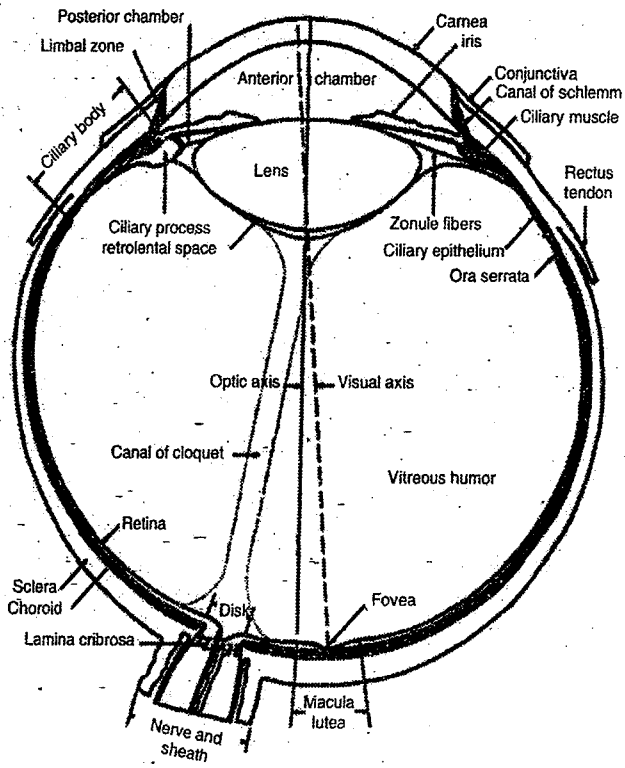


Fig. 2.3.1 : Human Eye (Horizontal Section)

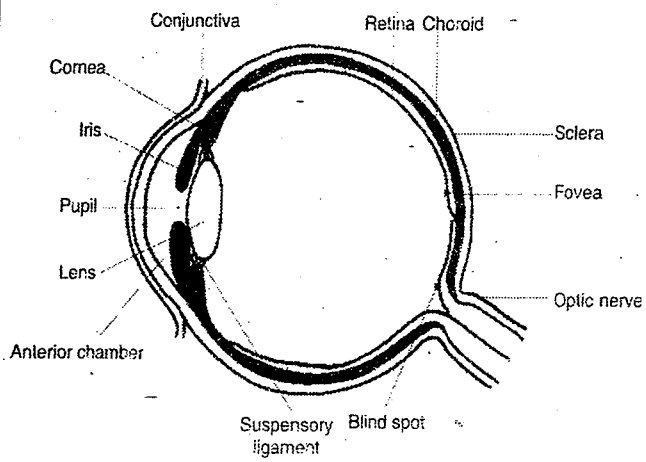


Fig. 2.3.2 : Human Eye

- The human eye consists of Cornea, Iris, Pupil, Lens, Blind spot, Fovea, Retina(rods, cones), Sclera, Conjunctiva, Anterior chambers, Suspensory ligament, Optic nerve etc.
- Light reflected from the object firstly appear on the cornea to the lens to a sharp and from the lens to a sharp image upside down onto the retina. The retina is highly sensitive in the case of light shades.
- Rod dominates peripheral vision. Approx. 120 million rods were present in a normal human eye situated towards the edge of the retina.
- The rods are the photoreceptor based at the retina which are more sensitive to light and provides a low level illumination.
- Saturation of the light may occur due to unresolved fine details at the rods edge of the retina. Sometimes makes a temporary blind spot.
- **Example :** After walking into the dark light sudden appearance of sunlight. The cones cannot function as those were suppressed by rods, normally we are unable to see anything for a while.
- Another receptor of human eye from the retina are cones. Compare to rods these are not much sensitive to light, hence it can have more light.
- According to wavelength and sensitive cones are divided into here types. This helps in color vision.
- Approximately 6 million cones are available at fovea i.e. a tiny area of the retina where images get fixated.
- Optic nerve extends in the eye via blind spot – Blind spot does not contain rods and cones like the retina.

Table 2.3.1 : Function of X – Y cells

Cells	Function	Location
X cells	Early Detection of Pattern	Concentrated at Fovea
Y cells	Early Detection of Movement	Wide at Retina

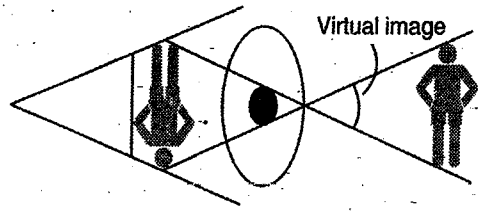
- A special nerve cells, i.e. 'ganglion cells' are present in the retina. Sometime patterns of peripheral vision remain undetected so that movement is perceived it happens due to distribution of X-cells and Y-cells.

(B) Visual Perception

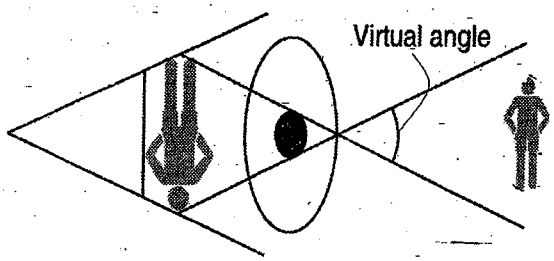
- Pictorial information input received by the visual apparatus must have to be filtered before passing it towards processing elements which allow us to recognize distance, color, scenes with their variations like disambiguate relative distance size, depth, differentiate to colors, coherence among scene brightness.

(C) Perceiving Size and Depth

- Consider you are on top of a hill and surrounded by a few trees at that top of a hill. You can easily observe road track from hilltop towards small villages or market on the downside, vehicle like bikes, car, buses, etc. moving to and from hillside road to the nearby marketplace.
- It means even though trees near to you are big enough closer compared to other, vehicles like car, buses looks comparably smaller than original size you can recognize the objects apart of sizes. Just by the size, depth, relative distance of an object we can recognize.



(a) Visual angle



(b) Visual angle remain some for different size and distance object

Fig. 2.3.3 : Visual Angle

- As we discussed an image of an object formed upside down on the retina. Apart of relative distance, the depth of an object, it has same visual angle with retina.
- Degree t minutes of arc unit for visual angle measurement are as follows :

1 Degree = 60 min of arc

1 min of arc = 60 sec of arc

- If the visual angle made by an object is very tiny, we cannot perceive the object at all.
- An ability of a human to perceive fine details is by its visual acuity. The large number of eye test was available to measure visual acuity.
- In case of rotating or moving object, once you can see objects, i.e. perceive the object and even it went away, our perception about that object remain same even its passing away even though a visual angle changed.
- Similarly a person's height once perceived, remain constant even if its visual angle changes.
- This phenomenon known as 'law of size constancy' it tells about the perception of size depending upon factors other than visual angle.
- Perception of depth is an important factor to determine relative position and distance of an object. Generally size, and height parameter help to clue about distance of an object.

(D) Perceiving Brightness

- Brightness is another important factor like size and depth: Brightness is directly concerned with level of lights and luminance i.e. light excreted or emitted by the object.
- Luminance depends on surface properties of an object and light falling upon it. Photometer is unit to used measure the physical characteristic.
- Contrast and luminance are relating factor, its luminance of an object background and it's the function of a reflecting object respectively.
- As per amount of luminance, brightness changes. In case of dim light, the rods of the human eye predominate vision.
- As very few rods present at fovea objects in dim light can be seen less easily when fixed upon and these objects were visible in peripheral vision.
- The Rods take over charge in case normal light. With increasing luminance, visual acuity increases. Flickering also increases with increased luminance.
- More than 50Hz switching light ON and OFF will treated as light perceived as ON. But if speed reduced or less than 50Hz light perceived as flicker.
- Flicker over 50Hz can be perceived in case of high luminance. Flicker is noticed in peripheral vision, i.e. more larger the display, the more chances about its flickering.

(E) Perceiving Colors

- Color is made up of three component Hue, Intensity and Saturation. An average person can discriminate 150 different hues. Spectral wavelength of light is used to measure hue factors of the color.

Table 2.3.2 : Color with respective wavelength

Color	Wavelength
Blue	Short
Green	Medium
Red	Long

- Brightness of color depends on the intensity and whiteness of color depends on the saturation. By varying brightness and whiteness in the color 7 million perceivable colors can be obtained.
- A human eye easily perceives color with the help of cones. Cones are highly sensitive to light as per distinct wavelength.
- There are here types of Cones for three different types of colors Blue, Green, Red.
- Best color vision is due to fovea while worst color periphery due to Rod predominately activity.
- Most of people are unable to discriminate between Green (medium wavelength) and Red (long wavelength) color. 3 - 4 % area covered by fovea is sensitive to blue light and make blue acuity lower.
- It should be noted approximately 8 % male and 1 % female are having problem in discriminating colors or suffer from color blindness.

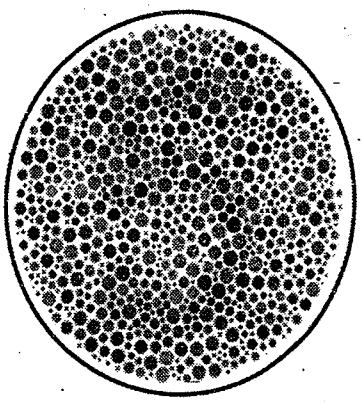


Fig. 2.3.4 : Gray-Black Color Test: A Normal Human Can Observe Digit 5 Like The Pattern

2.3.2 Illustration of the Capability and Limits of Visual Perception and Processing

- Threshold perceptual is measured in msec, it is necessary while understanding temporal image, threshold varies from object to object along with scene properties like.

Global scene properties	Threshold (in msec)
Naturalness	21
Depth	21
Camouflage	23
Navigation	24
Symmetry	28
Natural category	33
Indoor category	43
Object cluttered scene	135

- Visual processing involves image transformation and interpretation from light emitted by an object or reflection of object due to light or luminance onto the retina.
- Object remains at one place i.e. steady position and human keep moving or vice versa or both the human and the were moving still it observe object as a visual processing compensates for the movement of an image.
- To the retina, in a similar way though luminance is remain changing, the color and brightness of object were perceived as constant.
- Perceived color, movement of an (object) image to retina helps to resolve ambiguity in vision.

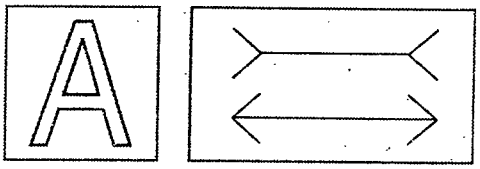


Fig. 2.3.5 : The Muller – Layer illusion – which line is longer

- If you think top line is longer compared to bottom line as top line looks like a concaved edge while bottom is with convexed edge then it is wrong both lines are of same length.
- In case of ponzo illustration, line at top appears longer as of distance effect where both lines are equal; it shows our perception of size is not truly reliable.

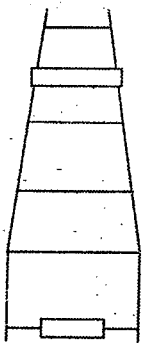


Fig. 2.3.6 : Ponzo illustration

Soccer and cricket game are equally liked from from young Indians.

Fig. 2.3.7 : Illustration

- Above sentence you read correctly ? Found anything wrong word 'from' is repeated.

2.3.3 Reading

- Reading is combination of perception and processing of the text, is important aspect of design where text data used in interaction.
- In mechanism of reading first phase is of perceive of text pattern and later it is decoded with reference to its appropriate internal representation syntactic and semantic analysis is the last operation performed with the phrases of sentences.
- Two movements of eyes are important saccades and regressions at the time of reading. The jerky movements of the eye at the time of reading is called saccades which is followed by fixation during the period of fixation perception occurs.
- The movement of eyes forward and backward on text is called as regressions. The more text is complex, the more is regression.
- Few experience states that a word can be perceived recognized as early as character. Words are scanned in a serial approach, character by character. An adult read average of 250 words per minute approximately.

- An easily perceivable and can be read text content has some specifications like line spacing, no of words per page.

Parameter	Range
Font size	9 – 12 point
Line length	58 – 132 mm

- According to few expert book texts, reading is compared gives more speed than computed screen text.
- Generally, long words can be perceived by brain with the help of vocabulary by reading leftmost and rightmost characters and later in sequential series from left to right word get recognized by brain, need to required to trace each character.

2.4 Auditory Channel

2.4.1 Hearing

- Sight (eye) is considered as primary sense while hearing (ear) is secondary sense. You can hear a sound hearing mechanism is done with help of ear further activity is by brain.
- For a while, close your eyes listen carefully sound from environment someone might be speaking, running, passing on (vehicle) you can recognize the activity with its parameters.
- Like if someone is speaking with you may recognize whether a known or unknown person voice, whether a person is male or female, if some vehicle passed you can recognize from and to which direction it moved.

2.4.2 The Human Ear

- The hearing mechanism begins with vibration in sound waves. The received waves transformed by three section of ear i.e. inner ear, middle ear and outer ear
- An outer ear is the portion of the ear, which observed easily, pinna and auditory canal are the part of it. Some part of the ear attached to head on both sides is pinna. Pinna is useful to serve to amplify sound with canal.
- An auditory canal used to pass sounds from the region of outer ear to middle ear. Canal consists of a wax like material, it prevent ear from material like dust, small insects and dirt. An eardrum middle ear or the tympanic membrane provides a cavity to the outer ear to pass sound waves to reach by cochlea of inner ear.
- The ossicles are the smallest bone in the entire human body, it present in the middle ear.
- Sound waves pass from auditory canal, vibrate eardrum further ossicles (middle ear) get vibrated. Ossicles transmit vibration to cochlea (i.e. inner ear).
- Outer and middle ear is filled with air, while inner ear is filled with denser cochlean liquid. Sound waves passed through ossicles to cochlea liquid are implied and concentrated waves.
- Inside cochlea cilia (delicate hair cells) bends because of vibrations in cochlea liquid and it generates a chemical transmitter which gives impulses to a auditory nerve.
- Some characteristic of sound helps to better understand it like pitch, loudness, timbre. Auditory system performs some actions of noise filtration on sound received to ear, it helps to concentrate and good amplified wavelength receiving to auditory nerve.
- For example, you are in cocktail party, where music sound is at its peak still you distinguish announcement made with some name or word phrases etc.
- A normal human ear is averagely capable to hear with the range of 20 Khz to 15 Khz frequencies.
- Interaction based sound applications are information status, navigation attention, speech to text conversion etc.

2.5 Haptic Channel

2.5.1 Touch

- Touch or haptic channel are not much focused like sight or hearing in HCI. There are three types of sensory receptors : thermo receptors, noiceptors, mechanoreceptors.
- Thermoreceptor responds for hot or cold sense of object. Nociceptros respond for intense pressure via sensation, pain, heat etc. Mechanoreceptor mainly responds to pressure, rapidly adapting mechanoreceptor and slowly adapting.
- Mechanoreceptor are its subtype on basis of quick and slow

response respectively.

- Some part of body are more sensitive or acuity compared to few other parts of the body. Whole body itself has sensation in unequal approach.
- Two point threshold test is used to measure acuity of two points of the body.

2.5.2 Kinesthesis

- It is awareness with the help of limbs and body. Joints receptor work there as sensation mechanism.
- Rapidly adapting, slow adapting and positional receptor are three types in it.

Sr. No.	Kinesthesis Receptor Type	Response area
1.	Rapid adapting	Movement of limb in a particular direction
2.	Slow adapting	Movement as well as static position
3.	Position receptor	On a static position of a limb.

2.5.3 Movement

- A human body parts send information of their sensation or input of their interaction (sight, hear, touch etc.) to brain. Brain works on it and gives instruction to concern organ for respective respond.
- This process is taking some time which can be either a part of response time or respond (Movement) time.
- Usually response time is equal compared to time taken respond as it consists of motor skills of organs. Motor skills get vary according to age group, physical activity etc.
- **For example :** Two friends playing a computer game (two player) for same scenario they may have different response and respond too. Depending on their approach to play and physical activity styles.
- An approx reaction time for an auditory signal is 150 ms, for visual signal it is 200 ms, for pain it is 700 ms.
- Depending upon skill and practices reaction time may get reduced. Depending on user speed of reaction accuracy may get varied.
- According to the Fitt's law for a movement : Where a, b are empirically determined as constant

$$\text{Movement time} = a + b \log_2 \left(\frac{\text{Distance}}{\text{Size}} + 1 \right)$$

Syllabus Topic : Human Memory

2.6 Human Memory

- Memory is like hard disk drive we store and retrieve information but from memory few things can not be recalled as human forget.
- Forgetting information from memory happen due to some reason. Memory has several abilities like encode, store, retain, recall information, stored past evidences used to recall information some times.
- On pattern of store, recall information human memory grouped into three types
  (1) Sensory Memory
  (2) Short Term Memory (STM)
  (3) Long Term Memory (LTM)

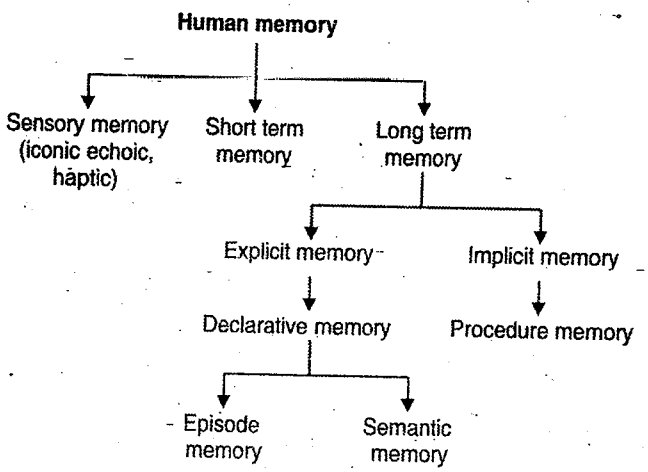


Fig. 2.6.1 : Human memory hierarchy

2.6.1 Sensory Memory

- Sensory memory works like buffer for memory system. Its buffer get input from stimuli received via senses.

Table 2.6.1 : Sensory Memory Channel and Stimuli

Sensory Channel	Stimuli	Approx Duration
Iconic memory	Visual	0.5 sec long
Echoic memory	Aural	3 – 4 sec long
Haptic memory	Touch	< 1 sec long

- Iconic memory has some persistency issue i.e. appearance of image even after removal of stimuli.
- **Example :** Fireworks a moving sparkling fire crackers leave persistent image.
- Echoic memory is experienced by the human ability for existence, direction of origination of sound.

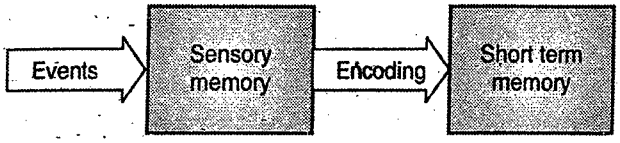


Fig. 2.6.2 : Sensory Memory Model

- With help of past experiences it try get newly information of rare sense information sensation.
- In case haptic sense, few things touch we recall at any time while most of haptic stimuli we forgotten depending on our concentration, recall to it repeatedly.
- We can recognize some face, voice, sometime touch even we are in noisy, crowded place, even we are not much familiar, How ? Just like earlierly discussed cocktail party evidence.
- It is because we are able to keep our focus on selective manner with the help of very short capacity based sensory and mental processes.
- Aurosal decide to which stimuli should be used to attend sense.

2.6.2 Short Term Memory (STM)

➔ **(SPPU - Dec. 2017)**

Q. Design and explain an experiment o investigate the decay aspect in human short term memory.

SPPU - Dec 2017, 5 Marks

- Short term memory also called as working memory, it as a scratch pad as used for temporal recall.
- To recall a long sentence of calculation which you do orally i.e. with pen and paper, we used intermediate stage of storage i.e. short form memory.
- Short term memory has a rapid access approx 70ms. similarly its decay factor is also rapid. It's capacity is less.
- There are two types of methodologies for measurement of memory capacity. In one approach length of a sequence needed in on order while another approach items can be recalled randomly.
- With first approach an average person can recall 7 ± 2 digits from the experiments of miller. If you can recall digits from a pattern of digits around five to nine, it means your digit span is average.

☞ **Try it out pattern I**

5 6 2 4 9 1 7 8 3 2 6 9

☞ **And now try this pattern II**

562 491 783 269

- Recalling digit from pattern II is little more easy and number of digit recalled is comparably more because pattern II digit arranged in group or chunk.
- 7 ± 2 rule is nothing but 7 ± 2 chunks you can recall (information retrieval).
- The successfully created chunks are known as closure. Chunks and closure helps to improve short term memory.
- From a sentence, we can recall last word more easily than middle (as per some experiments) is called recency effect.

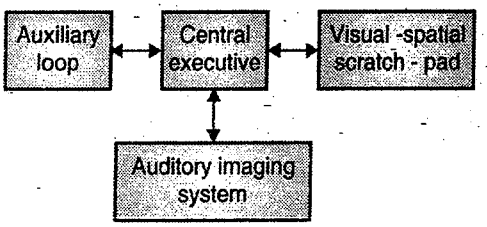


Fig. 2.6.3 : Model for short term memory

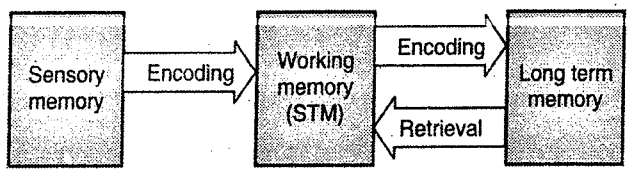


Fig. 2.6.4 : Short term memory operation

- Rehearsal improves working memory. Generally, 20 sec. duration is considered for working memory.
- Interference, and decay are two distinct factor which are concerned to working memory made it efficient for short term memory.

2.6.3 Long Term Memory

➔ (SPPU - Aug. 2017)

Q. Write a long term memory model script for case given below: An owner went veterinary hospital along with dog. (Textbook considered other cases as example).

SPPU – Aug. 2017 (In Sem.) 5 Marks

- It is a more vital part of human memory, it is main storage of information what so ever we know by our stimuli, reading, writing, observation, listening activity, past experience and so on.
- Long term memory is with large capacity storage of information with a potentially unlimited duration.
- Episodic memory and semantic memory are the two types of declarative memory which comes under explicit memory. Procedural memory is branch of implicit memory. While explicit and implicit memory combinely form a long term memory, as refer Fig. 2.6.1 : Human memory hierarchy.
- Episodic memory has information of events and experiences in serial approach. It is made from our lives daily experiences.
- Semantic memory is factual experiences, skills which person posses. Data or information to semantic memory is derived episodic memory as past experience used by semantic memory.
- Semantic memory works like linked list in data structure, it accesses information along with relationship between pieces of information.
- Semantic memory information model appears like a network structure parent class, child class, attributes in association.
- A model for semantic memory was postulated by Allan Collins and Ross Quillian. It is suggested that linking based sets of superordinate and subordinate were used to represent knowledge of objects, person, concept, events etc in a hierarchical manner.
- For example, a property which categories fish (gills and swimming) are kept at one level. Gills and other similar featured types fish (like shark, salmon) not kept with different types fish. Similarly with appropriate properties birds also kept in structure where birds were super ordinate of canary is an animal.

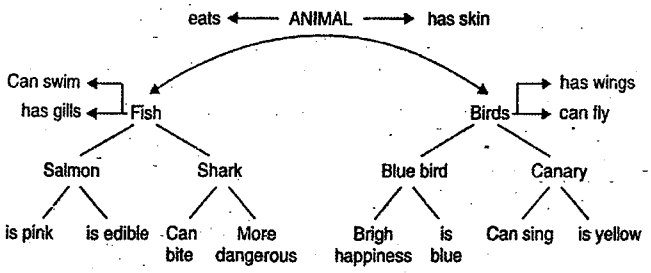


Fig. 2.6.5 : Collins and Quillian's model of portion of hierarchically organized memory structure

2.6.4 Retrieval of Information in Long Term Memory

- Next important phase of long term memory how information is retrieved ? Collins and Quillian designed an experiment with 'yes' or 'no' question like :
  1. Does a Canary eat ?
  2. Does a Canary fly ?
  3. Is Canary yellow ?
- These questions require semantic level to answer from your experience.
- 'Recall' and 'Recognition' are important aspect in information retrieval. Recalling is the reproduce of information from memory.
- In recognition, information presented with the help of knowledge. Cue help is recognition.
- Depending on question you have to traverse a level of bird-canary is yellow or can sing etc.
- Accordingly, "Is Canary a bird ?" question requires less time to answer than "Is Canary an animal ?" depending on level to transverse in hierarchy.
- It is revealed that 75 milliseconds require to answer long question to an average person like "Does a Canary eat ?" than "Does Canary fly".
- Less 75 millisecond will require to answer "Is a canary yellow ?" than to answer "Does canary fly?"

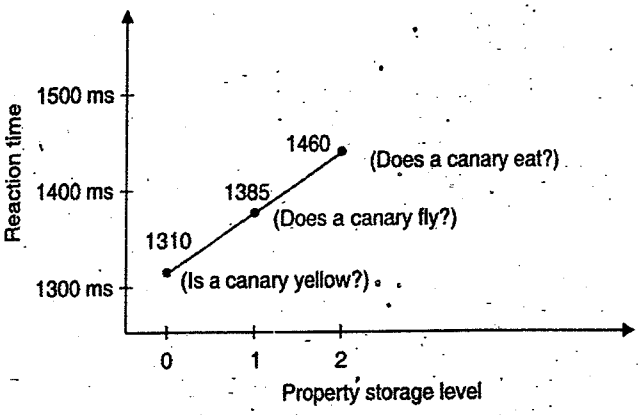


Fig. 2.6.6 : Graphical level of memory hierarchy traversal representation in semantic memory

2.6.5 Theory of Forgetting

- Decay and interference are the two factors which lead to forget information.
- According to Ebbinghaus, decay of information happen logarithmically i.e. it happens rapidly at beginning, later it slow down.
- According to Jost's law if two memory stresses which are equally strong at a given period, the older one will be more durable.
- Interference happens as new information acquired, old information get lost, it is also known as 'Retroactive interference'.

  Example : As you change mobile or phone number, you remember in use and old number and later on you were unable to remember old number. Because of new information mask to old one.
- Sometime it happens the old memory trace brake through and succeed to put interference with new information, is called as 'Proactive Inhibition'.

  Example : By chance you rotate driving wheel towards old friends house area than new area where he located.

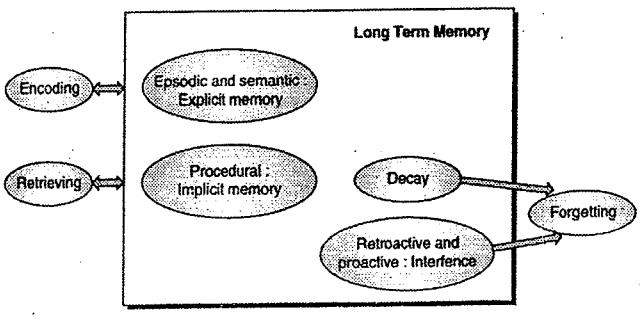


Fig. 2.6.7 : Long term memory model

Syllabus Topic : Thinking : Reasoning and Problem Solving

2.7 Thinking : Reasoning and Problem Solving

→ **(SPPU - Aug. 2017)**

Q. What is reasoning? Explain different types of reasoning with examples.

SPPU – Aug. 2017 (In Sem.), 5 Marks

- Thinking is an ability carried with the help of memory past experiences, knowledge, information, etc., to achieve a goal or to solve some puzzle or problems. It is cognitive function ; a meaningful mental representation.
- Reasoning is selective and controlled approach of thinking at higher level in a systematic and with the help of stepwise meaningful metal capabilities.
- Decision making is an art of choosing best policies among a wide set of policies, it is also a cognitive function.
- Problem solving is an ability to define a problem (with related sub problems), understand problem, thinking on reason to arise problems, remedies to be applied to solve problem and precaution for non-existence of the same in near future.

2.7.1 Reasoning

Inductive, Deductive and Adductive reasoning are the three types included in reasoning.

(A) Inductive Reasoning

- Inductive reasoning is a process of continuous learning from the environment a part of its unreliability issues. Like all Elephants has a trunk , all Monkey has a tail we observed it many times. But if anyone asked to prove it, we need to collect evidence or even if someone has to prove it is not true, then that user needs to collect evidence for the same.
- Wason suggested a theory about inductive reasoning, will see it with the help of an example: Each card has a letter on one side and number to another. Which card you prefer to pick the truth of the test of a statement ' If a card has an odd number on one side and a vowel on the other'?

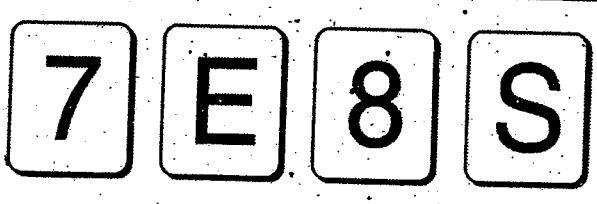


Fig. 2.7.1 : Wason's Card : An Example

- What will be your answer, a common response will come with 7 and E, it used only positive evidence. To check with negative evidence we must check a card with odd numbers and what is a letter on behind of it, even we preferred 7 and it may have a vowel at back side or not? i.e. if it has a vowel, then also as per statement, we chose correct card. Checking with this approach is negative evidence.

(B) Deductive Reasoning

- It is a type of a general statement, logic to a specific conclusion.
- Syllogism arguments are written in the form of A is B, C is A therefore B is C.
- Example :
  - It uses a general statement
  - General Statement: All men are mortal
  - With the help of specific reference
  - Specific Reference: Socrates is a man
  - It reaches to a conclusion
- **Conclusion :** Socrates is mortal

The Table 2.7.1 shown below is with major and minor premises and conclusion brought from both premises.

Table 2.7.1: Major and minor premises

Sr. No	Major Premise	Minor Premise	Conclusion
1	All men are mortal	Socrates is a man	Therefore, Socrates is mortal
2	All apples are fruit	A Johny Smith is an apple	Therefore, Johney smith is a fruit.

(C) Abductive Reasoning

- It is based on the fact or action of the object concerned. For example: Esha drives vehicle fast when she has been drinking. You know her for such habits. If we see Esha driving a car with high speed, an observer may infer that she has been drinking. It may be very unreliable; as she may have been called for some emergency.
- Such infer may lead to confusion, even error as action are unrelated. Without any evidence or support theory, unreliable reasoning was made.

(D) Problem Solving

It is process of solving a problem with the best of human past experience, knowledge and reasoning ability. Few information processing theories are proposed in problem solving i.e. Gestalt Theory and Problem Space Theory by Newell and Simon.

(E) Gestalt Theory

- According to psychologist Gestalt problem solving is reproducing known responses or an approach of trial and error.
- While few behaviorists suggested problem solving is productive and reproductive both, reproductive problem solving approach requires previous experience and productive problem solving approach requires insight and restructuring of the problem.
- Psychologist Gesalt backed up his approach with very few experimental evidence and it is attractive as concern to solve the problem. But due to insufficient evidences and not providing information about when and how restructuring occurs, it remains bit restricted.
- Another popular example with merely similar approach from Maier's pendulum problem (1931) i.e. based on productive restructuring.

Example based on Maier's Pendulum Problem

- The two strings dandling from ceiling are too far apart for a lady decorator to grasp them both a the same time; How can she (user) use the objects in the room to help her to tie them together?

She used weight of pliers as a pendulum to swing the string. When experimenter brushed few things she found solution in problem itself. The string movement had given insight which allowed the her to look at the problem in a completely new

way. This example also illustrates fixation: She (user) were initially was not able to see beyond use of pliers.

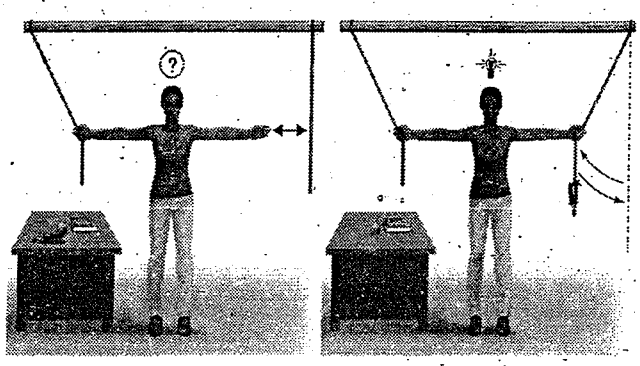


Fig. : 2.7.2 : Example based on Maier's Pendulum Problem

(F) Problem Space Theory

- The Problem solving center is based on problem space suggested by Allen Newell and Herbert Simon (1972). Generation of states is required in problem solving with the help of legal state transition operators.

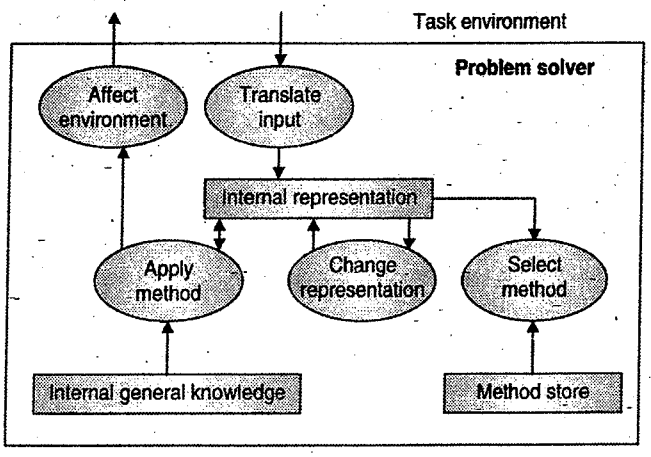


Fig. 2.7.3 : A Schematic Newell and Simon's (1972) General Theory of Problem Solving

- A problem is the perceived difference between the current object and desired object.
- An object is a thing, where the problem is related.
- An operator is a thing which is applied to produce a different object. A heuristic information is used to relate operators to reduce differences in between them.
- Theory of problem solving is discovered and to understand the system of heuristic.
- A problem has two states, one is the initial state and other goal state, an appropriate operator required to reach the goal.
- Heuristic in means-end analysis is the initial state compares with goals state to chose operator to reduce differences between two.

2.7.2 Skill Acquisition

Skill training	Skill rehearsal consolidation
– Find out client's selected mode of coping.	– Use coping models (either live or video clips)
– Explore how these coping efforts can be employed in present situation.	– Engage in collaborative discussion, rehearsal and feeddback of coping skills.
– Examine what inter/intra personal factors are blocking such coping efforts.	– Discuss possible barriers and obstacles to using coping skills and ways to anticipate and address such barriers. (d'nt worry it's a little pain part of treatment)
– Train problem-focused instrumental coping skills that helps to minimize, avoid impact of stress. (anxiety management, cognitive restructuring, problem solving skills, anger control, using social support)	

- Skill acquisition in candidate will be developed with the help of generic and cognitive skills like :
  - Application of subject knowledge and understanding.
  - Research skills in analysis and evaluation.
  - Interpersonal skills like negotiation and collaboration
  - Independent learning
  - Problem solving with critical thinking , logical and creative approaches
  - Presentation skills
  - Self evaluation with own skill development and future areas for development

- A very famous example is playing a game of chess. It ensembles from it is lends itself smoothly to demonstration in terms of problem space theory.
- An initial state is the opening board place and the goal state is to checkmate the King of opponent team i.e. single layer checkmating the other.
- Here, operatives need to move states to the base of legal moves of chess game instruction.
- Henceforth, it is possible to examine skillful deeds in the framework of the problem space theory of problem solving.

Syllabus Topic : Human Emotions

2.8 Human Emotions

- According to James-Lange theory, emotions are the interpretation of the human psychological response. Psychologically we try to respond to a stimulus and try to interpret the same in emotion.
- Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike.
- The hypothesis here is that we feel sorry because we cry, angry because we strike, afraid because we tremble.
- Emotion is generated with the help of cognitive and physical events.
- Donald Norman says : Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks.

2.8.1 Emotion Influences Human Capabilities

- Emotion has a powerful impact on our daily decision making, reasoning and thinking ability. Human capabilities are influenced by emotions.

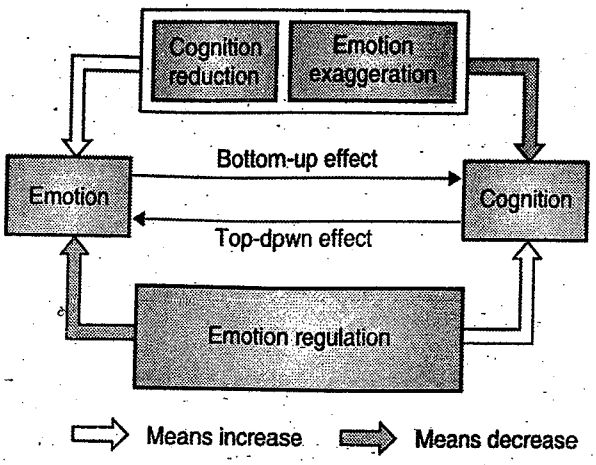


Fig. 2.8.1 : The Interactive Influence Model of Emotion and Cognition

- Our environment is full of our past experiences like achievements, failures, relationship, etc. and current scenarios like education, career, friends, family, job, business, culture and so on
- Environment can be distributed in cognitive, behavioral, emotional, physiological aspects.
- Where cognitive is thoughts, belief, self talk; behavioral is behaviors, actions; emotion is feeling, mood; physiological is genetic, physical, biology, etc.

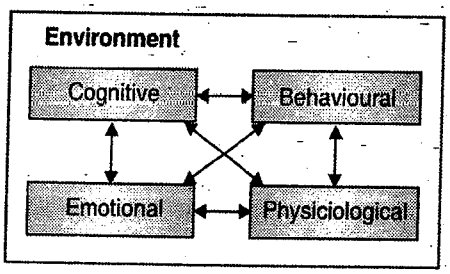


Fig. 2.8.2 : Human Emotion- Cognitive- Behavior-Physiology Elements Interaction

- Human thoughts were affect with his emotions, physiological state and behavior.
- Human behaviors affect with his thoughts, physiological state and emotions.
- Human emotions affect due to thoughts, behaviors and physiological state.
- Human physiological state affects on his thoughts, behaviors and feeling.

Syllabus Topic : Individual Differences

2.8.2 Individual Differences

- Individual differences can be made on basis of several factors mentioned below :

(I) Age

a) Older people

b) Children

(II) Physical Disabilities

a) Visual impairment

b) Hearing impairment

c) Physical impairment

d) Speech impairment

e) Dyslexia

f) Autism

(III) Cultural Differences

(IV) Sex

Syllabus Topic : Psychology and Design

2.8.3 Psychology and Design

- Psychology and design of system is one of the popular domain from Human-computer interaction (HCI). It works as a bridge between user thinking and reasoning capability with the technology, which is used to solve a problem.
- Users are observed on system. Psychological design aims to make an explicit consequences of design for its users.
- Psychological designers identify task which will be supported by the system. Few scenario are suggested to took test of task.
- Psychology help to identify target to design and provide few concerned perspective guidance. It is helpful for concluding design as succeeded or failure.

Mainly three goals are in consideration at the time of interaction design:

- **Interaction Design:** For young age group users like students and learners who want to design highly interactive applications, social networking web sites, interfaces, and digital products.
- **Strategic Design Planning:** Its like beginner stage of learners and experts of human computer interaction, such users needs own design consultancies, digital technologies
- **Creative Activity:** For researcher and developers who deeply interested in every user with their own psychology or distinct and different thinking ability to create a new interface or object. Accordingly they try to communicate with those object. As each user has its own set of requirement in a system, they try to each user a more accurate interaction.

□□□

UNIT III

CHAPTER 3

Understanding the Interaction

Syllabus Topics

- Models of interaction
- Ergonomics
- Interaction styles
- WIMP Interface
- Interactivity, Context of interaction,
- User experience, Paradigms of Interactions.

Syllabus Topic : Models of Interaction

3.1 Models of Interaction

– The better interaction happens with the help of well task, goal and intention are useful in task analysis; it helps to rectify the problem. It is helpful in designing an interactive system.

3.1.1 Donald Norman's Seven Stages of Action → (SPPU - Aug. 2017)

Q. Explain Donald Norman's stages of Interaction.
SPPU -Aug. 2017 (In Sem.) 5 Marks

It constitutes four stages of execution, three stages of evaluation.

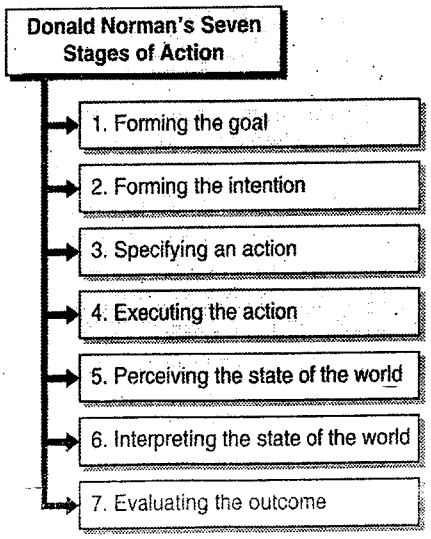


Fig. 3.1.1 : Donald Norman's Seven Stages of Action

Chris Heatwole described Donald Norman's stages of interaction along with a few scenarios mentioned below :

→ **Stage 1 : Forming a Goal**

This is what you want. As an example, I might want a place that I can relax outside that won't get muddy and that I don't have to move my outdoor furniture around to mow.

→ **Stage 2 : Forming the Intention**

This is what would satisfy the goal. A deck would satisfy my goal of a place to relax outdoors that won't get muddy or be in the way of mowing.

→ **Stage 3 : Specifying an Action**

What do I have to do to achieve the intention? I would need to build a deck to meet the requirement set in my goal.

→ **Stage 4 : Executing the Action**

Here I would do the steps of the action. I would build the deck.

→ **Stage 5 : Perceiving the State of the World**

Using the senses to gather information. My finished deck would be off the ground and have my outdoor furniture on it.

➜ Stage 6 : Interpreting the State of the World

What has changed? My furniture is off the ground away from the mud and no longer has to be moved to mow the lawn.

➜ Stage 7: Evaluating the Outcome

Did I achieve my goal? I can relax outdoors now without worrying about mud or moving furniture. I achieved my goal.

Q. Using Norman's terms describe and provide specific examples of how current user interfaces on these mobile devices succeed or fail in applying effective design. Refer specifically to AT LEAST FOUR of Norman's following terms, describe how the preferred computer interface capitalizes on :

Scenario: Today's portable computers and mobile devices include use several features to enhance us ability including a pointing device such as a mouse, overlapping windows and icons that represent different types of functions, audio cues and touch screens.

- The iPhone has several successful designs. Physical constraints constrain the possible operation.
- The touch screen of the iPhone changes to what the user needs, and limits the options available.
- When the phone rings, a button appears to answer the call, and another appears to decline.
- Those are the only two options available, so those are the only two buttons that appear on the screen. There is no confusion on what to do, or how. You simply select one or the other.
- A similar scenario appears if a call comes in while the user is on the phone. Options are limited on how to handle the situation, but the user doesn't need to have memorized a routine.
- The screen clearly lists the options and the only buttons to select are for those options. There are no extra buttons to distract or confuse. Semantic constraints deal with meaning in the situation.
- Norman uses the example of a LEGO motorcycle. The driver must sit facing forward and the windshield must be in front of the driver. On an iPhone the screen is one side.
- The user interacts with this side and the camera is the only thing on the back because the user does not interact with the camera, but it points away from him/her to take a picture.
- The speaker for listening is on the top of the screen and the microphone is on the bottom because a person's ear is on top and their mouth is on the bottom. These things need to go where they are.
- Visibility is making relevant parts visible. The iPhone has very few interfaces besides the screen.
- The Home button has important functions and is clearly located on the front of the phone beneath the screen. It also has a square printed on it, and it is depressed so it is easily seen and felt.
- The switch on the side of the phone that can be used to turn the ringer off has a red strip printed on it that is visible only when the phone has been silenced.
- Buttons that appear on the screen, such as the open button or the answer button, are create large, placed centrally and are often a color to make them noticeable.
- The unlock button has lettering that scrolls to draw attention to it. Feedback occurs when the silence switch has been moved to the silence position.
- The phone vibrates when this occurs to signal that the phone has been placed in silent mode.
- Changing the volume on the phone gives a visible cue on the screen abuts also an auditory cue that lets the user know how loud the volume has been set to. And logical constraints happen when options are not available.
- The user knows that information needs to be input using gestures on the screen when the keyboard is not available. This happens when setting the time on a calendar event.
- These are no instructions on how to use the image on the screen, but since the keyboard have not appear the user knows that touching the screen will be necessary to input information. Here the iPhone falls a little short.
- The graphical interface for inputting information on the calendar is something that needs to be learned. It relies on the

fact that it resembles a real-life object, but not everyone may be familiar with those objects. Cultural constraints are not satisfied with this feature.

Q. Norman uses doors as frequent design examples. Do you agree that one design is clearly better than the other? At what point do you think designers should settle on a learning curve as opposed to being able to use the item the first time? Or should they never settle?

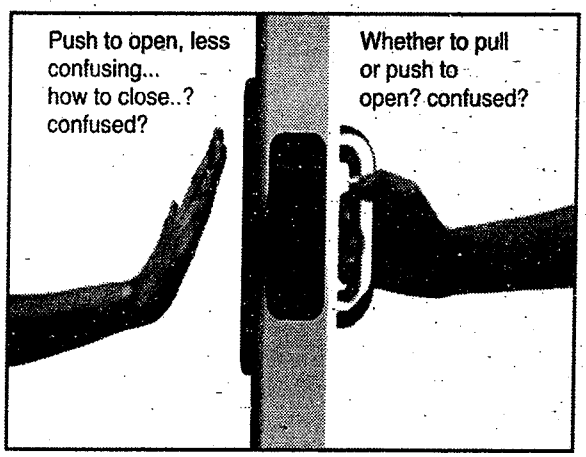


Fig. 3.1.2 : An Example of a door design for better illustration of a problem statement

- One problem with the design is that the bar to open the door does not indicate which side of the door needs to be pushed to open the door. The bar can be pushed from anywhere. The appearance of the handle is uniform and balanced, so it looks aesthetically pleasing. The other bar is designed so that the user should push on one side, the side that the door opens.
- While it would be possible to try and push on the other side, logic should tell the user that the handle is on one side and that side should be used. This makes it less likely that the user will attempt to open the door from the wrong side. It is a better design.
- Designing something so that users get it correct the first time should be the goal of the designer. To say that most will get it correct isn't enough?
- As Norman points out, just one percent of the population is still millions of people. It may not be possible to get it so that no one opens the door incorrectly, but that number should be extremely small, certainly not millions of people.
- However, there are times when a learning curve is going to have to happen. But this should only occur when a device is completely new.
- The introduction of the mouse to control a GUI operating system was not like anything before it and was going to have to be learned. But in these cases the learning curve should not be extreme.
- It should not take long to learn the new skill. The device should also be limited in its abilities to minimize the learning curve. Unnecessary features should not be added. The features that later showed up the mouse, like multiple buttons, wheels, and track balls would have been too much of a learning curve on the first mouse models.

3.2 The Interaction Framework

- The interaction framework is an approach to provide more descriptive interaction with the help of four components such as : the system, the user, the input and the output.
- The system language is preferably known with its core language, i.e. relevant computational attributes of domain of system state. A user's language is referred as task language, i.e. psychological attributes with user task relevance.
- An interface is formed by the combination of Input and Output components.

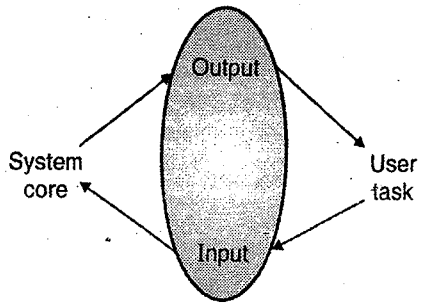


Fig. 3.2.1 : A Generalized Framework of Interaction

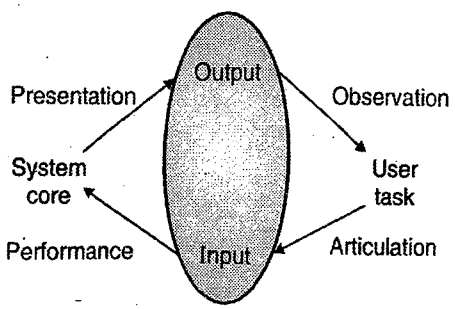


Fig. 3.2.2 : Translation between Components

- With the help of addressing both performance and articulation a dialog design and interface design can be accomplished at the input. Similarly, presentation and observation of the output.
- Interaction frameworks help to judge an overall usability of a framework. An analysis made for any framework is mostly with the help of frequently used functionality.
- vFor an example a text editor analysis task will suggest a few text editor with good reviews, but some user may agree and some may not. As each text editor has its some own specialty and as per users' requirement varies a set of users found it more useful than other and users view will be changing as per change in requirements.
- A social and organizational context has its own effect on interaction. Presentation and Screen design represent Output. The ACM SIGCHI Curriculum Development Group presents a framework for HCI as mentioned below:

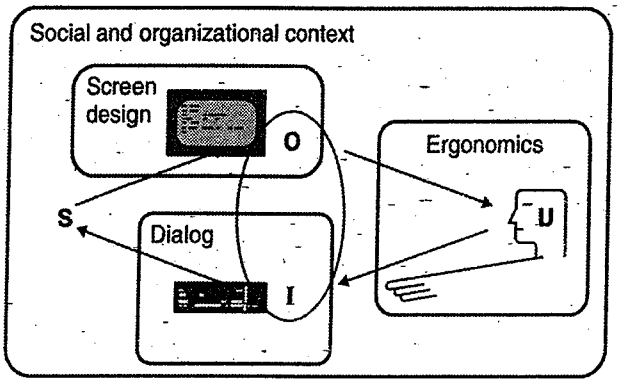


Fig. 3.2.3 : ACM SIGCHI Curriculum Development Group presents a framework

Syllabus Topic : Ergonomics

3.2.1 Ergonomics

- If ergonomics is studied at the special level than concerned with HCI only then it is more about human psychology and system constraints.
- It is more in details with arrangements of controls, displays, health issues, use of color, physical environment etc.
- In case of arrangements of controls and displays:
  - A set of frequently used controls and some part of displays should be arranged logically so user can get easily rid of it.
  - Controls and displays should be grouped with the help of functional control, sequential control and frequency control.
  - Inappropriate arrangements and sequence of controls in a tool, display of icons leads to inefficiency and frustration both in daily practices.
  - **For example:** if a tool allows Esc key to back from any pop up notification on a screen, it should be uniformly work within all modules, it should not happen user needs to use click event of a mouse or enter key at sometimes.
  - Critical display should be placed at eye level, while a use of proper light to avoid reflection and glare.
- In case of physical environment of interaction
  - Who will be the user? Where it is going to be in use? Whether users interacting by sitting, moving or standing position with the device? Likewise, more question arise will come into picture as per discussion within a specific domain.
  - Ergonomics focuses on the physical environment along with the layout and arrangements.
  - For a long period of works user should sit comfortably, it has a proper space to move around all the controls easily. Improves efficiency of the user.
- **In the case of Health issues**: It arises due to poor design, layout and arrangements of devices. The improper quality of physical interaction leads to health issues:
  - **Physical Posture:** It is needed in a way to get a proper display without any efforts as well as to reach all controls easily.
  - Some support should be allowed to rest the part of the body for a long time activity like mouse pad with wrist support for animation or design task where use of mouse is more, wrist support to keyboard tray. A

proper chair to rest back comfortably with the good hand rest with adjustable provisions.

- **Temperature :** A extreme hot or cold will affect a performance. Let say some network efficiency tests are held in a shielded room, in such environment a normal human cannot work efficiently with a good concentration for a long time as its coldest. Similarly, in case of server room too.
- Lighting should be in adequate form so a user can observe a monitor screen easily without any eye strain. It should be maintained to avoid glare and reflection.
- The noise level should be maintained at a comfortable level.
- Time spend on the system should be in a controlled manner. Excessive interaction with long time may affect issues with back pain, eye strain, care should be taken for in case of pregnant women for eyestrain and accessing controls etc.

– **In the case of colors :** Generally red, green and yellow color we follow in a daily practice for red to stop, green to go and yellow to standby or wait and watch, similarly red should be used to inform about emergency and alarms, yellow in standby or an auxiliary action, green to routine and normal activity.

– Use of blue color should be avoided to display critical information.

– Color has its own culture everywhere, it is not uniform like red is happiness and good fortune in China while rest of others think it as dangerous.

Syllabus Topic : Interaction Style

3.2.2 Interaction Style

– A dialog or a communication takes place between a computer (system) and a user is known as interaction.

– Each communication or dialog has its own effects in the interaction.

– There are several styles of interface are as follows:

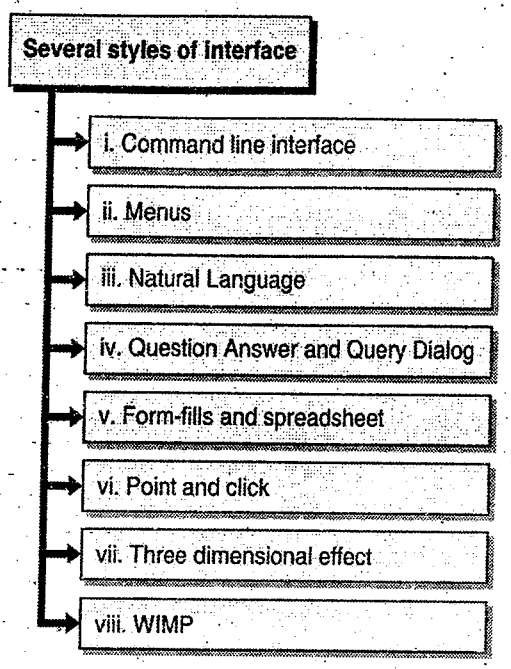


Fig. 3.2.4 : Several styles of interface

➜ (i) Command Line Interface

– It is preferred less in recent days as icon selection and touch and voice based interaction were in a use with plenty of options.

```
C:\>date
The current date is : 23/05/2018
Enter the new date : <dd-mm-yy>
C:\>time
The current time is : 16:30:45.69
Enter the new time : _
```

– Still command line interface is a one of the powerful mechanism of interaction as it gives an access to the entire environment in straightway approach.

– You need to be very hands on with abbreviation, function key, special characters to get an efficient interaction with the help of command line interface.

– At present, Telnet uses command line interface while access is via remote desktop.

➜ (ii) Menus

– The Menu can be displayed in various ways in more user friendly approach.

- Menu driven program or applications can be operated with the help of mouse, alphabetic keys, numeric keys, function keys and special keys.
- Menu options needed to be grouped logically and on the basis of functionality.
- For example, as shown in fig. 3.2.5 (a) below, menu of text editor has 'Save As' option, followed by 'Save', is a good practice.
- As shown in Fig. 3.2.5(b) below, Google drive for any file menu you will find 'Remove' options, immediate after 'Download' which is separated by a thin line still sometimes user by mistake, click on or more chances to select remove rather than download as a bad practice may happen.

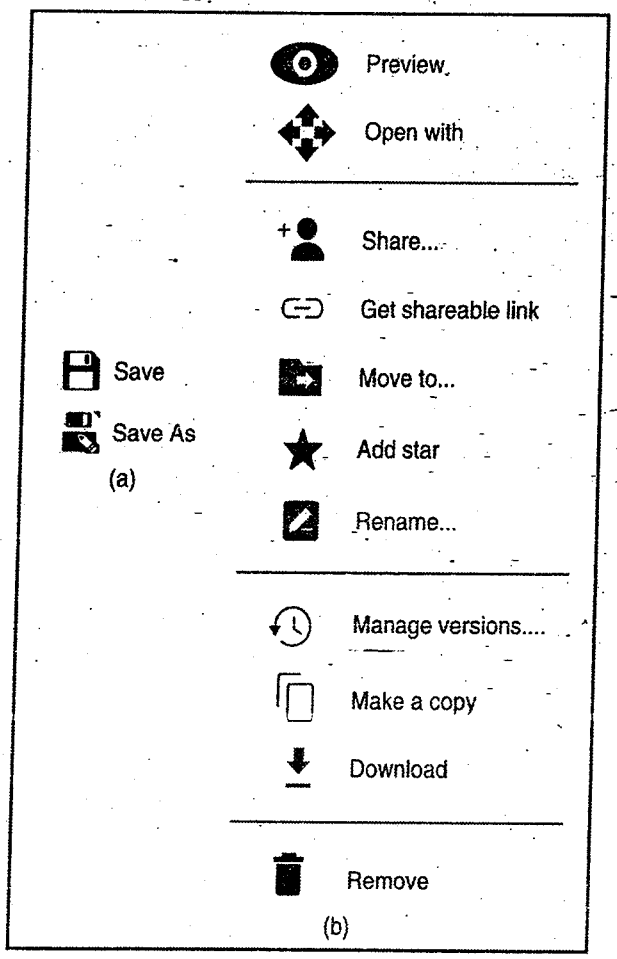


Fig. 3.2.5: Example of Menu

(iii) Natural Language

- It is relatively not much succeeded interaction, but it is more curiously studied and researched. Natural language input is now interpreted as per expectation to machine to understand. Ambiguity in the meaning of words processed sometimes makes it less efficient.

For example

- "The girl hit the cat with the stick"
- Here, confusion is whether the cat is holding the stick when it is hit or whether the girl is using the stick to hit.
- With the help of text to voice and voice to text conversion applications input can be provided to a system, which is helpful in some sort to establish a interaction with the help of natural language. But, again natural language has its set of issues of parsing, tokenization etc.

(iv) Question Answer and Query Dialog

- Yes/ No based a series of questions are asked to user and answer provided to a system which help to establish interaction. Yes/No/Maybe likewise response provides sufficient information with the help of questionnaires. It is also used to survey with a set of questionnaires and available answers in Yes/No or Multiple choice based questions.
- Another approach is dialog based interaction, where a set of certain questions is being asked to users via systems as per scenario predefined. It is operated with the help of queries and database. A user interaction within the application and hits are observed to know the user's interest and accordingly questions raised to get user review, feedback etc.

(v) Form-Fills and Spreadsheet

- A form fill is an easy and quick approach to fill the information within a form. It helps with buttons and icons for some repeatedly filled information or default values for some options.
- Form filling is an interaction approach of collecting information or database for some specific activity.
- For example : A student enrolment form for training and placement where the student need to fill form with various kind of information like personal details- name,

date of birth, address for communication, email id, academic details- educational qualifications along with marks or grade, passing year, board or university name, professional certifications, extracurricular activities- journals published, prize - participation in events, technical skills etc. Such parameters are involved in a form to fill which collect information from a user related to activity for which a form is designed.

- The spreadsheet has been just another layout of the form, more sophisticated version we can say. Generally, it is with the combination of rows and columns, tabular form helps to fill information more easily.
- It gives an easy layout of information on the more sorted way. Few basic calculation operations can be easily processed in spreadsheet to help of mathematical formulas.

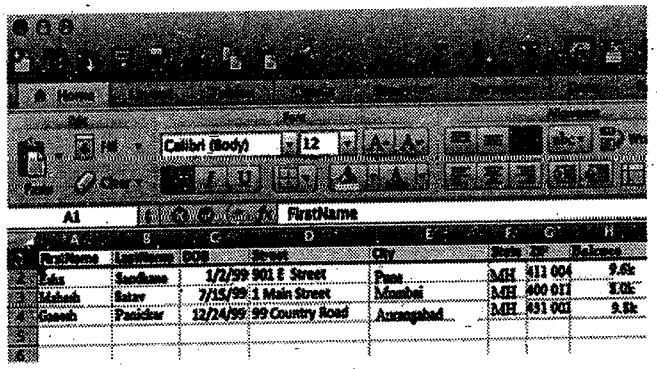


Fig. 3.2.6: A Spreadsheet Example

- Few popular spreadsheets are Microsoft Excel, Google Docs, iWork Numbers, Lotus1-2-3, OpenOffice, Lotus Symphony, VisiCals etc.
- Few popular spreadsheet use domains are finance, forms, research lab, academic and educational institutes, stock management tools etc.

➜ **(vi) Point and click**

- It is mostly used with touch screen based devices for interaction.
- Navigation tool help user to point out a location on the map and click to browse details entitled to the same.
- ATM with touch screen, a user need to point the activity to be performed from a mentioned various activities displayed on screen with iconic buttons and click to select it.

➜ **(vii) Three dimensional effect**

- Virtual reality uses 3D effect based interaction. The 3D effects are given to icons, scroll bars, text area, menu items with the help of shades for a more interactive interface. Sculptured elements are needed to represent in 3D effect for a more accurate representation.

➜ **(viii) WIMP**

- Windows-Icons-Menus-Pointers (WIMP) interface will be discussed in brief later in the same chapter.

Syllabus Topic : WIMP Interface

3.2.3 WIMP Interface

- It is introduced at Xerox PARC and later popularized by Apple Macintosh and nowadays mostly used by Microsoft Windows OS and others.
- WIMP stands for Window, Icon, Menu, Pointer. There are some additional objects used in a WIMP interface like buttons, toolbars, palettes, dialog boxes etc.

(A) Windows

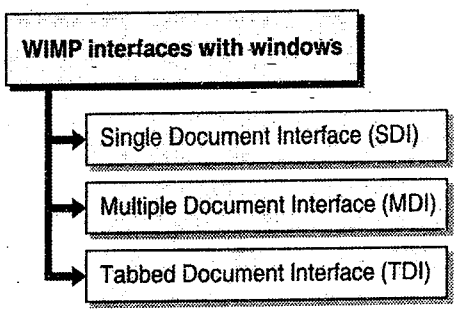


Fig. 3.2.7 : WIMP interfaces with windows

- Windows are designed with text, icons and buttons. A user can view, edit, modify or update content on it.
- It has scroll bars for viewing large scaled documents. Buttons are used to maximize, minimize, close, resize, save, save all, compile, debug, run, stop, redo, undo.

refresh, back, forward, print and so on activities depends on the window belonging to which application.

- Window uses frames to make groups of icons on the basis of operability and functionality.
- WIMP interfaces with windows in tiled or overlapping or cascading approach:

(1) Single Document Interface (SDI)

- Each primary window is assigned to each instance of the application.

Disadvantage

Task bar gets full when many documents are opened. Each primary window consists of program's toolkit and menu, moving from one window to another is difficult.

Advantage

It is less complex in visual point of view as primary window and document window are connected.

E.g. Notepad or text editor.

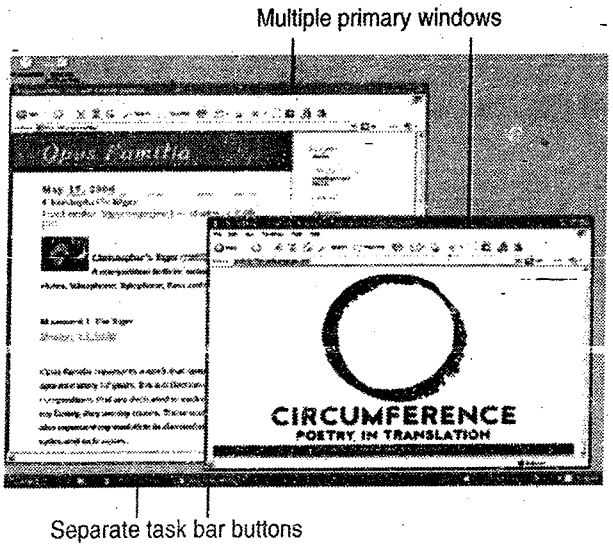


Fig. 3.2.8: An Example of SDI

(2) Multiple Document Interface (MDI)

- Multiple windows are residing under one parent window, multiple documents can viewed at a time. E.g. Adobe Photoshop. A sometimes minimized child window in a parent window makes visual complexity.

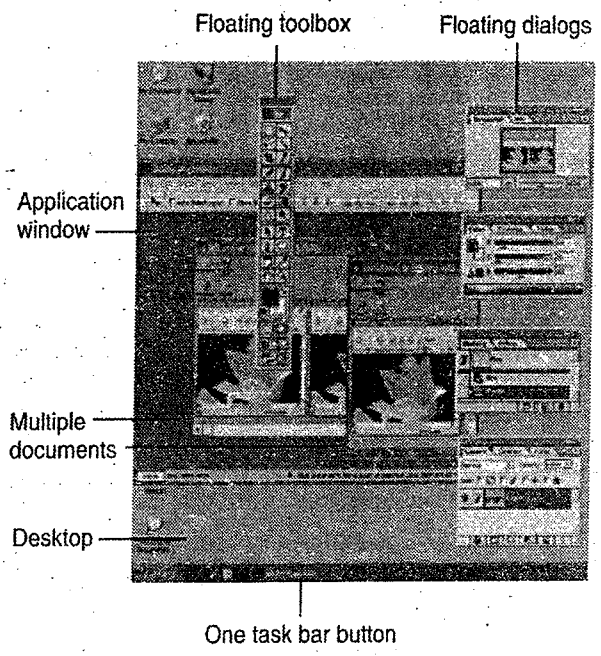


Fig. 3.2.9: An Example of MDI - Adobe Photoshop

(3) Tabbed Document Interface (TDI)

- Multiple windows can be accessed with help of arranging them in a tab, one tab can be viewed at a time. Multiple tab can appear in a sequence. E.g. Web Browser Applications.

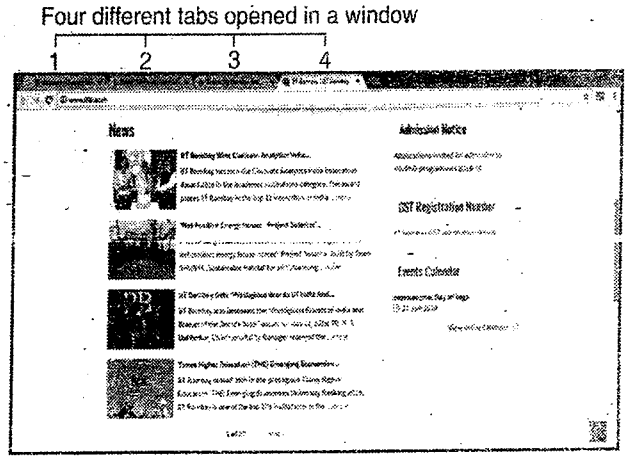


Fig. 3.2.10: An Example of TDI - Google Chrome® Web Browser Application

(B) Icon

- These are graphical representation with or without buttons, describe some actions or event or notify some information like warning, error, close, stop, go etc.

Iconifying is shrinking of window or resizing of window with the help of some icon.

- Icon also used to give a reminder about some periodically activities like updates to install, battery status, LAN or Wi-Fi status, Speaker On or Mute.
- Different icons are used as per the nature of the file. Some set of icon represents a word or test file similarly for image file, application file, system file etc.

(C) Menu

- The Menu can be categorized into Pop up menu and pull down menu. Options in the menu can be arranged as per designer and user point of view. Some menu provides option in a list below to menu item, some menu and options are provided in a circular fashion too, depending on how interactive user interface you required, targeted user group.

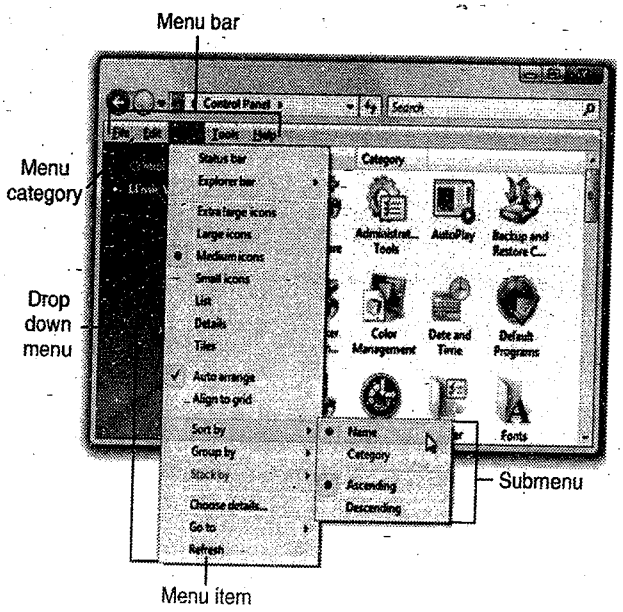


Fig. 3.2.11: An Example Of A Typical Drop Down Menu With Options From Control Panel, Microsoft® Application

- For mobile camera application menu is shown in a circular way and options in a list of few handsets. Some gaming application has menu and option both in a circular fashion.

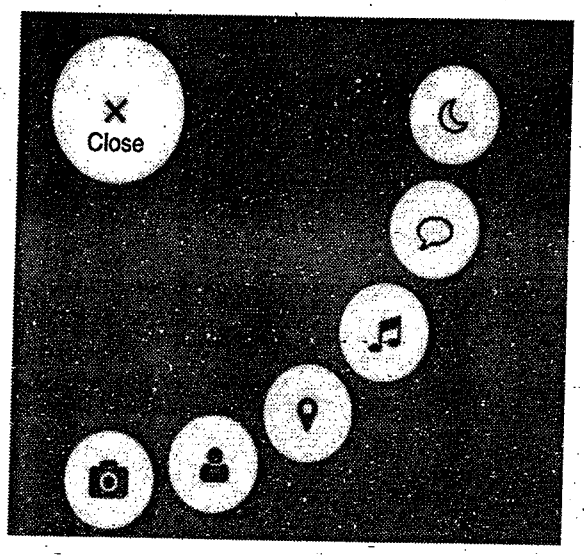


Fig. 3.2.12: A Circular fashion of Menu (close) and Options (camera, music, chat etc.)

(D) Pointers

- The pointer is an essential element drag and drop, selection of menu, options, buttons and icons.
- Various style pointer cursor is in use. Depending on tool set of the cursor is used. Like the Select tool and Hand tool for pdf reader, blinking line pointer in a text editor or command prompt.

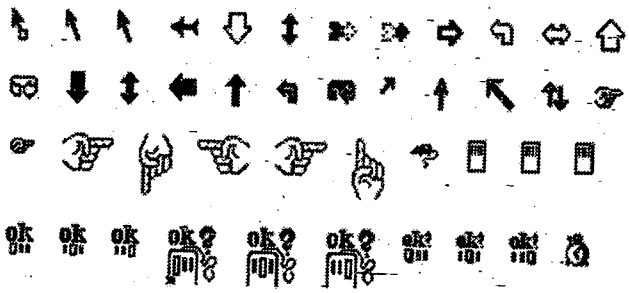


Fig. 3.2.13 : A variety of pointer cursors. Source: Sun Microsystems, Inc.

- Cursor also helps to inform system status like an hour glass indicate the system is busy. Few cursor changes shape and size as per task associated.

(E) Other Interfaces

- Dialog boxes are used to interact with immediate interaction in case of urgent input are required or notifying information to users for a specific task.

- The Palette is a collection of icons made up of reminiscent of the purpose of the different modes. Palette can create with the help of some menu and option in some system.
- Toolbars with full option and icons are available in many tool placed horizontally or vertically on the sideline of the window of the tool.
- Buttons has own identity in the interface. It has effects of highlight on mouse above and mouse over, click etc. Buttons are designed with 2D or 3D effects, icons on it.
- It has a set of functions assigned to it depending on the system which work on a click button event in which push buttons are used. Option button, checkboxes, push buttons, radio buttons (toggle button)such types of buttons was in use.

(F) Develop a System Menu

- Basically, new user and inexperienced user are learners of the system, they keep learning from environment of system with the help of menus.
- The menu should be designed with an approach where a experienced and inexperienced both user should be satisfied.
- In properly designed system menus are most wide and frequently used, it assists users to work in environment. Menus need to be recognized, user cannot recall menus; hence it utilizes users capability.
- While designing a graphical system, it should be kept in mind that system they designate command, properties which are applied on documents, windows and objects.
- A graphical menu may lead to sub menu or a display some data on new window or perform some action within a same window.
- It may require menu like menu bar with push-ups, pull-downs, tear offs, cascaded, iconic menu etc.
- While designing a web system, it should be kept in mind that system they designate web pages are applied as text and multimedia based representation as well as interaction.
- Menu includes hyperlinks in textual or image format, command buttons, textual toolbar, graphical toolbar.

Q. What parameters are considered at the time of developing a system menu at designer side?

- Menus can be studied with several parameters like:

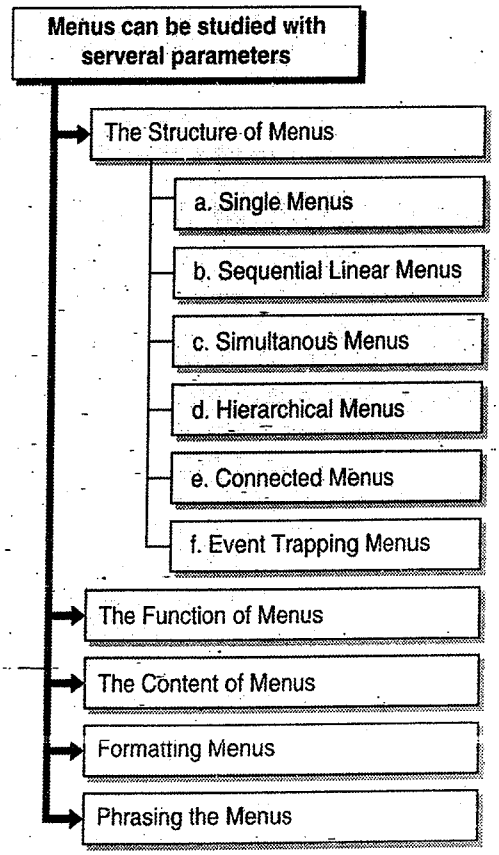


Fig. 3.2.14 : Menus can be studied with several parameters

and few other parameters are Navigation using menus, Web site navigation and links, Types of graphical menus etc.

➜ (1) The Structure of Menus

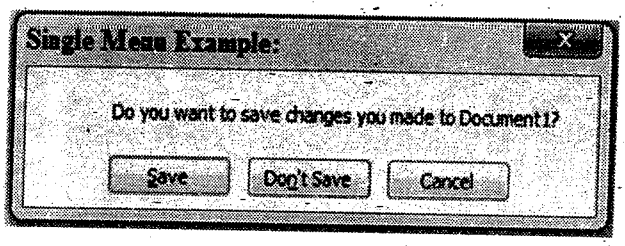
- Structure of menus provides flexibility to the user to access the menus via large or complex menu with the

hierarchical order while a small menu can be organized with the help of dialog box.

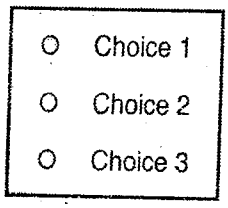
- Here, we will see few structure of menus :
  - (a) Single Menus
  - (b) Sequential Linear Menus
  - (c) Simultaneous Menus
  - (d) Hierarchical Menus
  - (e) Connected Menus
  - (f) Event Trapping Menus

➜ (a) Single Menu

- An immediate consequences of the option being selected should be concentrated.
- Even it has few more options it will be initiated in other menus.
- A single menu is concentrating on users single choice with a simple design. It is as simple as Yes / No questions.



(a)



(b)

Fig. 3.2.15 : Single Menu Example

➜ (b) Sequential Linear Menus

- It is a series of options need to select from a every small question arise or single menus.
- A long series of sequential menus is not good practice as user not remind exactly what answer submitted or chosen in very first menu, if some linked questions are asked in sequential linear menus.
- User found it tedious as menu after menu is presented. If user wants check what answer submitted or options selected in earlier menus then long or complex process needed to be completed.
- As all menus are important user need to attempt all without skipping as they are arranged in a sequence linear approach.

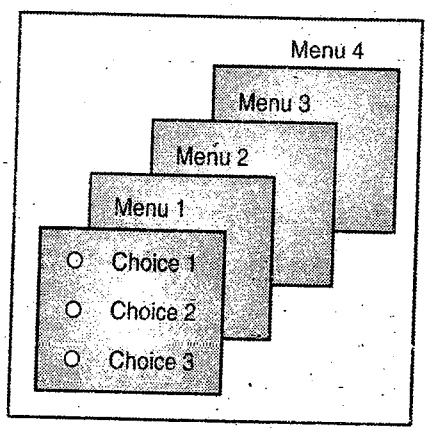


Fig. 3.2.16 : Sequential Linear Menu Example

➜ (c) Simultaneous Menus

- All choices are at once available with different menus help to figure out possibilities and comparison, no need to remind choice or preferences for previously attempted or other menus.

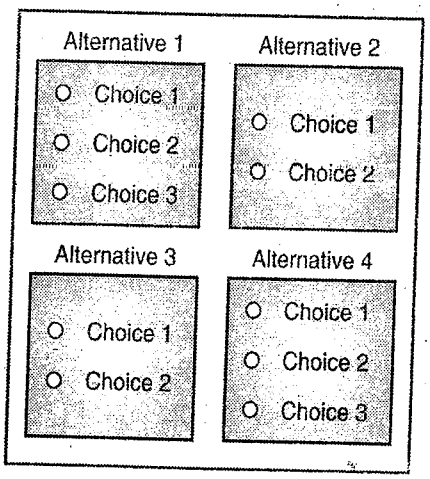


Fig. 3.2.17 : Simultaneous Menu Example

- This kind approach makes easy representation of menu dependencies and relationship.
- Sometimes, it is helpful while improper or poor relationship leads to confusion.

➜ (d) Hierarchical Menus

- Use of the hierarchical structure to represent menus is the best structure to represent menus with possibilities of valid and eligible selection to allow to view sub menus and options.
- Depth and breadth are useful in hierarchical structure.
- Depth represents the level of menu and options while breadth represents the variety of different sub menu and sub option at same level.
- A top-down approach is mostly used where a parent node or root node has child node and sub child node.
- The Parent node or Root node is considered as level 0, at every next depth next level appears.

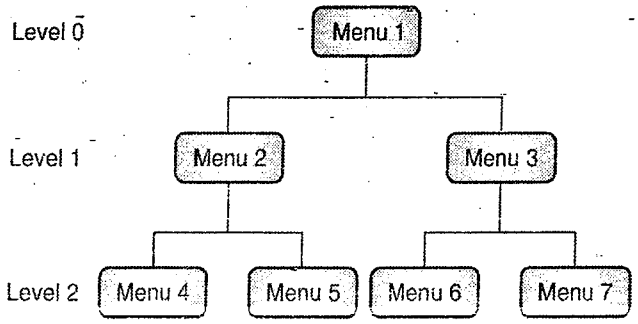


Fig. 3.2.18 : Hierarchical Menus Example

➜ (e) Connected Menus

- It structure where menus are interconnected with each other. It seems like cyclic structure sometimes due to connectivity established among menus.
- It gives full control to user to traverse among menus.

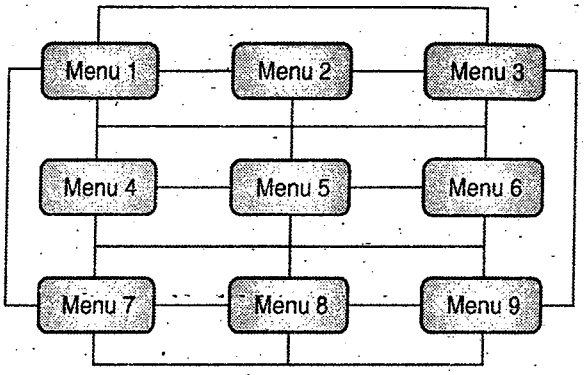


Fig. 3.2.19 : Connected Menus Example

➜ (f) Event Trapping Menus

- It allows users to switch among foreground task to background task. It helps user to quick response to menus appeared from background task and rejoin earlier task without loosing any data or killing any process.
- For example, user selected some text from editor and applied copy function and switched to spreadsheet window and operated paste function.

➜ (2) The Function of Menus

- Menu functions are navigation to new menu, execute an action or procedure, show cast some information, pass information or data to function.
- **Navigation to a New Menu:** Each user attempts to select some menu provides sub menus and options as per hierarchy made by the system.
- **Execute an Action or Procedure:** On traversing to expected menu, user select an appropriate menu among available options leads to execution of activities associated to the menu.
- **Displaying Information:** User's primary motive is to gain information, many times user need to reverse a long hierarchy of menu then only reach to expected information. Inexperienced user may spend more time but experienced user may retrieve expected information with the help following a proper sequence of menus.

- Data or Parameter Input: Certain sort of information is required from information to produce expected data, it is generally collected by dialog boxes of single menus structure.

(3) The Content of Menus

- It consists of context, title, choice description, completion instructions.
- A feedback from user is important to maintain the context as per user orientation. A verbal linkage or spatial linkage can be used to know the user's feedback. Verbal linkage provide a list of menus on screen which earlier preferred by user and on their selection user reach to recent menu or screen. Spatial linkage helps in graphical manner to express how previous choices made user to reach here in a single screen display.
- Menu title must reflect choice preferred on previously selected menus.
- Completion instructions are useful to inform the users how to indicate choices. Some explicit instruction may be need for inexperienced or new user but for experienced one such screen guidance seems time consuming.

(4) Formatting Menus

- A consistency is important in formatting which includes ordering choices, presentation and organization, navigation schemes choice selection methods.
- Display of menu which are frequently in use on screen for easy access.
- A grouping of menus should be done on logic and functionality basis to display on screen. Occasionally, required menus should pop-up on demand.
- Some common ordering policies should be maintained in formatting menus like :
  - Numeric ordering
  - Alphabetic ordering
  - Natural ordering
  - Small number of options
  - Separate destructive choices
  - Do not reorder menus
  - Consistency between menus.
  - Some common grouping policies should be maintained in formatting menus like :
  - Categorizing
  - Numbering
  - Ordering
  - Separation
  - Critical choices
  - Arbitrary visual grouping
  - Use of line separators in between groups.

(5) Phrasing the Menus

- Some common menu title policies should be maintained in formatting menus like :
  - Main menu
  - Sub menu
  - Keyword first
  - Capitalization
  - Task oriented wording
  - Parallel construction
  - Relationship to title
  - Consistency across menu
  - Numbering

- Command language
- Word as a command to computer.

– Use of keyboard keyboard equivalent (mnemonics, designation, keyboard selection), keyboard accelerators (ctrl + c : copy, ctrl + v : paste, ctrl + p : print, ctrl + n : new, ctrl + s : save, ctrl + x : cut, F1 : help, Esc: cancel, Shift+ F10 : Display pop up menu).

3.2.4 Select the Proper Kind Windows

– A window is a rectangular shaped with border assigned to it. It consists of tool bar, menu bar, A system screen may contain one or many window at a time as it have resize features.

A windows had some characteristics as below

(a) It is identified with a name or title on left top

(b) It can be resize in height and width

(c) At a time only one window remain active, only active window allow to alter contents.

(d) Windows can be arranged in a tiled, cascaded, or overlapping.

(e) Visibility of windows affected by space available for a window on a screen, sometimes window is fully hidden or semi hidden by other window or behind screen.

The attraction of windows

(a) **Access to Different Sources of Information**

A information from distinct sources is collected together in a presentation.

For example : A hotel booking user try to compare information from different sources for a particular value based search.

(b) **Presentation of Multiple Kinds of Information**

Multiple kind of information can be displayed simultaneously with the help of adjacent windows.

(c) **Presentation of Different Levels of Information**

A documents may consists of a table of contents and same time the contents of chapter linked to the chapter will be displayed in an adjoining window.

3.2.5 Components of Windows

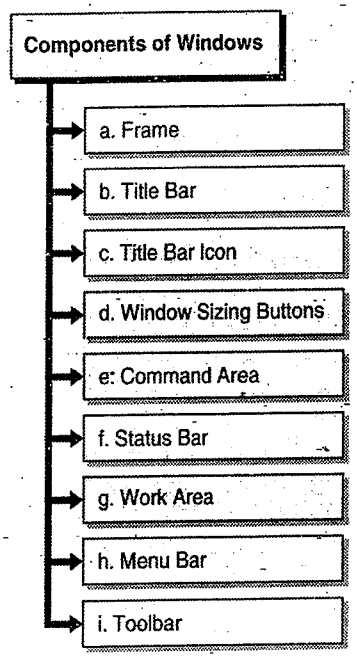


Fig. 3.2.20 : Components of Windows

– Many types of elements are found on windows, for better practice same location should be used for elements which are common in different windows in a design layout.

– Few inconsistencies occur due to location of the element in different system like minimize, maximize and close button are placed at right top of the window in Windows while at left top of the window in Linux.

- A window can be distinguished in a primary window and secondary window or dialog box as a secondary window. An illustration of primary window is as shown below :

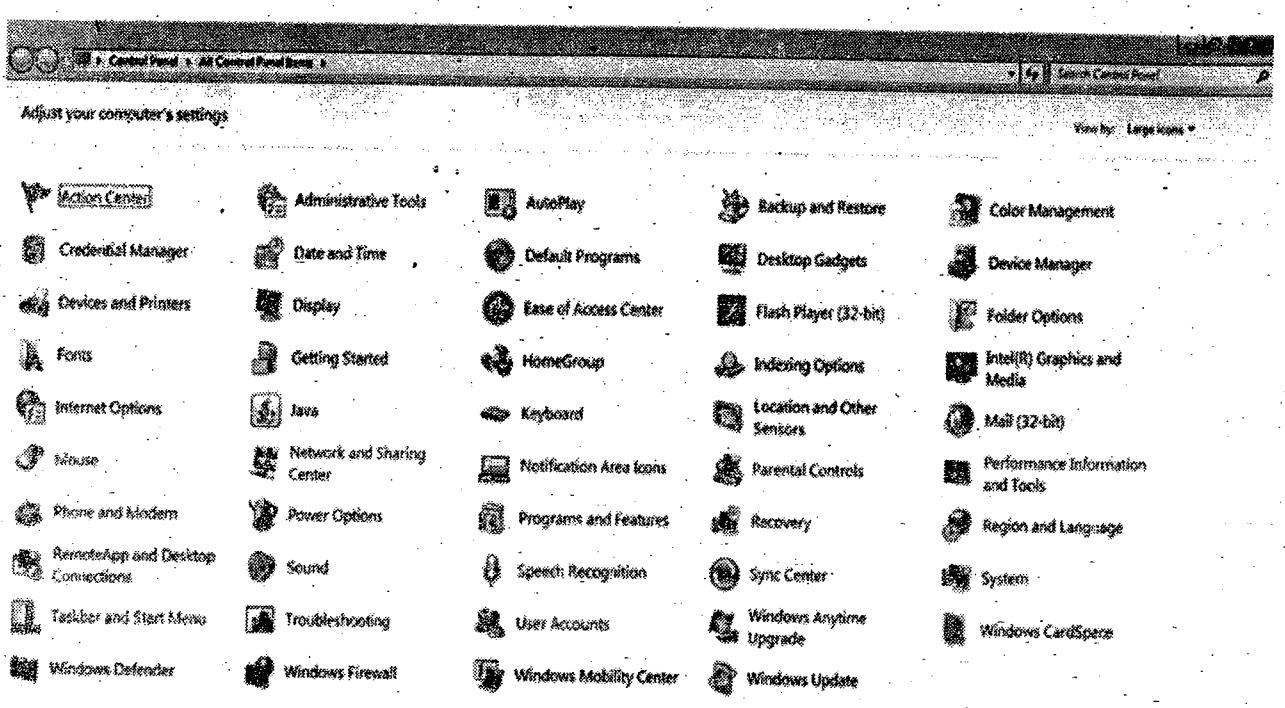


Fig. 3.2.21 : A sample for primary window (Microsoft Windows)

An illustration of secondary window is as shown below :

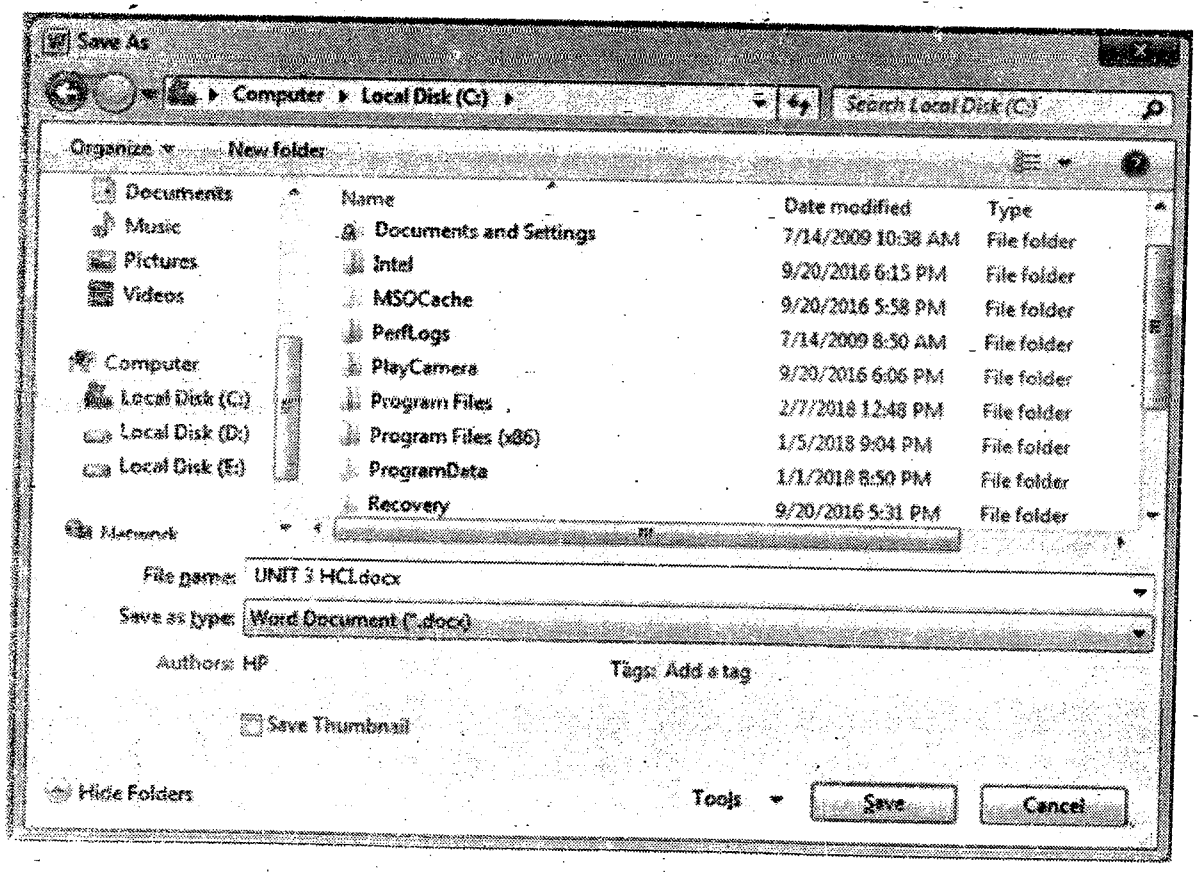


Fig. 3.2.22: Microsoft Windows dialog box (secondary window)

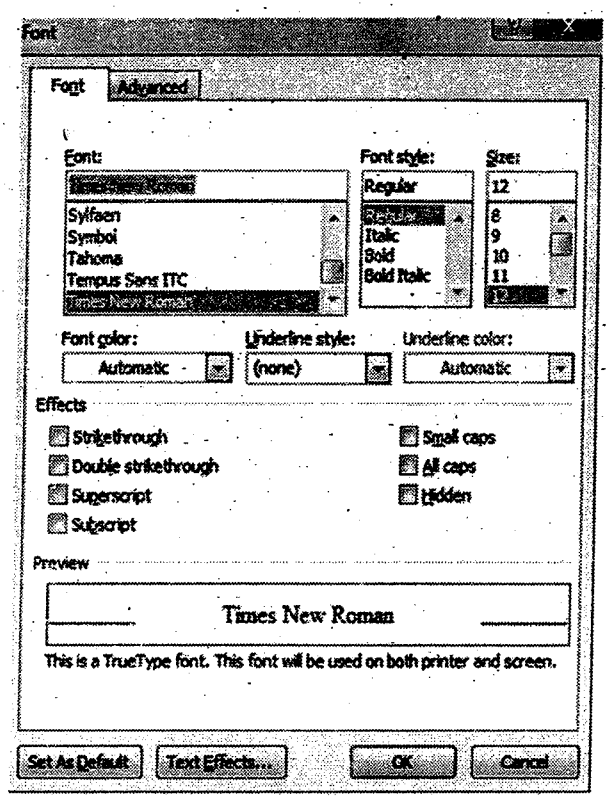


Fig. 3.2.23: Microsoft Windows secondary window

➜ a. Frame

- It is mostly a rectangular shaped structure, it can be easily distinguishable from other similar frame on a window as it has a color and thick border. It can be resized.
- Text generally read from left to right fits in this structure. While a single frame occupies entire window edges of frame helps to know the border of a frame.

➜ b. Title Bar

- The top edge of window is a title bar. It is also known as caption bar or title area. It is used to display descriptive information about of the title.
- Few title bar also consists of extreme left, extreme right, some control buttons (close, maximize, minimize and system retrieving functions). It is also provides a useful control to move windows.

➜ c. Title Bar Icon

- It uses a left top corner of a primary window. It has pull-down menu with list of commands linked with objects applicable to window, appears on right click or second click of mouse.
- As per some standard design guidelines for title bar a small icon based utilities should be availed to user.
- A file icon should represent in either case of data saved and unsaved, a user should come to know easily on the basis of representation of an icon.
- A small icon should represent its distinct identity whether a file is creates, load or saves documents.

➜ d. Window Sizing Buttons

- These are buttons located at the right corner of the title bar of the window.
- Generally, a left most button is Minimize buttons represented with a short a line and it is used to reduce the size of the window to the minimum.
- Middle positioned button is a maximize button shown by two overlapped box representation and used for to enlarge a window to a maximize its size or to restore the window to the previous size.
- The right most button is a close button, it is inscribed by X and used to close he window.
- Few operating system's windows follow exactly reverse arrangements of buttons located at right of the title bar.

➜ e. Command Area

- It is used to provide an input of commands to the system.
- Windows provide a command area at bottom. It found below a horizontal scroll bar if it horizontal bar is used.

➜ f. Status Bar

- It is located at the top of screen also known as status area.
- Microsoft recommends status bar at the bottom of screen used to describe the current activity, the selected menu, toolbar button or user highlighted items etc.

➜ g. Work Area

- It is an actual area of text or command line interpretation to perform a task to user.
- It is also referred as client area.

➜ **(SPPU - May 2018)**

Q. What are differences between menu bar and tool bar ? Many times user face the problems in understanding /learning tool bar icons. How resolve issue?. **SPPU – May 2018, 5 Marks**

➜ h. Menu Bar

- It is the horizontal representation of the menus a the top of window followed by a title bar.
- It is used to represent a various menu available to the user. Mostly, a pull down menu is preferred at menu bar.

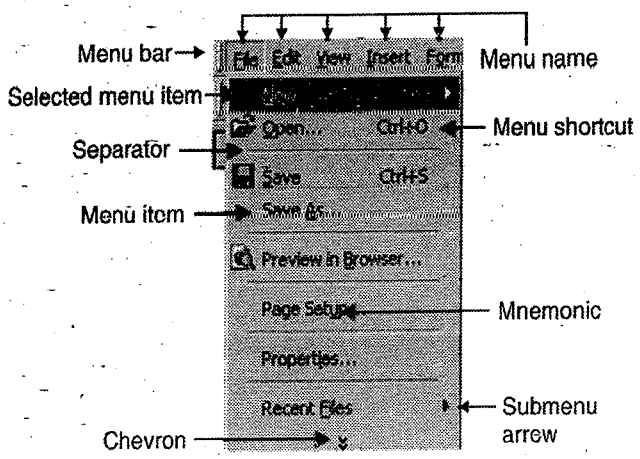


Fig. 3.2.24: A Structure of a Menu (Microsoft ®)

➜ i. Toolbar

- It is permanently displayed panel consists of tools provided by that application.
- Tools icon are placed on toolbar having a link associated with the respective set of functions.
- Tools are grouped on logical basis on toolbar. Ribbons, rulers or palettes, toolboxes etc. are few specialized toolbar.

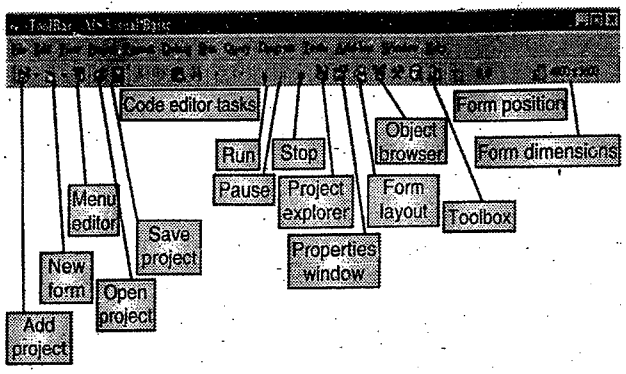


Fig. 3.2.25: Toolbar (Microsoft Visual Basics ®)

☞ Differences between menu bar and tool bar

(i) **Frequency:** Toolbars present only the most frequently used commands, whereas menu bars catalog all the available top-level commands within a program.

(ii) **Immediacy:** Clicking a toolbar command takes effect immediately, whereas a menu command might require additional input. For example, a Print command in a menu bar first displays the Print dialog, whereas a Print toolbar button immediately prints a single copy of a document to the default printer. Clicking the Print toolbar button immediately prints a single copy of a document to the default printer.

(iii) **Directness :** Toolbar commands are invoked with a single click, whereas menu bar commands require navigating through the menu.

(iv) **Number and density:** The screen space required by a toolbar is proportional to the number of its commands and that space is always used, even if the commands are not. Consequently, toolbars must use their space efficiently. By contrast, menu bar commands are normally hidden from view and their hierarchical structure allows for any number of commands.

(v) **Size and presentation:** To pack many commands in a small space, toolbars usually use icon-based commands (with tooltip-based labels), whereas menu bars use text-based commands (with optional icons). While toolbar buttons can have standard text labels, these do use significantly more space. Labelled toolbar buttons take at least three times as much space as unlabeled ones.

(vi) **Self-explanatory:** Well-designed toolbars need icons that are mostly self-explanatory because users can't find commands efficiently just using tooltips. However, toolbars still work well if a few less frequently used commands aren't self-explanatory.

Table 3.2.1: Microsoft® : MS Windows Components

List of components	Window containing components		
	Primary	Secondary	Dialog box
Frame of border – Boundary to define shape. – If sizable, contains control points for resizing	X	X	X
Title bar text – Name of object being viewed in window. – Control point for moving window	X	X	X
Title bar icon – Small version of icon for object being viewed. – Access point for commands that apply to the object.	X		
Title bar buttons – Shortcuts to specific commands	X	X	X
Close	X	X	X
Minimize/Maximize/Restore	X		
What's This? – Displays context-sensitive Help about any object displayed on window.		X	X
Menu bar – Provides basic and common application commands	X		
Status Bar – An area used to display status information about what is displayed in window	X		
Scroll Bar – Standard control to support scrolling.	X		
Size Grip – Control to resize window, located at right side of status bar.	X		

3.2.6 Select a Proper Device Based Controls

- Device based controls are used to pass an input to the system, it has a vital role in the interaction; such devices also known as pointing devices.
- A proper device should be chosen as per task from the user to perform proper control based action. Few device based controls are listed below :
  - o Trackball
  - o Joystick
  - o Graphic Tablet
  - o Light Pen
  - o Touch Screen
  - o Voice
  - o Mouse
  - o Keyboard

- A socio model describes the effect of formal and informal workgroups, supports transformation, upcoming trends of technologies and extended support mechanism for the same.
- A socio-technical model is focused on human and technical approaches within a system i.e. user and environment of interaction.
- Custom Analysis and Open System Task Analysis (OSTA) approaches used to check the impact socio-technical model.
- A Soft System Methodology (SSM) comes with the approach of organization as a system where people and technology are the components, developed by Checkland.

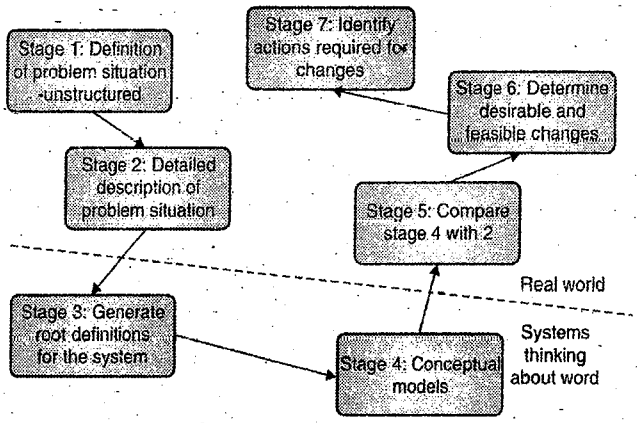


Fig. 3.4.2 : The Seven Stages of System Technology (Checkland)

Syllabus Topic : User Experience

3.5 User Experience

- User experience varies on every attempt of interaction with the system. User and system interaction activity gives a real time experience to user.
- User experience varies as per the scenario of ergonomic, physical, legal and safety, context and environment, aesthetic, economic constraints within the system.
- Guidelines from psychologist and philosopher of Human Computer Interaction helps to improve user experience.
- Phone usage pattern among users are estimated and shared with the help of table from RTI International, Survey Science Group, LLC and team of Douglas Currivan,
- David Roe, Jason Stockdale in journal: the impact of landline and cell phone usage patterns among young adults on RDD survey outcomes. Few tables of analysis are mentioned below :

Table 3.5.1 : Likelihood of Answering Landline Phone by Sharing of Cell Phone(s) in Household

How many calls to your regular home phone do you answer when you don't recognize the caller's phone number ?	No Shared Cells Phones (n = 1,346)	At Least One Shared Cell Phone (n = 784)
All or almost all	41.0% (552)	39.4% (309)
More than half	9.5% (128)	10.7% (84)
Less than half	9.1% (123)	11.2% (88)
Very few or none	40.3% (543)	38.7% (303)

Table 3.5.2 : Domestic Characteristics by Phone Usage Type

Survey measure	Primarily Cell Phone User (n = 863)	Mixed Phone User (n = 563)	Primarily Landline User (n = 570)
Age			
18 to 20	51.3%	46.9%	47.7%
21 to 24	48.7%	53.1%	52.3%
Gender			
Male	41.8%	40.7%	45.8%
Female	58.2%	59.3%	54.2%
Race / ethnicity			
Hispanic, any race	7.4%	7.3%	6.2%
Non-hispanic black	8.5%	7.1%	11.4%
Non-hispanic white	79.2%	80.1%	76.1%
Other race/ethnicity	4.9%	5.5%	6.3%
Marital status			
Married/engaged/relationship	32.5%	35.9%	30.6%
No significant other	67.5%	64.1%	69.4%

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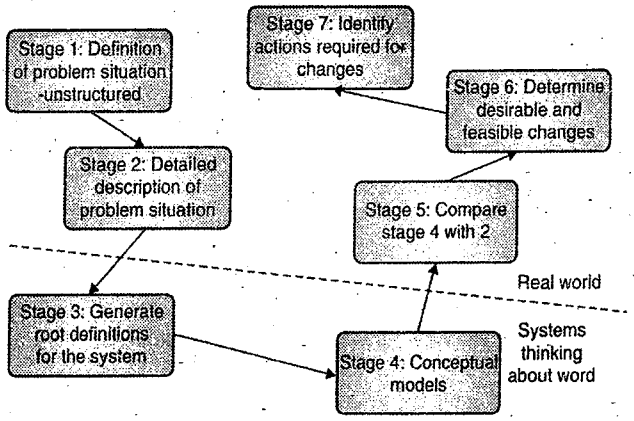

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Non-hispanic white	79.2%	80.1%	76.1%
Other race/ethnicity	4.9%	5.5%	6.3%
Marital status			
Married/engaged/relationship	32.5%	35.9%	30.6%
No significant other	67.5%	64.1%	69.4%

Survey measure	Primarily Cell Phone User (n = 863)	Mixed Phone User (n = 563)	Primarily Landline User (n = 570)
Employment Status *			
Employed, non-student	46.9%	42.3%	43.3%
Primarily student	45.4%	46.5%	41.6%
Other	7.7%	11.2	15.1%
Weekly income			
Less than $200	47.4%	51.1%	51.3%
$200 or more	52.6%	48.9%	48.7%
Housing type			
Own apartment or house	5.8%	9.6%	11.1%
Parent's apt. or house	87.9%	83.8%	83.8%
College dormitory	6.3%	6.6%	5.1%

Table 3.5.3 : Health Indicators by Phone Usage Type

Survey measure	Primarily Cell Phone User (n = 863)	Mixed Phone User (n = 563)	Primarily Landline User (n = 570)
Health Insurance Coverage *			
Yes	86.9%	85.4%	80.5%
No	13.1%	14.6	19.5%
General health Status			
Poor/Fair/Good	24.5%	25.4%	27.4%
Very Good/ Excellent	75.5%	74.6%	72.6%
Physical Health Not Good in Past Month			
Less than 3 days	76.9%	77.5%	77.8%
3 days or more	23.1%	22.5%	22.2%
Mental Health Not Good in Past Month *			
Less than 3 days	61.0%	67.4%	68.8%
3 days or more	39.0%	32.6%	31.3%
Moderate Physical Activities			
Less than 3 days	15.4%	14.8%	12.5%
3 days or more	84.6%	85.2%	87.5%
Vigorous physical activities			
Less than 3 days	43.0%	43.1%	42.9%
3 days or more	57.0%	56.9%	57.1%
Seen Health Professional in Past Year			
Yes	84.2%	83.7%	83.5%
No	15.8%	16.3%	16.5%
Current smoking status			
Non-smoker	79.8%	84.6%	80.7%
Smoker	20.2%	15.4%	19.3%
Binge drinking in Past Month *			
0 times	41.5%	52.1%	19.3%
1 or more times	58.5%	47.9%	52.1%

Syllabus Topic : Paradigms of Interactions

3.6 Paradigms of Interactions

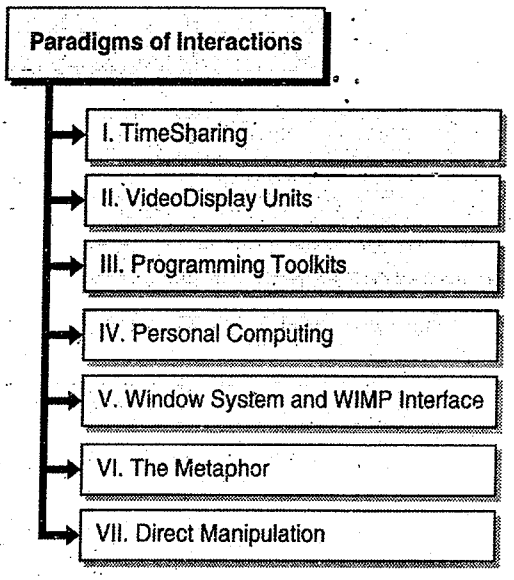


Fig. 3.6.1 : Paradigms of Interactions

- Successful systems are marked as systems with more usability, such systems are considered as a paradigms for the upcoming development in the field of interaction.
- Paradigms are in direct proportional relation with technological advances and application along with creativity to enhance the interaction.
- Techniques and design are the major area of improvement in the design. Few of paradigms of interaction are mentioned below:

➜ I. Time Sharing

- It is multiprogramming and multi tasking with the help of a user or group of users. A table with the records of IBM, Apple, Microsoft, Amiga etc. on year wise and technology basis are mentioned below :

Timeline (Year)	Technology Trends
1975	IBM 5100 OS APL/BASIC
1977	Apple II OS Woz integer basic in ROM
1980	IBM 5120 OS APL/BASIC
1981	Apple III OS SOS
1983	Apple Lisa OS Apple GUI First time using GUI
1985	Atari Amiga 1000 OS Amiga DOS 1.0.1.34 'Workbench' GUI
1986	IBM PC XT 286 OS PC-DOS v4
1989	Apple Macintosh Portable
1991	Apple Macintosh PowerBook OS Mac OS 7.01 – 7.6.1
1992	Amiga 4000 OS Amiga DOS 3.1
	Microsoft Release Windows 3.1
1993/2009	Microsoft release Windows NT
1995	Microsoft release Windows 95 (introduce internet explorer)
1997	Apple release Power Mac OS 8
1999-2004	Apple release Power Mac G4
2000	Microsoft release Windows 2000
2001/present	Apple release Mac OS X
2006/present	Apple release MacBook, MacBook Pro
2008	Apple release MacBook Air
2009/present	Windows release Windows 7
2012	Windows release Windows 8
2015	Windows release Windows 10
2018 (tentatively planned)	Windows release Windows 11

➜ II. Video Display Units

- Display screen shows a series of pictures to make an movie likewise effect in the past (specially for cartoon entertainment shows) and journey now goes beyond 3D image and movie screening, even some small screen sharing 4D and likewise.

- Video Display units journey on technology basis started from a Cathod Ray Tube (CRT) screen,
- Thin Film Transistor (TFT) screen, Liquid Crystal Display(LCD)screen, Light Emitting Diode (LED) screen.
- Earlier days video display units has problems like imbalanced light luminance, brightness and reflection, eye irritations etc. which are almost covered in recent technology with a good quality of display.
- Few video display unit works on touch sensation in the interaction.

➜ III. Programming Toolkits

- Douglas Engelbert looks technology as human problem solving capability. He thinks computers can be used to teach humans.
- Engelbert's team gives many human problem solving approach based tools developed at Augmentation Research Center like word processing and the mouse.
- Engelbart's dedicated research team at the Stanford Research Institute in the 1960s worked towards achieving the manifesto set forth in an article published in 1963:
  - By 'augmenting man's intellect' we mean increasing the capability of a man to approach a complex problem situation, gain comprehension to suit his particular needs, and to derive solutions to problems.
  - We refer to a way of life in an integrated domain where hunches, cut-and-try, intangibles, and the human 'feel for the situation' usefully coexist with powerful concepts, streamlined terminology and notation, sophisticated methods, and high-powered electronic aids.

➜ IV. Personal Computing

- Seymour Papert and his colleagues (few from MIT) designed a computer controlled mechanical turtle, used to design geometry shapes like circle and square, it was designed for Childs. Further Alan Kay took inspiration from Engelber and Papert both and he realized the power of computational machine.
- In early 1970s gives a dedicated system for a single users i.e. personal computers. In mid 1970s a successfully handled personal computer was named as Dynabook by him.

➜ V. Window System and WIMP Interface

- Window is common platform for interaction with many application. Multiple windows can be operated by a single user. Windows, Icon, Menu, Pointers helps to improves interaction among the system and user.
- In 1981, The Xerox Corporation introduced the 8010 star information system and it was the first system used as commercial interaction device based on WIMP interface.

➜ VI. The Metaphor

- Papert used metaphor while LOGO language was in development process which is used to teach children. Metaphor are useful to knowledge transfer(KT) i.e. to teach new technology concepts or transferring technical details to someone who qualifies the perquisite for the same.
- The metaphor helps to improve and increases the familiarity between he user and system i.e. computer application.

➜ VII. Direct Manipulation

☞ **Features of direct manipulation are listed below**

(i) Direct manipulation gives visibility to interested objects

(ii) It provides rapid feedback to all actions on the basis of incremental approach while engaged with the interface

(iii) Reversibility of all actions, so that users are encouraged to explore without severe penalties

(iv) Correct actions as per syntactic manner, it helps to improve legal operation activities

so that others can fulfil the requirement. For example, some user may like an eye-mounted video display, but other may not like. Young user may like new movies, but old age may like old movies.

The golden rule of design

- The golden rule of design is *"understand your materials"*.
- In real life examples, such as material for study table may be different of each table. But in human computer interaction material means:
  - **Understand** ***computers*** **:** Understand its limitations, capacities, tools, platforms.
  - **Understand** ***people*** **:** Understand psychological, social aspects, human error.

Syllabus Topic : What is Interaction Design ?

4.2 What is Interaction Design ?

- The interactive design means to design interactive system and its services. While designing designer must focus, how users will interact with system, what services are required, supported environment for interactive interface.
- It is also called as interactive system design, user interface design, web design, user centric design.
- Interactive design supports user activities with computing technology – have become embedded in everyday life, enabling all kinds of activities and experiences anywhere and anytime. These interactive products might include computer applications, websites, heating controllers, smart watches, bio-sensing garments, satellite navigation systems, interactive books, social media, computer games, digital hearing aids, advanced driver assistance systems, healthcare technology such as drug delivery systems, mobile applications, web services and many more.
- As computing technology has developed, the nature of users' interaction with technology has changed - and the role of interaction design has expanded accordingly
- It is an important module of user experience design umbrella.
- It is not just artifact of interface design but also provides how it is useful for understanding of system.
- It creates effective products and enables the user to enable the user to accomplish their objectives.

Basic four Activities in Interaction Design

1. Need Identification and requirement establishment
2. Development of design
3. Build interactive version of the design
4. Evaluate design

These four activities permeate three characteristics

1. Early focus on users design and evaluation of artifact
2. Usability and user experience goals are identified , documented and agree for user interface right
3. Designer never get right design first time

4.2.1 Interaction Design Process

Designing of interactive products is the process of different five phases; out of that four are interactive system design phases and one is the interaction and prototyping loop phase shown in Fig. 4.2.1.

1. **What is wanted or Requirement :** this phase gathers what exactly is needed for the design process. As a precursor to this it is usually necessary to find out what is currently happening. For example, how do people currently watch movies? What sort of personal appliances do they currently use?

   For gathering requirements various techniques are used such as: interviewing people, videotaping them, looking at the documents and objects that they work with, observing them directly, etc.
2. **Analysis :** From gathered requirement, find some key issues and communicate to the next stages of interactive design process.
3. **Design :** To apply numerous rules, guidelines and design principles to design interactive system.
4. **Iteration and prototyping :** It is a close loop phase. This phase need to evaluate a design to see how well it is working and where improvements can be needed. The evaluation can be done using the design on paper, but it is hard to get real feedback without trying it out in real environment. Most user

interface design therefore involves some form of prototyping, producing early versions of systems tested on real users.

5. **Iteration and prototyping :** It is last phase need to create it and deploy it. This phase involve writing code, making hardware, writing documentation and manuals – everything that tested on a real system.

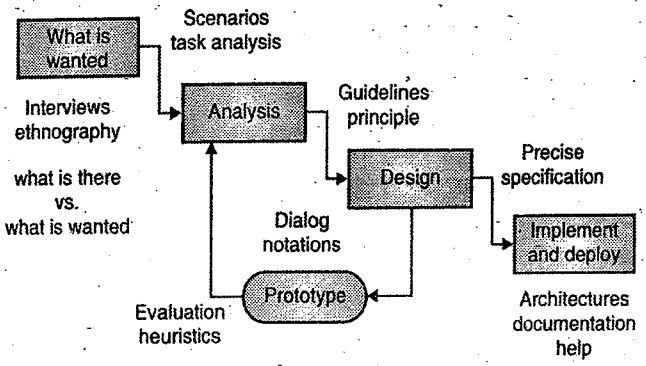


Fig. 4.2.1 : Interactive design Process

Syllabus Topic : The Software Design Process

4.3 The Software Design Process

- Software engineering is a discipline used for software design process or life cycle.
- It is used to provide software solution for any problem. Software requirement analysis is the important component software design process. Software design process applicable to all phases of life cycle.
- It is a user centric or semi-automated software design process. It is user experience design process, so it support to story board to determine specifications.
- While designing it applies concepts of fundamental modelling and UML (Unified Modelling Language).
- Software design process divides software products based on available technologies in two categories: Platform specific and platform independent software.
- It enables the designer to apply sequence of steps with past experience, technical and creative skills to design good software.
- Success of designed software depends on reliability, quality and services provided by software.
- It describes all aspects of designed software, it enables the user to navigate the design process all functionality.

4.3.1 Software Design Process Principles

Set of software design process principles are:

- **It should not suffer from any tunnel vision:** Designer must known different approaches of design. Analyse each approach based on requirement and available resources.
- **It should be traceable to evaluate the model:** Single design approach may not provide good design solution. A design approach supports to analyse the model any point of time to traced multiple requirements, how they satisfied by the design model.
- **The design should not reinvent the wheel:** Designer should use set of design patterns that before used for system design or choose different design pattern to reinvention. To reduce design time and required resources, designer should be invested in representing truly new ideas by integrating patterns that already exist when applicable.
- **It should reduce intellectual distance between real world problem and software product.** The design should be designed such a way that it support to impersonate the structure of the problem domain, whenever possible.
- **The design should show uniformity and integration:** A design is consistent if it appears fully rational. In order to accomplish this result, rules of style and format should be defined for a design team before design work start.
- **The design should be structured to accommodate change.** The design structure should be accommodating changes made by designer any point of time.

☞ **Following design concepts enable a designer to achieve this principle:**

- The design should be structured to accommodate any unusual circumstances such as aberrant data, events; or operating conditions are encountered
- **Design is not coding, coding is not design.** Designer and developer don't mix design and coding. The level of abstraction of the design model is higher than the source code. The only design decisions made at the coding level

should address the small implementation details that enable the procedural design to be coded.

- **The design should be assessed for quality as it is being created, not after the fact:** Many design and design measure concepts are available for designer to accessing quality of software product throughout the development process.
- **Review the design for minimising conceptual or semantic error:** Design team must first address the conceptual errors in design such as any ambiguity, inconsistency then focus on syntax error.

Syllabus Topic : User Focus

4.4 User Focus

Before starting interaction design exercise, we must know who is the intended user or users. We must consider these three parameters

1. Know your users
2. Personae
3. Cultural probes

4.4.1 Know your Users

- Before staring designing interactive system, we must know who is a user or users, single user or multiple users, role of each user and level of system access or interaction level of user. For example: If user is manager then it has full access of system, or if user is from sales, then only sales related access or interaction with system, not other functionality.
- So you must know in details like :
  - Who are they?
  - Probably not like you!
  - Talk to them
  - Watch them
  - Use your imagination

Who are they?

- Who is the user for software product?
- Known the qualification, experienced computer user or no
- Know the age of the users.
- Ask these questions again and again to users to get detailed information related to system and its context.
- When developing generic software, it very difficult to answer such questions. Generic software is for everyone, but is very difficult to find intention and purpose of use. For example video player may use any age user, but intention and purpose of use is different.

Probably *not* like you !

- While designing system is very easy for you to design system for you as per your interest and abilities, but other your may not like software. Other or real users not like you, so know your user is most important for designing of good software.
- **For example:** Design a website for latest fashion cloths for men and women. If all developers are men, they will develop website but they miss some empathetic skills related to women.

Talk to Them

- If you need to understand others, the best ways to speak with them number of time in different situation and ask or discuss questions. This is possible many ways such as discussion open ended questions, social questions, job related questions and structured interviews. This will brings potential users in design process or you can involve users in design process.
- Participation of real user in design process improves quality of product and produce better design.

Watch Users

- It is most important to watch professionals, those who working in your project domain. How they are practiced or find what their difficulties are. Also hear them, what they say.
- Watch, how they spend their working hours, watch their activities through directly in person or indirectly through video recording. After this go personally and discuss your observations or findings with them. They may explain when shown recording or while discussing. Your observations tell you what they do and they will tell you why.

Use Your Imagination

- Every time it is not possible to involve real users in design process. It increases the cost and required time for designing. If involvement of real user is not possible then imagine their experience and required functionality.
- Persona is a design method is used by design team to produce user focused design. Persona contains an imaginary person who represents as real users. It is based on previous studies of actual user's observations.

4.4.2 Persona

- Persona is a user focusing designing process. A persona is a example of imaginary user, not a real user. It uses surrogate users and makes them a real.
- **For example:** Manish is 37 years old manager working in warehouse from last five years. She completed part time diploma for business administration.
- She is mother of two children aged 18 and 13 and does not like to work late.
- She did introductory online computer course some years ago, but it was interrupted when she was promoted and not find time to complete.
- She met one small accident 3 year ago and her right-hand movement is slightly restricted.
- She is eager about her work and is happily completes all responsibility with in time, but she feel threatened by the introduction of another new computer system.

4.4.3 Cultural Probes

- Cultural probes or design probes is a technique used to inspire ideas in a design process. It serves as a means of gathering inspirational data about people's lives, values and thoughts. Cultural probes use a collection of tools, artifacts and tasks intended to provoke the user to look and think about their environment in new ways.
- The probes are small packages that can include any sort of artifact (like a map, postcard, camera or diary) along with evocative tasks, which are given to participants to allow them to record specific events, feelings or interactions.
- Probe packs are items to prompt responses e.g. glass to listen at wall, camera, postcard, given to people to open in their own environment they record what is meaningful information to them. It is used to inform interviews, prompt ideas, culture designers.

Syllabus Topic : Scenarios

4.5 Scenarios

- Scenarios are detailed description about system design. Some scenarios are lengthy but some of very shot such as press the save button.
- Design scenarios are used as tool to communicate ideas about user's action.
- Another benefit is to map design scenarios to formal idea and then convert it into creative design approach.
- User scenarios are scenarios to describe in details users actions and goals for product design.
- It is mostly used to capture user's key interaction with system only.
- It focuses on users motivations and these motivations are helps the designer to understand intention behind this when they interact with system. User scenarios are very useful for usability testing.

Scenarios are used for

- Communicate with designers, clients and users
- Validate other models such as task models or dialog and navigation models.
- Express what a system would look like, but not how it behaves.
- Scenarios are reused for designing effective interactive systems. It helps to find how user deals, what user wanted in potential design.
- It also helps to check implementation work and generate test cases for final evaluation of design.

Some scenarios are linear scenarios and are called contrast scenarios. Linear scenarios are represents a single path amongst all the potential interactions.

Why Use Scenario ?

- **It forces to think practically:** It forces a designer team to reflect the context by describing actual situation of use.
- **More or less detailed depending on the stage of the design:** It captures a variations in people, goals, contexts, technologies and activities
- **Encourages inconsistency in design :** It generate contexts for evaluation studies of design,
- It explores usability issues in very early stage in the design process
- It help identify usability targets and likely task completion times
- It bridge the gaps between researchers, designers, users and developers

What to Consider When Writing Scenarios

Good scenarios are must answer the following key questions:

- Who is the user?
- Why does the user come to the use design?
- What goals does he/she have?

4.5.1 Types of Scenarios

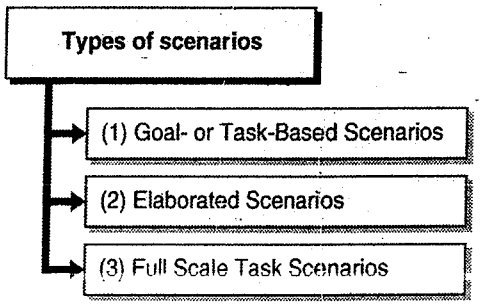


Fig. 4.5.1 : Types of scenarios

1. Goal- or Task-Based Scenarios

Goal or task is given to user and states user does this without providing any detail information about how to complete the scenario. These scenarios are useful in helping to define your design architecture and content and usability testing.

Example: Goal is to reach next week to Japan for conference. User job is to complete given goal.

2. Elaborated Scenarios

These are story like scenarios, given in every detail. Based on given story develop contents, functionality and behaviour of design.

Example : Mr. and Mrs. Macomb are retired school teachers who are now in their 70s. Their Social Security checks are an important part of their income. They've just sold their big house and moved to a small apartment. They know that one of the many chores they need to do now is tell the Social Security Administration that they have moved. They don't know where the nearest Social Security office is and it's getting harder for them to do a lot of walking or driving. If it is easy and safe enough, they would like to use the computer to notify the Social Security Administration of their move. However, they are somewhat nervous about doing a task like this by computer. They never used computers in their jobs. However, their son, Steve, gave them a computer last year, set it up for them, and showed them how to use email and go to websites. They have never been to the Social Security Administration's website, so they don't know how it is organized. Also, they are reluctant to give out personal information online, so they want to know how safe it is to tell the agency about their new address this way

3. Full Scale Task Scenarios

It describes details of each step to user, how to complete given task. It may contains either report all the steps of particular task or describe the steps you plan to set up for users.

Example : Jackie wants to fly to Århus next Thursday, returning on the last flight on Friday. She wants to know how much this would cost, and whether it would be cheaper to take a different flight back. She is not quite sure how Århus is spelt on the computer. When she has found the right flight, she wants to confirm the purchase with a credit card

Scenario example for booking an airline ticket

You want to fly to Bangalore next Monday morning for a HCI conference and return back on Thursday morning. You have to book the flight that suits your timing, with a credit card.

In this scenario users to complete 3 different tasks-

1. Signup/login on the app or on website
2. Search for flight as per the schedule
3. Book the flight

Syllabus Topic : Navigation Design

4.6 Navigation Design

- **Navigation** is the process of navigating a system, application or web site for network of information resources, which is organized as dialog box, widgets, hypertext or hypermedia. The user interface used for navigation may be dialog box, widgets, hypertext or hypermedia or web browsers.

Table 4.6.1 shows similar level of interaction in other type of applications and devices.

Table 4.6.1: Type of applications and devices

PC Application	Website	Physical Devices
Widgets	Form elements, tags and links	Buttons, dials, lights, displays
Screen design	Page design	Physical layout
Navigation design	Site structure	Main modes of device
Other apps	The web, browser,	The real world!
Operating system	External links or Hyper text	Embedded OS

For example: user wants to configure facebook social and security setting. For doing same you interact at several levels:

- **Widgets :** Use appropriate widgets set given configuration.
- **Screens or windows :** in this find things on the screen and understand the logical grouping of buttons.
- **Navigation within the application :** User must know what will happen when a button is pressed or must navigation of system.
- **Environment :** Facebook is a social app, user must know its environment.

What to consider when designing Web Navigation?

- The navigation of your site should be easily accessible. That implies the navigation of the site should avoid very complicated designs and moreover it should be very clear and concise.
- When utilizing images for your navigation, make sure that there is some text associated with them. Rule of thumb, **"Always use text with images."**
- Don't overwhelm your user. Designing a website with so many designs and navigation buttons might leave a user with too many choices, which can lead to frustration.
- Be consistent with you design. You don't need to have exactly the same navigation on every page but the most important features throughout the site should remain constant. *Remember to follow conventions.*

Why Navigation of a website is important?

Navigation is one of the most important aspect of a website, in fact, it is the brain of the website. It determines whether the user stays or leave. Web navigation is the gateway into the various areas of a web page. Like the GPS, web navigation guides the user within a page. Envision the frustration when your GPS takes you to the wrong place. Yes, that's how frustrating it can be when you have a web site with terrible navigation. Web navigation is important for the following reason:

- It gives the user a sense of direction. A good web navigation helps users find whatever they are looking for by pointing them in the right direction.
- Web navigation also tells us where we are. A good web navigation should always have **"You are here"** indicator. This indicator offers users with some assistance with determining their next destination and let them know if they are in the right place.
- It is the instruction manual of a website. Done accurately, web navigation tells users how to utilize the site without any difficulties regardless of expertise.
- It gives the user trust in the architect or designer of the site. A good navigation is one of the best opportunities a site has to create a lasting impression.

☞ **When writing navigation for any application must consider following point**

☞ **First you have to find**

1. Who is going to use the application?
2. How do they think about it?
3. What will they do with it?

☞ **Second you have to find structure**

1. **Local Structure :** It means single screen only.
   (a) When designing local structure must look for these four things.
   (b) Knowing where you are: It gives state of interaction.
   (c) Knowing what you can do: It means, what can be pressed or clicked to go somewhere or do something.
   (d) Knowing where you are going – or what will happen: It means, what can be pressed or clicked to go somewhere or do something
   (e) Knowing where you've been – or what you've done: It helps you to feel in control and understand your navigation of the information space.
2. **Global Structure :** It means whole website or structure of site, movement between screens within application. While designing global structure, it is for
   (a) **Hierarchical Organization :** In this look for full structure of application of website. It defines functional boundaries, roles, user type, or some more simple breakdown of a system. For example: Fig. 4.6.1 shows a high-level breakdown of messaging system.

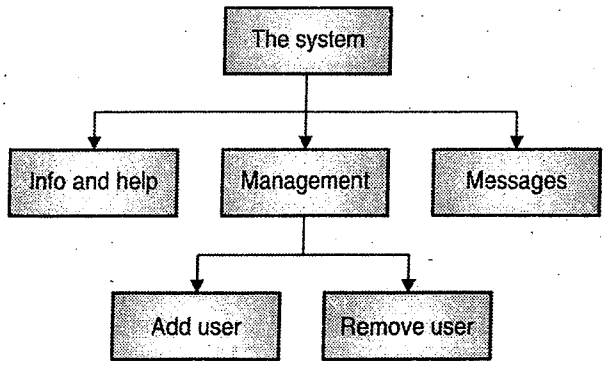


Fig. 4.6.1 : Hierarchical Organization of Messaging System

   (b) **Dialog :** The word 'dialog' is used to refer to this pattern of interactions between the user and a system.

   When you get down to detailed interactions, such as editing or deleting a record, there is obviously a flow of screens and commands that is not about hierarchy.

   Fig. 4.6.2 network diagram shows main states linked together with arrow. It shows what leads to what and What happens when include branches and loops.

   Figure describes massaging system network diagram had functionality to add user or remove user. In this when adding new user, it returns to main screen and when removing user it prompt user "conformation", then it returns to main screen.

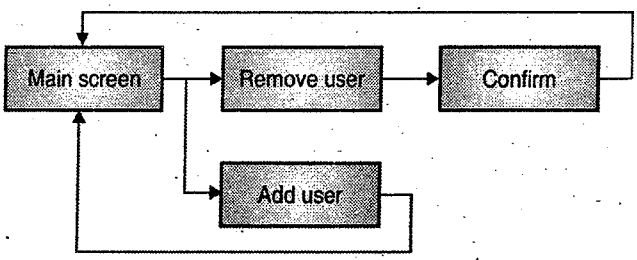


Fig. 4.6.2 : Network diagram for Messaging System

   (c) **Implications Navigation Design**

   These are implications in navigation design: -

   - **Style issues:** Style normally conform positions for menus on a PC application to platform standards, 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.
   - **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.
   - **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.

Syllabus Topic : Screen Design

4.7 Screen Design

- Screen design plays most important role in human computer interaction. Through screen information conveyed required information to user.
- Screen design developed using various different techniques such as CRT to LED and also touch screen.
- In the early days hardware and software resources are limited, so designers focussed on professor efficiency only. From last decade hardware prices are dropped, due to this computer and portable devices became affordable to anyone.

Human Considerations in Screen Design

Use of a screen, and a system, is affected by many factors. These include:

- Size of screen
- How much information displayed on screen
- Aspect ratio of screen
- Supported languages
- How screen different from other
- Screen look and reliability

How to Distract the Screen User

A list of factors that distract the screen user:

- Unclear captions
- Improper type and graphic emphasis
- Misleading headings
- Irrelevant and unnecessary headings
- Inefficient results
- Clustered and cramped layout
- Poor quality of presentation
- Legibility
- Appearance
- Arrangement
- Visual inconsistency
- Lack of design features
- Over use of 3D presentations
- Overuse of too many bright colors
- Bad typography

What Screen Users Want

User looking for in the design of screens

- An orderly clean clutter free appearance
- An obvious indication of what is being shown and what should be done with it.
- Expected information located where it should be.
- A clear indication of what relates to what.
- Plain and simple English
- A clear indication of when an action can make a permanent
- change in data

What screen users do

- Identifies a task to be performed or need to be fulfilled.
- Decides how the task will be completed or need fulfilled.
- Manipulates the computers controls.
- Gathers necessary data.
- Forms judgments resulting in decisions relevant to task

Syllabus Topic : Prototyping Techniques

4.8 Prototyping Techniques

→ (SPPU - Dec. 2017)

Q. What is a prototype ? Explain different types of rapid prototyping technique?

SPPU - Dec. 2017, 8 Marks

A *prototype is* a concrete representation of part or all of an interactive system. A prototype is a tangible artifact, not an abstract description that requires interpretation. Designers, as well as managers, developers, customers, and end users, can use these artifacts to envision and to reflect upon the final system.

4.8.1 Prototypes in HCI

- In HCI, prototypes take many forms
  - A storyboard (cartoon-like series of screen sketches)
  - A power point slide slow
  - A video simulating the use of a system
  - A cardboard mock-up
  - A piece of software with limited functionality
  - Even a lump of wood

4.8.2 Prototype Types

All above different forms of prototypes are grouped in three Types

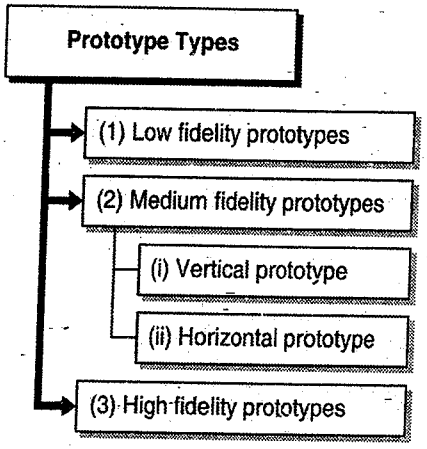


Fig. 4.8.1 : Prototype Types

➜ **(1) Low fidelity prototypes**

Basically paper mock-up of the interface is used. It gives look, feel, functionality of system **and** Quick and cheap to prepare and modify the interactive system. The Purpose of this is to use brainstorm for competing designs and elicit user reaction including any suggestions for modifications. It includes:

- **Sketches :** In a sketch, the outward appearance of the intended system is drawn. Typically a crude approximation of the final appearance of sketches. Such crude approximation helps people concentrate on high level concepts, but difficult to visualize interaction.
- **Storyboarding**: It is scenario-based prototyping. Scenarios are described in details or scripts of particular usage of the system.
- **Pictiv :** Pictiv stands for "plastic interface for collaborative technology initiatives through video exploration". Basically, using readily available materials to prototype designs. Sticky notes are primarily used with plastic overlays. It represents different interface elements such as icons, menus, windows etc. by varying sticky note sizes. Interaction demonstrated by manipulating sticky notes so it is easy to build new interfaces "on the fly". Interaction sticky note manipulation is videotaped for later analysis.

➜ **(2) Medium fidelity prototypes**

These type prototypes built using computers and it is more powerful than low fidelity prototypes. It simulates some but not all functionalities of the system. It engaging end users more so that user can get better feeling of the system. It can be helpful in testing more subtle design issues. It is classified into two types

(i) **Vertical prototype :** In this type limited number of selected features is implemented in-depth. Such prototype helps to evaluate common design ideas in depth. Example: working of a single menu item in full.

(ii) **Horizontal prototype :** In this entire surface interface is implemented without any functionality. No real task can be performed with such prototypes. Example: first screen of an interface. It provide many useful tools e.g., power point slides, animation.

➜ **(3) High fidelity prototypes**

It is typically based on software implementation of the design with full or most of the functionalities. It requires money, manpower, time and effort. Typically done at the end for final user evaluations.

4.8.3 Prototypes as Design Artifacts

A prototype is an important component of the design process. Successful prototypes have several characteristics :

- They support creativity, helping the developer to capture and generate ideas, facilitate the exploration of a design space, and uncover relevant information about users and their work practices.

- They encourage communication, helping designers, engineers, managers, software developers, customers, and users to discuss options and interact with each other.
- They also permit early evaluation since they can be tested in various ways, including traditional usability studies and informal user feedback, throughout the design process.

4.8.4 Prototype Dimensions

Through four dimensions designer analyse the performance of prototype and prototyping techniques:

- ***Representation :*** Representation dimension describes two types such as hard and soft. Designer refers this as paper sketches and computer simulation respectively. It is also represented as **offline prototypes or paper prototypes and online prototypes or software prototypes.**
  - **Offline prototypes** : It requires papers and paper like media to draw sketches. These sketches are draw by professionals to show some meaningful information or story. These are handmade sketches so computers are not required. These sketches are created early stage of design and these created very quickly. They are usually thrown away when they have served their purposes.
  - Offline prototypes are very economical and generated quickly. This permits a designer to complete design in short time and helps to prevent from becoming overly attached to the first possible solution. It explores the design in terms of space and examines the alternative approaches for design.
  - **Online prototypes** also called **"software prototypes"**: It run on a computer. They include computer animations, interactive video presentations, programs written with scripting languages, and applications developed with interface builders.
  - The cost of producing online prototypes is usually higher, and may requires killed programmers to implement advanced interaction and visualization techniques or to meet tight performance constraints.
  - Software prototypes are usually more effective in the later stages of design, when the basic design strategy has been decided.
  - Online prototypes introduce an intermediary between the idea and the implementation, slowing down the design cycle
- ***Precision*** : *It* describes the level of detail at which the prototype is to be evaluated, such as informal and rough or highly polished;
  - Precision refers to the relevance of details with respect to the purpose of the prototype. For example, when sketching a dialog box, the designer specifies its size, the positions of each field and the titles of each label.
  - However not all these details are relevant to the goal of the prototype: it may be necessary to show where the labels are, but too early to choose the text. The designer can convey this by writing nonsense words or drawing squiggles, which shows the need for labels without specifying their actual content.
  - The level of precision usually increases as successive prototypes are developed and more and more details are set.
  - The forms of the prototypes reflect their level of precision. Sketches tend not to be precise, whereas computer simulations are usually very precise.
  - Graphic designers often prefer using hand sketches for early prototypes because the drawing style can directly reflect what is precise and what is not.
  - The wiggly shape of an object or a squiggle that represents a label are directly perceived as imprecise. This is more difficult to achieve with an online drawing tool or a user interface builder.
- ***Interactivity*** : *It* describes the extent to which the user can actually interact with the prototype, such as "watch only" or fully interactive;
  - An important characteristic of HCI systems is that they are interactive: users both respond to them and act upon them. Unfortunately, designing effective interaction is difficult.
  - Many interactive systems including many websites have a good look but a poor feel. HCI designers can draw from a long tradition in visual design for the former, but have relatively little experience with how interactive

software systems should be used: personal computers have only been commonplace for a couple decades.

- Another problem is that the quality of interaction is tightly linked to the end users and a deep understanding of their work practices: a word processor designed for a professional typographer requires a different interaction design than one designed for secretaries, even though ostensibly they serve similar purposes.
- Prototypes can support different levels of interaction.
  - Fixed prototypes, such as video clips or pre-computed animations, are non-interactive. The user cannot interact, or pretend to interact, with it. Fixed prototypes are often used to illustrate or test scenarios.
  - Fixed-path prototypes support limited interaction. The extreme case is a fixed prototype in which each step is triggered by a pre-specified user action.
  - For example, the person controlling the prototype might present the user with a screen containing amen. When the user points to the desired item, he or she presents the corresponding screen showing a dialogue box.
  - When the user points to the word "OK," he or she presents the screen that shows the effect of the command. Even though the position of the click is irrelevant (it is used as a trigger), the person playing the role of the user gets the feel of the interaction.
  - Of course, this type of prototype can be much more sophisticated, with multiple options at each step. Fixed-path prototypes are very effective with scenarios and can be used for horizontal and task-based prototypes.

- ***Evolution :*** Evaluation means select effective and efficient prototype for design life cycle. It may be throw away or iterative.
  - Prototypes have different life spans: rapid prototypes are created for a specific purpose and then thrown away, iterative prototypes evolve, either to work out some details (increasing their precision) or to explore various alternatives, and evolutionary prototypes are designed to become part of the final system.

4.8.5 Rapid Prototyping

The goal of rapid prototyping is to develop prototypes very quickly, in a fraction of the time it would take to develop a working system. By shortening the prototype-evaluation cycle, the design team can evaluate more alternatives and iterate the design several times, improving the likelihood of finding a solution that successfully meets the user's needs.

Rapid prototypes also serve to cut off unpromising design directions, saving time, and money. There are two types of rapid prototyping techniques:

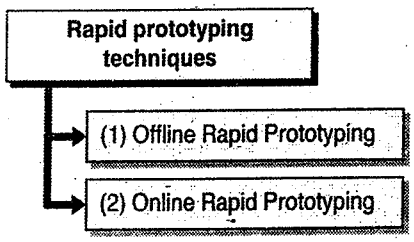


Fig. 4.8.2 : Rapid prototyping techniques

➜ 1. Offline Rapid Prototyping

Offline prototyping techniques range from simple to very elaborate. Because they do not involve software, they are usually considered a tool for thinking through the design issues, to be thrown away when they are no longer needed. This includes simple paper and pencil sketches, three-dimensional mock ups, Wizard of Oz simulations, and video prototypes.

- *Paper and pencil :* It is fastest form of prototyping involves paper, transparencies and Post-it notes to represent aspects of an interactive system.
- By playing the roles of both the user and the system, designers can get a quick idea of a wide variety of different layout and interaction alternatives, in a very short period of time.
- Designers can create a variety of low-cost special effects. For example, a tiny triangle drawn at the end of a long strip cut from an overhead transparency makes a handy mouse pointer, which can be moved by a colleague in response to the user's actions.

- **Post-it notes**, with prepared lists, can provide pop-up menus. An **overhead projector** pointed at a whiteboard makes it easy to project transparencies hand drawn or pre-printed, overlaid on each other as necessary to create an interactive display on the wall.
- ***Mockups.:*** Mockups is full size or scale model of a device or design. It is used in software development to create user interfaces that show the end user what the software will look like without having to build the software or the underlying functionality. It shows all dimensions of software same as architect showing 3D model of upcoming real estate project.
- Mockups are used by interactive system designers to move 2D sketches drawn on transparencies or paper. The materials used for this are cardboard, foam-core, etc.
- Mockups are allows the designer to concentrate on the physical design of the device, such as the position of buttons or the screen. The designer create several mock ups for new system and then compare input or output options on each mockups. Designers and users should run through different scenarios, identifying potential problems with the interface or generating ideas for new functionality.
- Mock ups can also help the designer how an interactive system will be incorporated into a physical space.
- ***Wizard of Oz :*** Wizard of OZ is a rapid product development design methodology to improve user experiences.
- It is mainly used to simulate and test unimplemented technology. Simulation consists of paper prototypes, fully implemented systems, and everything in between.
- It gives impression to the user that they are working in real system but user interacts with partially function system.
- User thinks having interacting with a real computer system, but a developer is responding to output rather than the system.
- It is used early in design to understand users' expectations or requirements. Human operator simulates the functionality of the system behind the scenes. Don't need to build the whole system! Just have your "wizard" simulate it for the user.
- It builds an interactive application without much coding, only front end interface is coded. A remote wizard controls the interface's characteristics based on user input directly.
- It build interactive application, it is faster, cheaper and easier than making a real thing.
- It was originally used to develop natural language interfaces. Since then, the technique has been used in a wide variety of situations, particularly those in which rapid responses from users are not critical.
- ***Video prototyping :*** It uses recorded videos of user interaction with the new system. They differ from video brainstorming in that the goal is to refine a single design, not generate new ideas. Video prototypes may build upon paper and pencil prototypes and cardboard mock ups and can use existing software and images of real-world settings.

➜ 2. Online Rapid Prototyping

- Online rapid prototyping has higher precision as compared to offline rapid prototyping. It communicates ideas with clients, end users, developers and managers better way.
- It is used by the design team to fine tune the design layout or an interaction. It shows problems in the design early stage of design, so it reduces cost and required time of design.
- It supports dynamic interactions or visualizations in run time, it is not possible in offline.
- It is categorized in two types: non-interactive and interactive simulations.

☞ Non-interactive simulations

- Non-interactive simulations are created using offline prototypes.
- Tools widely sued for non -interactive simulations are Macromedia Directo. In this designer defines various graphical objects called as "sprites". Adobe Illustrator, Deneba Canvas and Adobe Photoshop are used to create sprites or graphical objects.
- It also supports animation of graphical objects and when objects appears and disappears determined by time line.
- Experience developers are used director tool to create interactive simulation.

☞ Interactive simulations

- For interactive simulation designers can also use tools like as Adobe Photoshop to create Wizard of Oz simulations.

- For example, the effect of dragging an icon with the mouse can be obtained by placing the icon of a file in one layer and the icon of the cursor in another layer and by moving either or both layers. The visibility of layers, as well as other attributes, can also create more complex effects. Like Wizard of Oz and other paper prototyping techniques, the behaviour of the interface is generated by the user who is operating the Photoshop interface. More specialized tools, such as Hyper card and Macromedia Director, can be used to create simulations with which the user can directly interact.
- ***Scripting Language :*** It is the most advanced rapid prototyping tool used for quick or rapid development of prototype. It may or may not part of final design prototype.

Syllabus Topic : Wire-Framing

4.9 Wire-Framing

- Wire-frame is represents the skeletal of design. It is also known as screen blue print or page layout. It is crated before any design work started so there no distraction of colours and visual elements.
- It is mostly used to finalize content and functionality on a page by user and client.
- It used in early stage of development process to finalize basic structure of page before visual design and addition of content.
- It provides relationship between the pages and structure of an interface. It gives details page layout, structure of interface, functionality and content if design.
- It will continuously refresh the requirement of prototype. It continuously monitor all requirements are considered by development team or not.
- Wireframes often end up evolving into the requirements for a system. It contains pencil drawings or sketches on a whiteboard, or they can be produced by means of a broad array of free or commercial software applications.
- It can be created using a variety of software applications, for example, Visio, Excel, Word, Illustrator, Photoshop and Power Point.

Wireframe Structure

Each wireframe has following components:

- **Title:** It on top of each wireframe and it describes the purpose of the wireframe. It is numbered with 1.0 or 1.1 nomenclatures.
- **How to get here:** This describes how the user got to this panel
- **Concept/Purpose/Objective:** This describes what the objective is or purpose is for this panel.
- **Content/Data:** This describes all the content on the panel including any buttons or icons.
- **If/Then:** This describes a user behavior and the result of that behaviour (e.g., what panel is rendered after the 'If' condition is met).
- **Navigation Links/Buttons:** This describes any navigation links on the page.
- **Error conditions:** This section describes any errors that may result from user behaviour and what message wireframe they will receive.

Advantages of Wire-framing

- It involves client in design process
- It provides an early visual to client for review a design
- Users are involved in early stage of design to get feedback for prototype usability testing.
- Make changes efficiently
- Save time and cost because designs, once approved by the client and the users provide confidence to the designer.
- It ensures the page content and functionality of design is positioned correctly based on user needs.

Disadvantages of Wire-framing

- It is very difficult to explain why wireframes are needed to clients. Because it not included any design concepts or technical details
- When designer translate wire frame in design, it changes position of elements on page, it is very difficult to explain why page contains change.

Syllabus Topic : Understanding the UI Layer and Its Execution Framework

4.10 Understanding the UI Layer and Its Execution Framework

Interactive applications are implemented and executed using the user interface (UI) software layers. The UI layer refers to a set of software that operates above the core operating system. It encapsulates and exposes system functions for :

- Fluid input and output (I/O)
- Facilitation of development of I/O functionalities (in the form of an application programming interface/library [API] or toolkit)
- Run-time management of graphical applications and UI elements often manifested as windows or graphical user interface (GUI)

Since most interfaces are graphical, the UI layer uses a 2-D or 3-D graphical system based on which GUI elements are implemented shown in Fig. 4.10.1. The Fig. 4.10.1 shows following UI layers :

- An API for creating and managing the user interface elements (e.g., windows, buttons, menus) and
- A window manager to allow users to operate and manage the applications through its own user interfaces

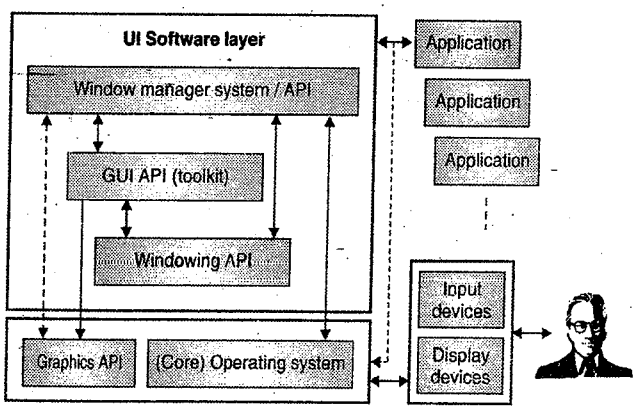


Fig. 4.10.1 : User interface software layer for a window-based multitasking UI

- Fig. 4.10.1 describes the UI layer as part of the system software in many computing platforms. The user interacts with the window/GUI-based *applications* using various input and output *devices*. At the same time, aside from the general applications, the user interacts with the computer and manages multiple application windows/tasks (e.g., resizing, focusing, cutting and pasting, etc.) using the *window manager*.
- The window manager is regarded as both an application and API. User applications are developed using the APIs that represent abstracted I/O-related functionalities of the UI layer, such as those for window managing (resizing, iconifying, dragging, copy and paste, etc.),
- GUI elements and widgets (windows, menus, buttons, etc.), and basic windowing (creating/destroying window, deactivating window, etc.). These APIs are abstracted from the even lower-level APIs for 2-D/3-D graphics and the operating system.
- Though such an architecture and abstraction, it becomes much easier to develop and implement interactive applications and their user interfaces.

Syllabus Topic : Model-View-Controller (MVC) Framework

4.11 Model-View-Controller (MVC) Framework

- So far, we have only focused on the user interface (UI) objects and their behavior. Obviously, a complete application consists not only of UI objects, but those for the core functions of the application as well. How do we effectively develop the larger interactive programs with two such parts: UI and internal functional core?
- For this purpose we requires development framework or methodology suited for highly interactive systems. **Model-View-Controller (MVC) Framework** is allow to develop interactive program where the core computational and interface parts are developed in a modularized fashion and combined in a flexible manner.
- The MVC approach was first proposed as a computational architecture for interactive programs rather than a methodology by the designers of the programming language called Small Talk, which is one of the fist object-oriented and modular languages.
- The modular nature of the MVC architecture naturally shaped the interactive program development style or

methodology. Fig. 4.11.1 shows MVC framework with three main components:

- Model
- View
- Controller

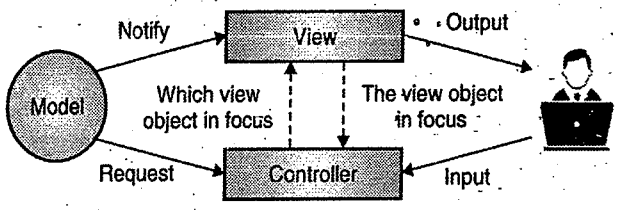


Fig. 4.11.1 : MVC Architecture for Interactive Application

Model

- Model is the central component of the pattern. It expresses the application's behavior in terms of the problem domain, independent of the user interface. It directly manages the data, logic and rules of the application.
- **For example:** An interactive banking application, the model will be parts of the program that maintain the balance, compute the interest, make wire transfers, etc.
- It represents logical structure of data in a software application and the high-level class associated with it. This object model does not contain any information about the user interface.
- The model has no knowledge of how the central information will be presented to the user (output/presentation) or how the transactions (input) are made.

View

- A view can be any output representation of information, such as a chart or a diagram. Multiple views of the same information are possible, such as a bar chart for management and a tabular view for accountants. It is part of the application corresponds to the implementation for output and presentation of data.
- For instance, views might be windows and widgets that display the list of transactions and the balance of a given account in a banking application, or they might play a background audio clip depending on the score level for a game. As a whole, there may be multiple views for a single application (or model). For instance, there could be different view implementations for different display platforms or user groups
- It is a collection of classes representing the elements in the user interface such as all of the things the user can see and respond to on the screen, like buttons, display boxes, etc.
- When the model is changed, the view of that model must be ***notified*** so that it can change the visual representation of the model on the output display.

Controller

- The *controller* is the part of the application corresponds to the implementation for manipulating the view, ultimately it manipulate the internal model. It takes external inputs from the user and then interprets and relays them to the model.
- The controller thus practically takes care of the input part of the interaction. It uses the underlying UI execution framework or operating system to achieve this purpose (while the view is mostly independent from the operating system or platform).
- It represents the classes connecting the model and the view, and is used to communicate between classes in the model and view.
- In addition, the controller sometimes might also change the content of the display without changing the model. For instance, if the user wanted to simply change the color of a button (e.g., for UI customization purpose), the controller can directly communicate with the view to achieve this effect.
- Once the object in focus is identified, the corresponding event handler would be invoked. The controller will only relay a query or message for a certain change or manipulation to happen to the model rather than actually making the change itself.

View/Controller

- In several application architectures, the view and controller may be combined into one module or object because they are so strongly related to each other. For instance, a UI button object will be defined by attribute parameters such as its size, label, and color as well as the event handler that invokes the methods on the model for change or manipulation.

□□□

UNIT V

CHAPTER 5

HCI - Design Rules, Guidelines and Evaluation Techniques

Syllabus :

- Principles that support usability
- Design standards
- Design Guidelines
- Golden rules and heuristics
- Using toolkits
- User interface management system (UIMS)
- Goals of evaluation
- Evaluation Criteria
- Evaluation through expert analysis
- Evaluation through user participation
- Choosing an Evaluation Method.

5.1 Introduction

The major design issue in design decision is how to provide ability to determine usability consequences in design. Solution to this problem is to require some design rules. Design rules are rule that designer follow these rule to increase usability of software product. Design rules are divided in two dimensions: Authority and Generality.

Authority : In this designer may follow design rule or taken as suggestion for design.

Generality : In this rule can be applied to many design situations or whether it is focused on a more limited application situation.

Rules are varying in their level of abstraction. Some rules are defined as abstract design rules and some of them for specific design rules. Abstract design rules are general and have low authority. Specific design rules are not general; they are some specific application and have high authority.

Interactive systems design rule are supported by psychological, cognitive, ergonomic, sociological, economic or computational theory. The design rules are used to apply the theory in practice.

Syllabus Topic : Principles that Support Usability

5.2 Principles that Support Usability

An important goal of interactive system is to increase usability of system. Usability of any system are measured by how it is ease for user to achieve specific goal. In HCI design rules are defined to attain and increase usability of interactive system.

Abstract design rules are also called as design principals.

These principles are divided into three main categories:

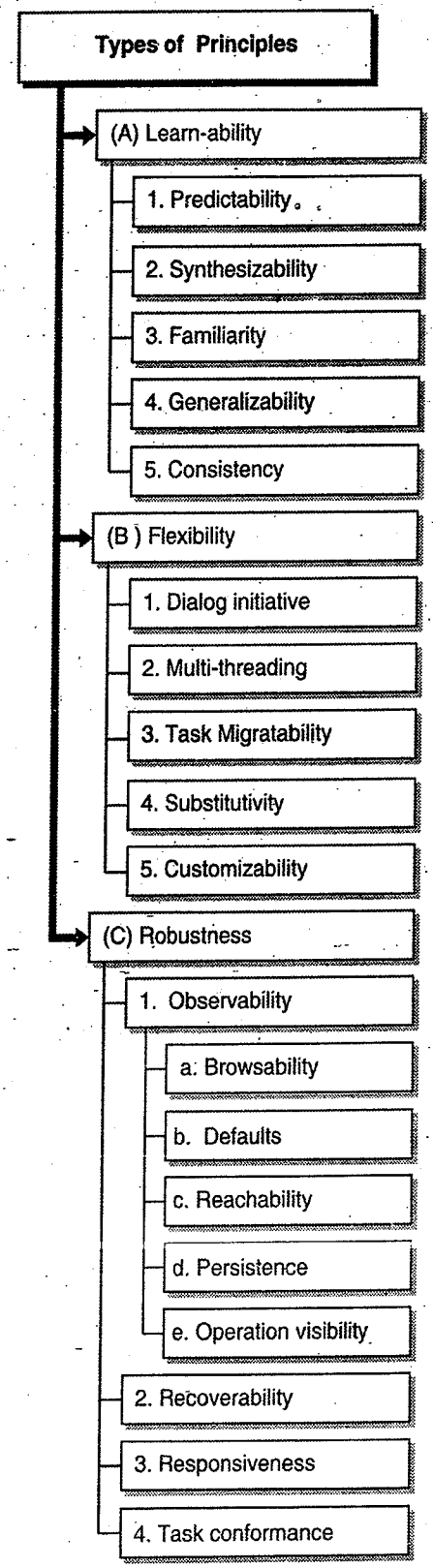


Fig. 5.2.1: Types of Principles

(A) **Learnability :** How it is ease for new users to effectively interact with system and achieve maximal performance.

(B) **Flexibility :** How the system is flexible to the new user and how user and system exchange information.

(C) **Robustness :** On what level system tolerates user generated error and support to achieve defined goal.

5.2.1 Learnability

- Learnability is a important feature of the interactive system that allow beginner or new user to understand how to use system initially and how to attain a maximal level of performance.
- Table 5.2.1 shows the specific principles that supported by learnability.

Table 5.2.1 : Summary of principles affecting learn-ability

Principle	Definition	Related principles
Predictability	Support for the user to determine the effect of	Operation visibility
Synthesizability	future action based on past interaction history	Immediate/eventual honesty
Familiarity	Support for the user to assess the effect of	Guess ability, affordance
Generalizability	past operations on the current state	
Consistency	The extent to which a user's knowledge and	

➜ 1. Predictability

- Predictability of an interactive system means how new user interact with system. User predicates the actions to achieve specific goal.
- There are many degrees to which predictability can be satisfied.

- It determining effect of future actions based on past interaction history.
- Fig. 5.2.2 shows examples of predictability.

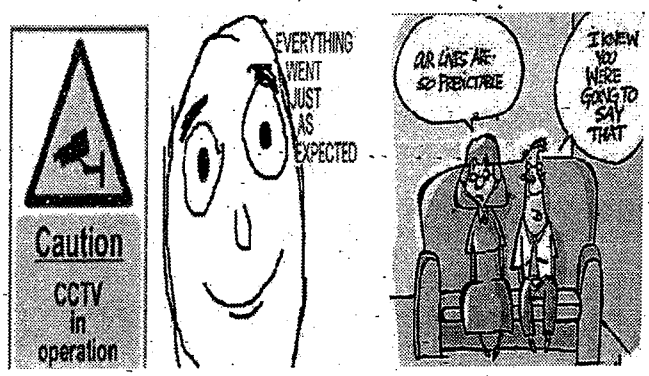


Fig. 5.2.2 : Example of predictability

- Predictability of an interactive system is distinguished from deterministic behavior of the computer system alone.
- Most computer systems are ultimately deterministic machines, so that given the state at any one point in time and the operation which is to be performed at that time, there is only one possible state that can result.
- Predictability deals with the user's ability to determine the effect of operations on the system. Another form of predictability has to do with the **user's ability** to know which operations can be performed.
- **Operation visibility** refers to how the user is shown the availability of operations that can be performed next.
- If an operation can be performed, then there may be some perceivable indication of this to the user.
- This principle supports the superiority in humans of recognition over recall. Without it, the user will have to remember when he can perform the operation and when he cannot.
- Likewise, the user should understand from the interface if an operation he might like to invoke cannot be performed.

➜ 2. Synthesizability

- Predictability says nothing about the way the user forms a model of the system's behavior. Synthesis is the ability of the user to assess the effect of past operations on the current state.
- It can observe account of a change, for example moving a file in command-line vs WIMP interface.
- Fig. 5.2.3 shoes example of synthesizability.

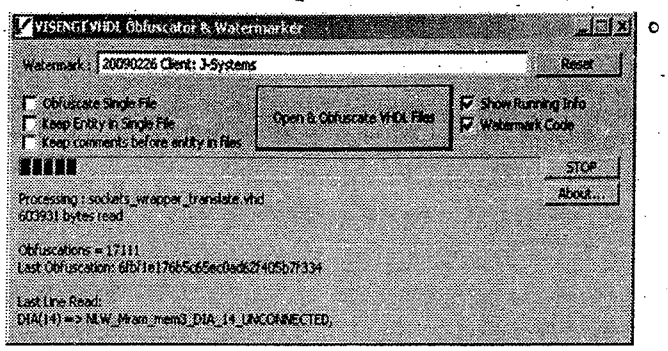
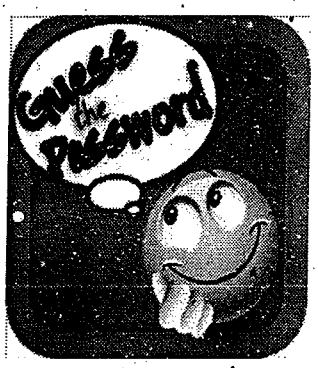
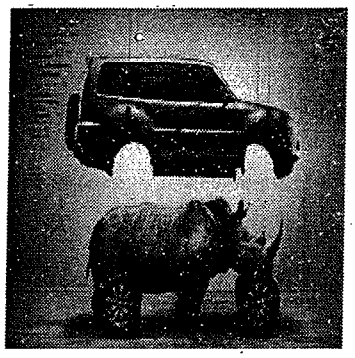


Fig. 5.2.3 : Example of synthesizability

➜ 3. Familiarity

- In this new users have given wide experience existing application domain, so user familiar with functionality of interactive system.
- Familiarity is obtained through interactions with the real world and with other computer systems.
- Familiarity of an interactive system for new user can measures the correlation between the user's existing knowledge and the knowledge required for effective interaction.
- In this how prior knowledge is applies to new system, for this purpose it uses guess-ability; metaphors; affordance. Fig. 5.2.4 shows examples of familiarity.





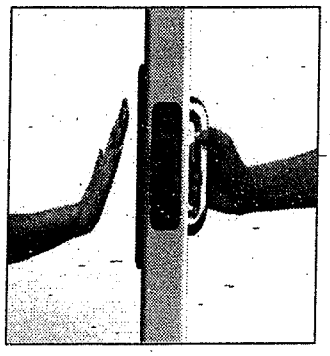


Fig. 5.2.4 shows examples of familiarity

➜ 4. Generalizability

Itextends specific interaction knowledge to new situations, e.g. cut/paste/copy across apps. Fig. 5.2.5 shows example of generalizability.

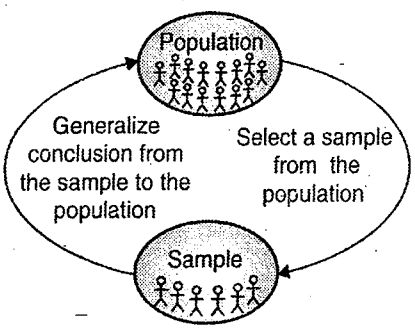


Fig. 5.2.5 Example of generalizability

➜ 5. Consistency

- Consistency of interactive system is measures through the result of system or behaviour system are similar to situations or similar task. Consistency is probably the most widely mentioned principle in the user interface design.
- Consistency can be expressed every time system gives same result for same set of inputs.

5.2.2 Flexibility

- Flexibility of system means how the end-user and the system exchange information.
- Table 5.2.2 shows principals affecting flexibility.

Table 5.2.2 Principals affecting flexibility

Principle	Definition	Related principles
Dialog initiative	Allows the user to initiate communication of system form one dialog to another dialog.	System/user Pre-emotiveness
Multi-threading	It provides ability to the system to support user interaction to more than one task at a time	Concurrent vs. interleaving, multi-modality
Task migratability	The ability to pass control for the execution of a given task so that it becomes either internalized by the user or the system or shared between them	–
Substitutivity	Allowing equivalent values of input and output to be arbitrarily substituted for each other	Representation multiplicity, equal opportunity
Customizability	Modifiability of the user interface by the user or the system	Adaptivity, adaptability

1. Dialog initiative

- All dialogs are initiated by system; user simply responds or requests the information to system.
- Dialogs are two types User pre-emptive and system pre-emptive dialog.
- User pre-emptive dialogs are used for actions initiated by user and these are more flexible and more desirable.
- In this user gets freedom from system imposed constraints on input dialogue and user should be able to abandon, suspend or resume tasks at any point.
- User pre-empt dialog box maximise the flexibility and System User pre-emptive dialogs are initiated by system and user only respond to request for information.
- In some scenarios system initiated dialog are required for security purpose and avoids potential serious damage. Model dialog boxes are initiated by system and direct dialog boxes are initiated by user.
- The main of dialog initiation is to increase the ability of user to pre-empt the system and reduce the system ability to pre-empt the user.

2. Multi-threading

- Multi threading ability of system allows user to interact more than one task at a time. It supports two types: **Concurrent and Interleaving**.
- Concurrent multi-threading means input to multiple tasks at a time.
- Interleaved multi-threading means many tasks, but input to one at a time.
- Windows system is a good example of multi-threaded dialog; it interleaved multiple overlapping tasks of all available current tasks.
- Windows always opens separate dialog boxes for each functionality for example windows opens new dialog for notepad, for file management another and so on.

3. Task Migratability

- Task migratability means to transfer the control of execution of tasks from system and user and vice versa based who can do it better. Task migratabity means to automate the routine task of system.
- User get bored doing routine tasks and stop concentrating, automate routine tasks, but don't fix function allocation.
- The best example Task migratability is spell checker of word processor. System is automated to check spelling in documents.

4. Substitutivity

- Substitutivity is allowing equivalent values of input and output to be substituted for each other.
- Substitutivity reduces user errors and cognitive effort. For example, printer page layout, use inch or cm.
- If we consider substitutivity with respect to output or the system's rendering of state information is called equal opportunity and representation multiplicity means graph and figure.
- Representation multiplicity illustrates flexibility for state rendering and Equal opportunity gives the distinction between input and output at the interface.

5. Customizability

- Customizability of system means to support modifiability of the user interface by user.
- Modifiability of the user interface by the user is called as adaptability and by systems is called as adaptivity.
- Difference between user-initiated and system-initiated modification is user initiated or adaptability allows user to adjust input and output of interface and system initialled or adaptivity means automates the user interface by system automatically.
- From the system side, modifications done by a programmer actually changing the system and its interface during system maintenance.
- Automatic modification means that the system would make based on its knowledge of the user.

5.2.3 Robustness

- The robustness of that interaction covers features that support the successful achievement and assessment of the goals.
- A summary of these principles is presented in Table 5.2.3.

Table 5.2.3 principles

Principle	Definition	Related principles
Observability	User has ability to determine internal state of system from what system perceives..	Browsability and reachability are related principles. Browsability explore current state without changing it. Reachability navigate through observable states.
Recoverability	User has ability to take corrective action upon recognizing error	Reachability correct error by using forward; backward recover.
Responsiveness	How the user perceives the rate of communication with the system	
Task conformance	Does system support all tasks user wishes to perform in expected ways?	Task completeness, task adequacy.

➜ **1. Observability**

- Observability means user should be able to evaluate the internal state of the system from its perceivable representation.
- Feedback system creates good observability.

Observability has following five principles:

(a) **Browsability** : Browsability explore current state without changing it.

(b) **Defaults** : Default means default state of system. It may be static or dynamic. Static default means not evolved in any session and dynamic defaults means evolved in session.

(c) **Reachability** : Reachability navigate through observable states.

(d) **Persistence:** It deals with previous knowledge about system or deals with previous session stored states.

(e) **Operation visibility:** It gives the current state of system to user.

➜ **2. Recoverability**

- Recoverability supports for undoing errors means ability of user to take corrective action once an error has been recognized.
- Recoverability means the ability to reach a desired goal after recognition of some error in a previous interaction.
- Recovery may be initiated by the **system** itself or by the **user**.
- When recovery initiated by the **system itself, it concerns to** fault tolerance, safety, reliability and dependability.
- When recovery is initiated by the user, it is important to known reason of recovery actions.
- It is linked with reachability because we want to avoid blocking the user from getting to a desired state from some other undesired state.

There are two types of recoverability : Forward and Backward

1. **Forward:** Forward means ability to fix when we can't undo. It accepts current state and reach to desired state, it do negotiation.
2. **Backward :** Backward means undo previous error. It undo the effects of previous interaction and returns to a prior state before proceeding.

➜ **3. Responsiveness**

- Responsiveness means Users perception of rate of communication with system.
- Response time is a time for system to respond in some way to user actions. Short durations and instantaneous response times is expected from system.
- It should communicate feedback with appropriate action. If system sends quick response then it is called Instantaneous

response and response is delayed means system working on response. Delayed response means sensitivity to delay depends on context.

- If delay is inevitable, provide reassurance or time affordance.

➜ **4. Task conformance**

- Task conformance is degree to which the system supports the user's all tasks.
- Task conformance related principles are : Task completeness and task adequacy.
- Task completeness takes care of the coverage issue and task adequacy takes care of the user's understanding of the tasks.

Syllabus Topic : Design Standards

5.3 Design Standards

- Design standards are set by national or international bodies to ensure compliance by a large community of designers.
- Standards require sound underlying theory and slowly changing technology.
- Hardware standards more common than software high authority and low level of detail
- ISO 9241 defines usability as effectiveness, efficiency and satisfaction with which users accomplish tasks. In this effectiveness can you achieve what you want to?, Efficiency can you do it without wasting effort? and satisfaction do you enjoy the process?
- Requirement of standard are as follows :

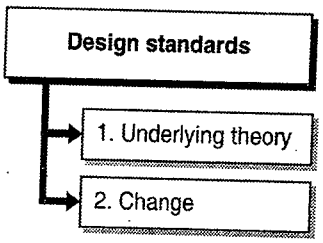


Fig. 5.3.1 : Design Standards

➜ **1. Underlying theory**

- Hardware standards are based on understanding human factors and hardware specifications.
- Software standards are based on underlying theories or cognitive science, which are less well formed, still evolving and not very easy to interpret in the language of software design.

➜ **2. Change**

- Any changes in hardware is very difficult and expensive as compared to software. Software changes are easy, flexible and less costly. Requirement change occurs frequently software but requirement changes are very less in hardware. Hardware standards are relatively stable as compared to software.
- Design standards for hardware and software designed by standard institution, such as the British Standards Institution (BSI) or ISO.
- ISO 9241 standard for VDT Visual Display Terminals and has total 17 parts. Seven of these are concerned withdraw are issues – requirements for visual display, keyboard layout, workstation layout, environment, display with reflections, display colors and non-keyboard input devices.
- Seven parts are devoted to software issues – general dialog principles, menu dialogs, and presentation of information, user guidance, command dialogs, direct manipulation dialogs and form-filling dialogs.
- However, standards covering software issues are now being produced, for example, the draft standard ISO 14915 covers software ergonomics for multimedia user interfaces.
- One component of the ISO standard 9241, pertaining to usability specification, applies equally to both hardware and software design. In the beginning of that document, the following definition of usability is given:
  - **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.

Syllabus Topic : Design Guidelines

5.4 Design Guidelines

- Design guidelines are used to provide providing a direct means for translating detailed design specifications into actual implementation.
- Design guidelines are sets of recommendations towards good practice in design.
- They are intended to provide clear instructions to designers and developers on how to adopt specific principles, such as intuitiveness, learnability, efficiency, and consistency.
- Instead of dictating conventions, design guidelines provide helpful advice on how to achieve a design principle that can be platform-specific or cross-platform.

Some of general design guidelines are

- Maintain consistent interaction. There are different types of consistence's such as internal consistency, external consistency, analogical consistency.
- Guideline should be more suggestive and general
- Provide the user with control over the interaction, supported by feedback.
- Use of familiar terms and associations to represent a new concept
- Use abstract guidelines applicable during early life cycle activities and detailed guidelines applicable during later life cycle activities.
- Use guidelines aids to resolving conflicts in design
- Use direct manipulation whenever possible.
- Designs should be aesthetically nice ideally without compromising on the usefulness and usability of the system.

Syllabus Topic : Golden Rules and Heuristics

5.5 Golden Rules and Heuristics

- Golden rules are check list for good design.
- There are different collections of design rules defined by various authors such as :
  - Shneiderman's 8 Golden Rules
  - Norman's 7 Principles
  - Nielsen's 10 Heuristics

5.5.1 Shneiderman's Eight Golden Rules of Interface Design

Shneiderman's eight golden rules provides a key principles of interface design. These Rules of Interface Design are as follows:

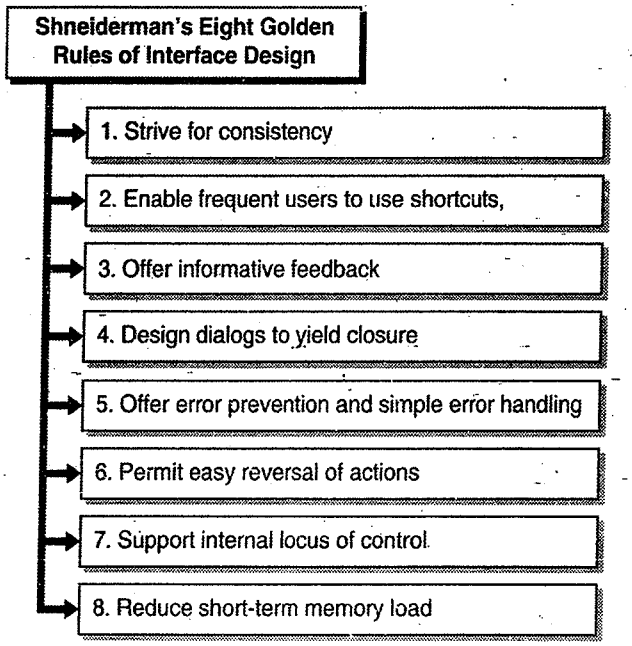


Fig. 5.5.1: Shneiderman's Eight Golden Rules of Interface Design

1. Strive for consistency

- Use familiar icons, colors, menu hierarchy, call-to-actions, and user flows when designing similar situations and sequence of actions.

2. Enable frequent users to use shortcuts

- Provide keyboard shortcuts to frequent user, so they can complete as task quickly.

3. Offer informative feedback

- From informative feedback known where they are at and what is going on at all times.

➜ **4. Design dialogs to yield closure**

- Don't keep your users guessing. Tell them what their action has led them to.

➜ **5. Offer error prevention and simple error handling**

- No one likes to be told they're wrong, especially your users. Systems should be designed to be as fool-proof as possible, but when unavoidable errors occur, ensure users are provided with simple, intuitive step-by-step instructions to solve the problem as quickly and painlessly as possible.

➜ **6. Permit easy reversal of actions**

- Designers should aim to offer users obvious ways to reverse their actions.

➜ **7. Support internal locus of control**

- Allow your users to be the initiators of actions. Give users the sense that they are in full control of events occurring in the digital space.

➜ **8. Reduce short-term memory load**

- Human attention is limited and we are only capable of maintaining around five items in our short-term memory at one time. Therefore, interfaces should be as simple as possible with proper information hierarchy, and choosing recognition over recall.

5.5.2 Norman's Seven Principles for Transforming Difficult Tasks into Simple Ones

Norman's Seven Principles are as follows :

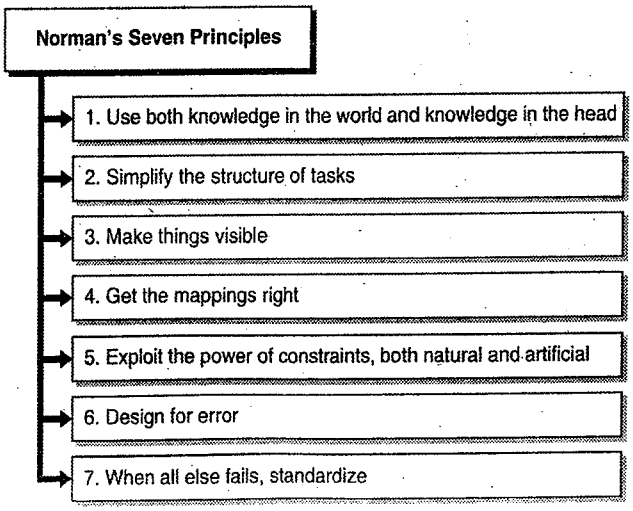


Fig. 5.5.2 : Norman's Seven Principles

➜ **1. Use both knowledge in the world and knowledge in the head**

The user's knowledge model is not necessarily the same as the knowledge model of the world..

➜ **2. Simplify the structure of tasks**

Decompose complex task structure into the simple task structure as simple.

➜ **3. Make things visible**

Interface should be very clear to user for taking action on the system.

➜ **4. Get the Mappings Right**

Map the object clearly with interface so user can use functionality properly.

➜ **5. Exploit the power of constraints, both natural and artificial**

How a designer needs to embed constraints in the sequence of operations in an interface such that the user is guided to the right sequence choice by reducing the chance of error in choosing the wrong option.

➜ **6. Design for error**

Errors happen when there is a mismatch between User's mental model, designers' understanding of User's mental model; system limitations.

➜ **7. When all else fails, standardize**

In certain situations / contexts wherein the nature of the task is critical , the user needs to be ' forced' to follow a the only choice as given (afforded) by design

Syllabus Topic : Using Toolkits

5.6 Using Toolkits

- Toolkits are used to provide level of abstraction between different objects. Interaction of objects input and output intrinsically linked with screen.
- Toolkits enable the developer to development of interfaces based on entirely new paradigms.

- It help **design, implementation and evaluation** of the interface as per given a specification, given design and evaluates after it is designed.
- Create easy-to-use interfaces and allow the designer to rapidly investigate different designs.
- It also allow non-programmers to create user interfaces.
- It provides portability across different machines and devices and easy to use themselves.
- Examples of toolkit are OSF/Motif, X View for the X Window system, the Macintosh Toolbox and the Software Development Toolkit for Microsoft Windows.
- Using toolkit
  - Easy to interact with OS
  - It manage layout and components of design
  - The quality of interface is good
  - Develop a application in short period of time i.e. Rapid prototyping
  - Easier to incorporate changes motivated by evaluator.
  - Re-use affords investment in high quality tools.
  - Consistency of interface design.
  - Enable collaboration among specialists
  - Less code to write due to component re-use.
  - Better modularization, separation of concerns
  - Tools may abstract complex systems or algorithms.
  - Easier to port an application to different hardware or software environments if device dependencies are isolated in the user interface tool.
- Fig. 5.6.1 shows how the button behaviour changes for each functionality.

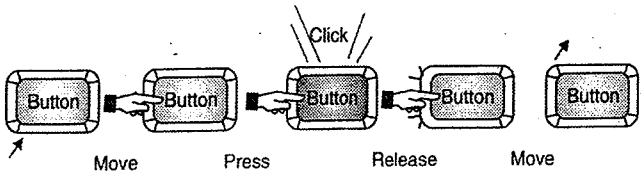


Fig. 5.6.1 : Example of behavior of a button

Syllabus Topic : User Interface Management System (UIMS)

5.7 User Interface Management System (UIMS)

- Availability of so many toolkits, they provide limited range of interaction object.
- Toolkits are providing all functionality, so it needed user interface management system.
- UIMS is inexpensive and very easy to user by non programmers also, as compared to toolkits.
- Toolkits are even difficult use by experienced programmers.
- UIMS is a fully fledged system has set of programming and design techniques. It adds more level of services for deigning interactive system.
- The main purpose of UIMS is
  - It provides conceptual architecture for interactive system design
  - It separates application business logic and GUI or presentation layer.
  - It provides different implementation techniques for separation of application business logic and GUI or presentation layer
  - It supports designing, implementing and evaluating a interactive system

5.7.1 UIMS as a Conceptual Architecture

UIMS conceptual architecture separates semantic or business logic of application from interface provided for user.

☞ **UIMS conceptual architecture improves :**

a) **Portability of application : It** allow user to use the same application on different systems or it supports different OS.

b) **Reusability of interfaces:** It increases the reusability if interfaces in other applications.

c) **Multiple interfaces:** It supports to access same functionality through different interfaces.

d) **Customization** : It supports to customization of user interfaces by designer and the user.

The separation between application business logic and presentation layer, both communicate each other effectively. This communication is referred to as **dialog control**. Conceptual architecture has three major components of an interactive system:

- The application
- The presentation and
- The dialog control.

5.7.2 UIMS Conceptual architectures

(A) Seeheim Model

Seeheim Model is the first conceptual architecture of a UIMS was formulated at a workshop in 1985 at Seeheim, Germany. It has three logical components as follows:

(a) **Presentation :** It is also called as GUI, It is responsible for the appearance of the interface and what output and input is available to the user. It is also responsible for low level input and output.

(b) **Dialog control** : It smoothen the communication between the presentation and the application.

(c) **Application interface** : It separates application and interfaces. It manages communication with the application and provides view of interfaces.

Fig. 5.7.1 shows the block diagram of the Seeheim model.

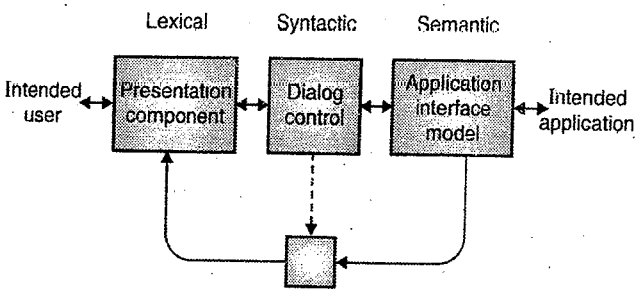


Fig. 5.7.1 : Block diagram of Seeheim model

(B) Smalltalk Based Model

- Smalltalk is based on model–view–controller (MVC) and object oriented paradigm.
- In this, model represents application semantic, view represents graphical interface of application and controller process input request.
- It has ability to build new interactive systems based on existing ones.

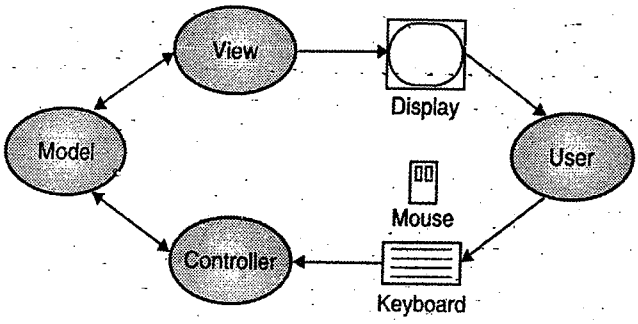


Fig. 5.7.2 : MVC based Smalltalk Model

- It is object oriented based programming model. It is simple and uniform: everything is an object, and objects communicate only by sending each other message.
- Within the context of Smalltalk, objects are implemented in code through encapsulation and polymorphism.
- Encapsulation is the approach used in Smalltalk to bundle everything needed into an object to preserve the integrity of the enclosed data.
- The Smalltalk object model is based on a set of simple rules that are applied uniformly. The rules are as follows:
  - Rule 1: Everything is an object.
  - Rule 2: Every object is an instance of a class.
  - Rule 3: Every class has a superclass.
  - Rule 4: Everything happens by sending messages.
  - Rule 5: Method lookup follows the inheritance chain.

(C) PAC Model (Presentation- Abstraction-Control)

- The Presentation-Abstraction-Control architectural pattern (PAC) defines a structure for interactive software systems in the form of a hierarchy of cooperating agents.

- Every agent is responsible for a specific aspect of the application's functionality and consists of three components: presentation, abstraction, and control shown in Fig. 5.7.3.
- The PAC abstraction component corresponds roughly to the model component of MVC.
- The presentation component in PAC is a combination of the view and control components in MVC.
- The control component of PAC mediates between agents and has no equivalent in MVC.

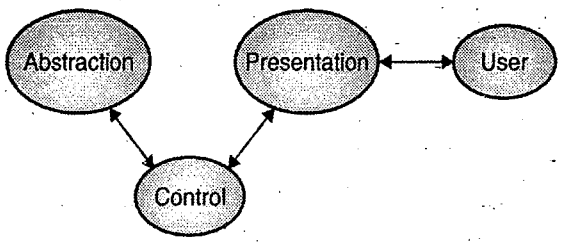


Fig. 5.7.3 : PAC Model

- **Control:** It is similar to the Controller in the MVC architecture. It processes external events and updates the model as well presentation part.
- **Abstraction:** It contains the data, like in MVC. However, it may be just part of the complete data structure of the application, and it does not play an active role in the notification of changes.
- **Presentation**: It is exactly looks like the View of MVC. It displays the information from the Abstraction

5.7.3 Differences between PAC and MVC

PAC	MVC
It groups input and output together.	It separates them.
PAC provides an explicit component for to see that abstraction and presentation are kept constant with each other.	MVC leaving it to the programmer or designer.
is not linked to any gramming environment.	It supports any programming environment.
It easily isolates the control component.	It is not easily isolating the control component.
It is more of a conceptual architecture than MVC.	MVC is less conceptual architecture.

5.7.4 UIMS Implementation Considerations

- UIMS implementation considerations various programming languages, object oriented concepts and techniques.
- Various dialog controller implementation techniques are:
  - (a) Menu networks
  - (b) Grammar notations
  - (c) State transition diagrams
  - (d) Event languages
  - (e) Declarative languages
  - (f) Constraints
  - (g) Graphical specification

Syllabus Topic : Goals of Evaluation

5.8 Goals of Evaluation

The role of evaluation is assessing our designs and tests our systems to ensure that they actually behave as we expect and meet user requirements.

Evaluation has three main goals :

1. To assess the extent and accessibility of the system's functionality: The system's functionality is important in that it must accord with the users requirements. So the design of the system should enable users to perform their intended tasks more easily. The use of the system must be matching the user's expectations of the task.

2. To assess users' experience of the interaction: This includes considering aspects such as:
   - How easy the system is to learn.
   - Its usability.
   - The user's satisfaction with it.
   - The user's enjoyment and emotional response.
3. To identify any specific problems with the system: This includes
   - Unexpected results -> confusion amongst users.
   - Related to both the functionality and usability of the design.

Syllabus Topic : Evaluation Criteria

5.9 Evaluation Criteria

When evaluating the interaction model and interface, there are largely two criteria: **Usability and User experience**

a) Usability

- It refers to the ease of use and learn ability of the user interface. Usability can be measured in two ways, **quantitatively or qualitatively.**
- **Quantitative** assessment often involves task-performance measurements. That is, we assume that an interface is "easy to use and learn" good usability, if the subject is able to show some absolute minimum user performance on typical application tasks.
- The assessment of a given new interface is better made in a comparative fashion against some nominal or conventional interface in terms of relative performance edge.
- Popular choices of such performance measures are task completion time, task completion amount in a unit time (e.g., score), and task error rate.
- For example, suppose we would like to test a new motion-based interface for a Smartphone game.
- We could have a pool of subjects play the game, using both the conventional touch-based interface and also the newly proposed motion-based one.
- We could compare the score and assess the comparative effectiveness of the new interface. The underlying assumption is that task performance is closely correlated to the usability i. e. ease of use and learn ability.
- **Qualitative** evaluations often are conducted together with the quantitative analysis.
- In most cases, quantitative evaluations amount to conducting a usability survey, posing usability-related questions to a pool of subjects after having them experience the interface.
- A usability survey often includes questions involving the ease of use, ease of learning, fatigue, simple preference, and other questions specific to the given interface.

b) User experience

- User experience (UX) is the other important aspect of interface evaluation.
- There is no precise definition for UX. It is generally accepted that the notion of user experience is "total" in the sense that it is not just about the interface, but also something about the whole product/application and even extends to the product family, for example MS Office.
- It is also deeply related to the user's emotions and perceptions that result from the use or anticipated use of the application through the given interface.
- Thus UX evaluation involves a more comprehensive assessment on the emotional response, under a variety of usage contexts and across a family of products/ applications/interfaces shown in Fig. 5.9.1.

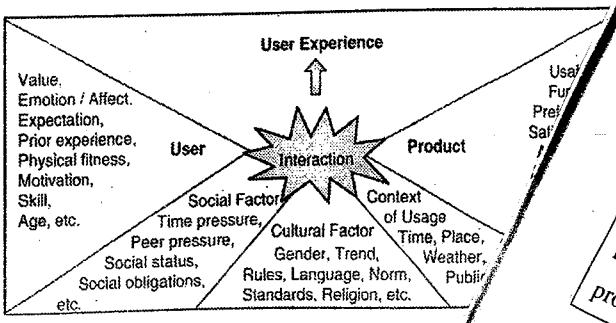


Fig. 5.9.1 : Various aspects of user expe

5.10 Evaluation Through Expert Analysis

There are four types of evaluations conducted by experts or system designers for analysis :

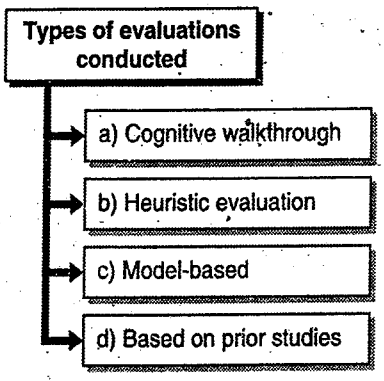


Fig. 5.10.1: Types of evaluations conducted

- Cognitive walkthrough
- Heuristic evaluation
- Model-based
- Based on prior studies

5.10.1 Cognitive Walkthrough

- Cognitive walkthrough Proposed by Polson *et al. The origin of* cognitive walkthrough is based on software engineering code walkthrough.
- Walkthrough means sequence of steps, e.g., "code walkthrough" is when a programmer shows her source code to others and explains, line by line, how the code works Cognitive walk through his when a user explains how he/she is using an interface, talking as he/she per forms each action and explaining as he/she goes then, experts analyze the user's process.
- Cognitive walkthrough used to identify potential problems using psychological principles. For each task cognitive walkthrough considers: What impact will interaction have on user? What cognitive processes are required? What learning problems may occur?
- In order to conduct a cognitive walkthrough, experts need to know four things :
  1. A specification or prototype of the system.
  2. A description of the task the user is to perform on the system..
  3. A complete, written list of the actions needed to complete the task with the proposed system.
  4. An indication of who the users are and what kind of experience and knowledge the evaluators can assume about them.

When evaluator doing cognitive walkthrough, he must try to give answer the following four questions:

1. Is the effect of the action the same as the user's goal at that point?
2. Will users see that the action is available?
3. Once users have found the correct action, will they know it is the one they need ?
4. After the action is taken, will users understand the feedback they get ?

☞ **When to do a Cognitive Walkthrough**

- Cognitive walkthrough Can be done at any stage in the development process once you have a 'prototype' or actual system implementation to work on
  - o Can be done with paper prototype
  - o Can be done with a shrink-wrapped product

5.10.2 Heuristic Evaluation

- Heuristic evaluation proposed by Nielsen and Molich.
- Heuristic evolution typically performed on a design specification so it is useful for evaluating early design, but can also be performed on a prototype or full system. Therefore, 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 critique a system to come up with potential usability problems.
- It is important that there be several of these evaluators and that the evaluations be done independently.
- Nielsen's experience indicates that between three and five evaluators is sufficient, with five usually resulting in about 75% of the overall usability problems being discovered.
- **When to use Heuristic Evaluation :** It can be used very early stage of development and from first sketches and outline descriptions.

- To aid the evaluators in discovering usability problems, a set of 10 heuristics are provided.
- Each evaluator assesses the system and notes violations of any of these heuristics that would indicate a potential usability problem.
- **Heuristic evaluation:** Heuristic is a guideline or general principle or rule of thumb that can guide a design decision or be used to critique a decision that has already been made. 3-5 evaluators is sufficient.
- Severity rating on a scale of 0-4 (less-most)
  - 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

☞ **Ten heuristics or Nielsen's ten heuristics are**

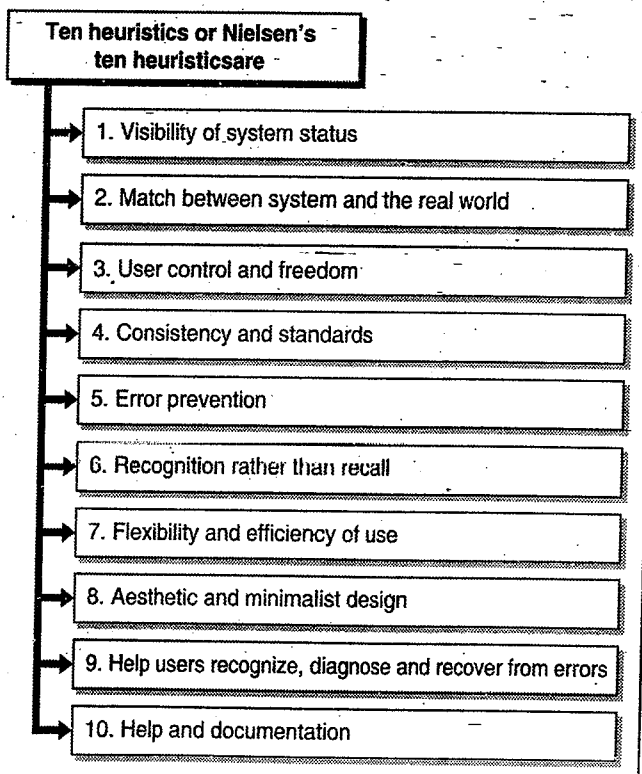


Fig. 5.10.2 : Ten heuristics or Nielsen's ten heuristics

➜ **1. Visibility of system status**

This means the user needs to be constantly made aware of his/her interaction with the interface while interacting.

➜ **2. Match between system and the real world**

Tendency to use programming language and syntax on the display, while understandable to the software programmer, will certainly be a mismatch to a user

➜ **3. User control and freedom**

- It giving users the option to undo a mistake without having to "go through an extended dialogue." It's about empowering your users to be able to fix errors likely caused by navigational mishaps or by clicking on the wrong thing without your intervention.
- It encourages designs to "support undo and redo" which today can also refer to giving users the ability to go back, perhaps without losing information they've already entered, and forward between screens, pages, forms and so on.

➜ **4. Consistency and standards**

- Within an interface if multiple words or actions are used to mean the same thing, it only leads to confusion in the user due to perceived lack of consistency.
- Interaction pattern gets disrupted. When pattern becomes complex, user's cognitive load increases.

➜ **5. Error prevention**

- Errors can happen regardless the level of expertise of the user or familiarity of the interface.
- A good principle of design is to seek out error prone interactions, build in error prevention within the dialogue.

➜ **6. Recognition rather than recall**

- Reduction on cognitive load during the interaction ensures that the user is not asked to rely on means and methods that extract human cost.

- If an interface requires specialized training and use of memory to operate it will be quickly abandoned by the human user

➜ **7. Flexibility and efficiency of use**

- Once a user becomes adept at using an interface , he/she upgrades into a higher level user from a novice. Such users will always seek to complete the task faster.
- An interface needs to allow this. It needs to be flexible and make it possible for the user to adopt quicker dialogues through shortcuts.
- The user feels efficient as well as proficient.

➜ **8. Aesthetic and minimalist design**

- Visual clutter in the interface only adds to inefficiency however impressive it is visually.
- Simplicity is equal to efficiency is equal to elegance is equal to beauty is the aesthetic algorithm in minimalism.
- Use of least number of elements minimalism is more scientific rather than artistic.

➜ **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.
- Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

5.10.3 Model-based Evaluation

- Model based evaluation uses high-level models such as GOMS are used to predict user's performance and low-level models such as Fitts law-keystroke, dialogue timing are used to assess limits of user's performance.
- Dialog models can also be used to evaluate dialog sequences for problems, such as unreachable states, circular dialogs and complexity.
- Models such as state transition networks are useful for evaluating dialog designs prior to implementation.

5.10.4 Based on Prior Studies

- This is a final approach to expert evaluation exploits this inheritance, using previous results as evidence to support (or refute) aspects of the design.
- It is expensive to repeat experiments continually and an expert review of relevant literature can avoid the need to do so.
- Based on prior studies uses empirical models evolved from previous studies give indicators of generic interface elements
- For example, menu types, command name recall, color schemes, button labels, icon designs, etc.

Syllabus Topic : Evaluation Through User Participation

5.11 Evaluation Through User Participation

Evaluation through user's participation means on evaluating a design by users rather than testing with actual user.

User participation in evaluation tends to occur in the later stages of development process when there is at least a working prototype of the system in place.

This may range from a simulation of the system's interactive capabilities, without its underlying functionality.

It can be done at different stages of development.

Evaluation through user participation approaches are:

- Empirical or experimental methods
- Observational methods
- Query techniques

- Methods that use physiological monitoring, such as eye tracking and measures of heart rate and skin conductance

System developers can simulate missing or undeveloped pieces of interface using techniques like "Wizard of Oz" where a human takes the part of the pieces that will later be automated.

Following are the elements of user evaluation

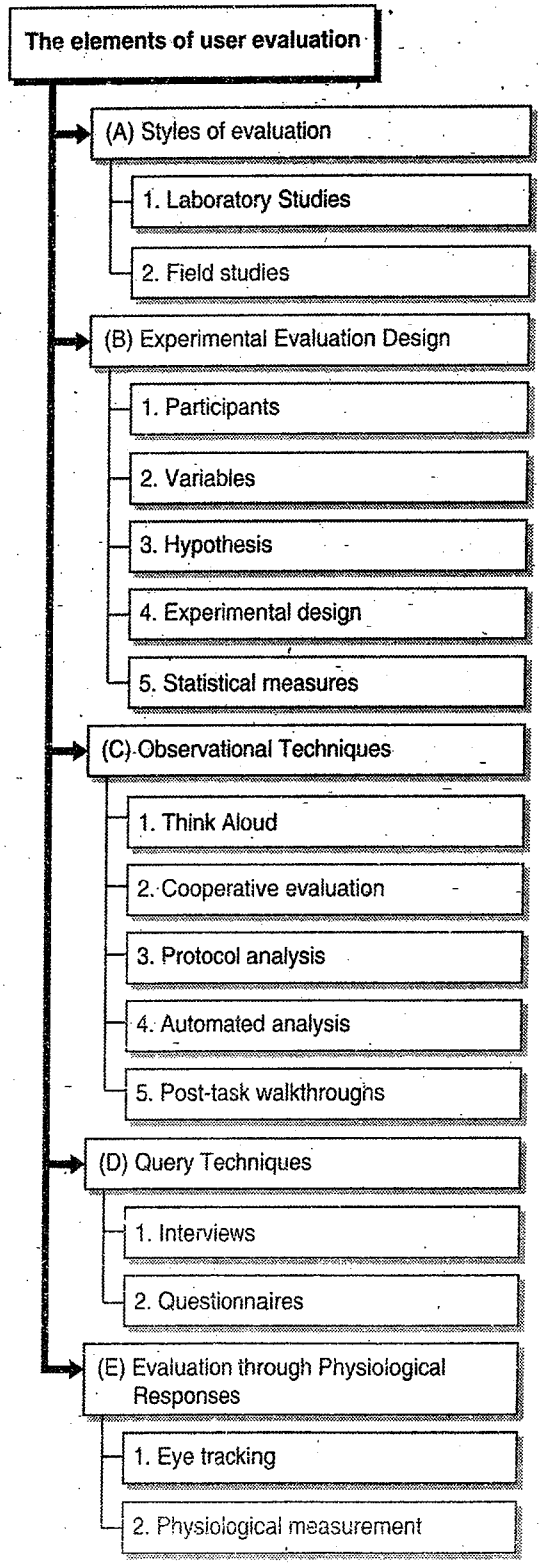


Fig. 5.11.1 : The elements of user evaluation

- Styles of evaluation
- Experimental evaluation design
- Observational techniques
- Query techniques
- Evaluation through physiological responses

5.11.1 Styles of Evaluation

Styles of evaluation have two types

A) Laboratory Studies

B) Field studies

➜ **A) Laboratory Studies**

- Laboratories studies are conducted in controlled settings. In this users are taken out of their normal work environment to take part in controlled tests.
- This requires well-equipped usability laboratory may contain sophisticated audio/visual recording and analysis facilities.

☞ **Advantages**

- Specialist equipment available
- Uninterrupted environment

☞ **Disadvantages**

- Lack of context
- Difficult to observe several users cooperating

➜ **B) Field studies**

- In this designer or evaluator is taken out into the user's work environment in order to observe the system in action.
- Field studies are conducted in "in situ", i.e., in situated settings.
- Field observation is to be preferred to laboratory studies as it allows us to study the interaction as it occurs in actual use.
- Field observations are difficult in high levels of ambient noise, greater levels of movement and constant interruptions, such as phone calls.

- The context is retained and you are seeing the user in his 'natural environment'.
- It is in "open" nature situation means you will observe interactions between systems and between individuals that would have been missed in a laboratory study.
- But some situations Laboratory is required as discussed in above.

☞ **Advantages**

- Natural environment
- Context retained (though observation may alter it)
- Longitudinal studies possible

☞ **Disadvantages**

- Distractions
- Noise

5.11.2 Empirical Methods: Experimental Evaluation Design

- It evaluates design to use controlled experiment. It is controlled evaluation of specific aspects of interactive behaviour.
- Evaluator choose hypothesis to be tested of design. Evaluator considers the number of experimental conditions, which differ only in the value of some controlled variable. Change in behavioural measure attributed to the different conditions.
- The factors affects reliability of system are:

(a) Participants
(b) Variables
(c) Hypothesis
(d) Experimental design
(e) Statistical measures

➜ **a) Participants**

- Choose carefully, to "simulate" actual end users means participants should be chosen to match the expected user population as closely as possible.
- In evaluation experiments, participants should be chosen to match the expected user population as closely as possible.
- This will involve experimental testing with the actual users but this is not always possible.
- If participants are not actual users, they should be chosen to be of a similar age and level of education as the intended user group.
- Size of sample or number of users: usability studies recommend 3-5 users, also called "subjects" and controlled experiments recommend at least twice this number; even more when statistical significance is sought from results.

➜ **b) Variables**

There are two types of variable:

- **Independent variable (IV):** If characteristic changed to produce different conditions. e.g. interface style, number of menu items
- **Dependent variable (DV):** These are measured variable in the experiment. These variables depend in independent variable. e.g. time taken, number of errors

➜ **c) Hypothesis**

- Hypothesis is used to predict the outcome of an experiment.
- It is framed in terms of the IV and DV. e.g. "error rate will increase as font size decreases"

➜ **d) Experimental design**

- Experimental design uses two methods: within group design and between group design.
- In within group design or within subject design each subject performs experiment under each condition. Transfer of is learning possible in within group design. It isless costly and less likely to suffer from user variation.
- In between the group design or between-subjects design each subject performs under only one condition and no transfer of learning happens. More users required for

this type of experimental design. More variation can bias the results.

➜ e) **Statistical measures or Analysis of data**

- It uses two rules: Look at the data and to save the data.
- Choice of statistical technique depends on type of data and information required.
- Type of data are two types:
  - **Discrete Data** - It contains finite number of values
  - **Continuous Data** - It contains any value.
- Types of test has three types:
  - **Parametric test:** It assumes normal distribution of data. It is robust and powerful test type.
  - **Non-parametric:** It does not assume normal distribution. It is less powerful and more reliable.
  - **Contingency table:** It classify data by discrete attributes and count number of data items in each group.
- For example: 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.

Answer :

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

Participants	Taken from user population.
Hypothesis	Color coding will make selection more accurate.
IV (Independent Variable) DV (Dependent Variable) Design	Color coding. Accuracy measured as number of errors. Between-groups to ensure no transfer of learning or within-groups with appropriate **safeguards if participants are scarce.**
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.
Analysis	t test.

5.11.3 Observational Techniques

- Observational technique observing and recording the actions and behaviours of user while interacting with system.
- It gives complete set of predefined task to user and observation is carried out at working place. This may be happens during normal duties of user.
- In this evaluator observe and records the users' actions.
- Following are the Observational techniques:
  1. Think Aloud
  2. Cooperative evaluation
  3. Protocol analysis
  4. Automated analysis
  5. Post-task walkthroughs

➜ 1. **Think Aloud**

- Think aloud is also called as cooperative evaluation method. In this observation technique asked the user to describe what he is doing and why, what he thinks is happening etc. The evaluator can clarify point of confusion.

☞ **Advantages**

- It is simple method requires little expertise.
- It provides useful insight of system
- It show how system is actually work and use

Disadvantages

- This is subjective evaluation, requires more time
- It select one or two functionality as a time

2. Cooperative evaluation

- A variation on think aloud is called as cooperative evaluation. In this user is encouraged to see him as a collaborator. Both user and evaluator can ask each other question throughout.
- Evaluator can ask the user questions typically of the 'why?' or 'what-if ?' type, if his behavior is unclear, and the user can ask the evaluator for clarification if a problem arises.
- This more relaxed view of the think aloud process has a number of advantages :
  - The process is less constrained and therefore easier to learn to use by the evaluator
  - The user is encouraged to criticize the system
  - The evaluator can clarify points of confusion at the time they occur and so maximize the effectiveness of the approach for identifying problem areas.

3. Protocol analysis

In protocol analysis evaluator uses :

(a) Paper and pencil method

- It is cheap, limited to writing speed
- Analysts write down interpretations and unconnected event as they occur.
- It is hard to get details of event due to limited writing speed.

(b) Audio recording

- This is good for think aloud but difficult to match with other protocols.

(c) Video recording

- It is accurate and realistic, needs special equipment usch as camera, obtrusive.
- For getting details of participants, position and angle of camera is important.

(d) Computer logging

- It is automatic and unobtrusive technique. It generates large amounts of data difficult to analyze.
- It provides details of user actions at keystroke level.
- Automated software's are available in market, they provides built-in logging, recording and playback facilities.

e) User notebooks

- It is coarse and subjective, useful insights, good for longitudinal studies.

4. Automated analysis

Automatic protocol analysis tools are provided to automat solutions for protocol analysis. Evaluator use recording of these tools and making a detailed notes to show the users.

The following tools are used for protocol analysis:

a) **Experimental Video Annotator :** It is automated tool used by evaluator. It installed on multimedia workstation and direct link is provided to a video recorder.

b) **Workplace project: It is used to store** different data streams, such as video, audio, notes and diagrams. Evaluator compare the records of each for a given point in the interaction.

c) **DRUM : This as includes** video annotation and tagging facilities. It supports a complete methodology for evaluation, based upon the application of usability metries on analytic metrics, cognitive workload, and performance and user satisfaction. DRUM is concerned particularly with measuring performance. It includes manuals, questionnaires, analysis software and databases.

5. Post-task walkthroughs

- In post-task walkthrough evaluator interviews users after they have completed the experimental interaction with the system, and shows them a video recording of their session and asks them to narrate what they did and why.
- It is useful to identify reasons for actions and alternatives considered. It is necessary in cases where think aloud is not possible.

- The advantage of a delayed walkthrough is that the analyst has had time to frame suitable questions and focus on specific incidents.
- The disadvantage is a loss of freshness.

5.11.4 Query Techniques

Query techniques evaluator asks user directly about the interface. Query techniques can be useful in eliciting detail of the user's view of a system. There are two main types of query technique:

A) Interviews
B) Questionnaires

A) Interviews

- Interviewing users about their experience with an interactive system provides a direct and structured way of gathering information.
- In this analyst questions user on one-to -one basis usually based on prepared questions.
- The level of questioning can be varied to suit the context and that the evaluator can probe the user more deeply on interesting issues as they arise.
- Mostly it follows top-down approach, start from general questions then go in details of leading questions.
- Interviewing is informal, subjective and relatively cheap method.

Advantages

- can be varied to suit context
- issues can be explored more fully
- can elicit user views and identify unanticipated problems

Disadvantages

- very subjective
- time consuming

B) Questionnaires

- Another querying technique is questionnaires. In this fixed set of questions given to users.
- It is less flexible as compared to interview technique, because questions are fixed, but it can reach wider participant group and take less time. Fixed set of questions may be less penetrating.
- It can be analyzed more thoroughly.
- It can be administered at any point in the design process such as during requirements capture, task analysis and evaluation.
- It is used to analyse users need, preferences and experience.

Advantages

- quick and reaches large user group
- can be analyzed more rigorously

Disadvantages

- less flexible
- less probing

Questionnaire includes the following types of questions

- **General Questions :** It includes questions about age, sex, occupation, place of residence, previous experience, and so on.
- **Open Ended Questions :** It includes unprompted opinion on a question or open ended questions on current situations and they are useful for gathering general subjective information but are difficult to analyze in any rigorous way, or to compare, and can only be viewed as supplementary
- **Scalar Questions :** It includes the questions, which is evaluated based on numeric scale. Scales of 1 to 5 or 1 to 7 have been used effectively.

  For example,

  It is easy to recover from mistakes.

  Disagree 1 2 3 4 5Agree
- **Multi-choice Questions :** It includes multiple choice questions and select only one or multiple response for such

questions. For example: How do you most often get help with the system (tick one)?

- Online manual ☐
- Contextual help system ☐
- Command prompt ☐
- Ask a colleague ☐

– **Ranked Questions:** This contains item list and user has to give preferences to each item list. For example: Please rank the usefulness of these methods of issuing a command (1 most useful, 2 next, 0 if not used).

- Menu selection ☐
- Command line ☐
- Control key accelerator ☐

5.11.5 Evaluation through Physiological Responses

– Applications involving the measurement of human physiological responses are becoming increasingly popular in Human Computer Interaction (HCI). This is partly due to the increased availability of low-cost, high specification sensing technologies.

– Areas such as brain computer interaction, evaluation and affective computing are all benefiting from the rich data source such sensing technologies make available.

– One of the problems with most evaluation techniques is that we are reliant on observation and the users telling us what they are doing and how they are feeling. For this purpose medical devices are used to record user's physiological responses while using interface.

– Currently two methods are used to record user's physiological responses :

a) Eye tracking

b) Physiological measurement

➜ **a) Eye tracking**

– Recent improvements in hardware and software have made it very easy for **Eye tracking for usability evaluation.**

– Modern systems are using a head-mounted camera to monitor the eye.

– Recently there have been rapid improvements in the software available both for the control of eye-tracking equipment and the analysis.

– These software are produces large volumes of data.

– For eye movement measurement head or desk mounted fixed equipment tracks the position of the eye.

– Eye movement reflects the amount of cognitive processing a display requires.

– Eye measurement includes

- **Fixations :** Eye maintains stable position. Number and duration indicate level of difficulty with display
- **Saccades** : Rapid eye movement from one point of interest to another.
- **Scan paths :** moving straight to a target with a short fixation at the target is optimal scan path.

➜ **b) Physiological measurement**

– Physiological measurements means to measure changes in heart rate, breathing and skin secretions.

– Emotional response of user linked to physical changes, these may help determine a user's reaction to an interface.

– It can be measure by attaching various sensors and probes to user.

Measurement includes :

– **Heart activity:** It measure blood pressure, volume and pulse. It can find stress or anger.

– **Sweat glands activity:** It measure Galvanic Skin Response (GSR). It can indicate levels of arousal and mental effort.

– **Electrical activity in muscle:** It measure electromyogram (EMG) of muscles. It can reflect involvement in a task.

- **Electrical activity in brain:** It measures electroencephalogram (EEG) of brain. It can gives decision making, attention and motivation.

There are some difficulty in interpreting these physiological responses, these may be differ form person to person and situation to situation. There is no clear relationship between these events and measurement.

5.12 Choosing an Evaluation Method

Various techniques are available for evaluating an interactive system. Factors distinguishing evaluation techniques:

- At design time vs. implementation time
- Laboratory evaluation vs field evaluation
- Subjective vs objective evaluation
- Type of measures: qualitative vs. quantitative
- Level of information: high level vs. low level
- Level of interference: obtrusive vs. unobtrusive
- resources available: time, subjects, equipment, expertise

5.12.1 Factors distinguishing evaluation techniques

There are 8 factors to take into consideration when choosing the appropriate evaluation technique :

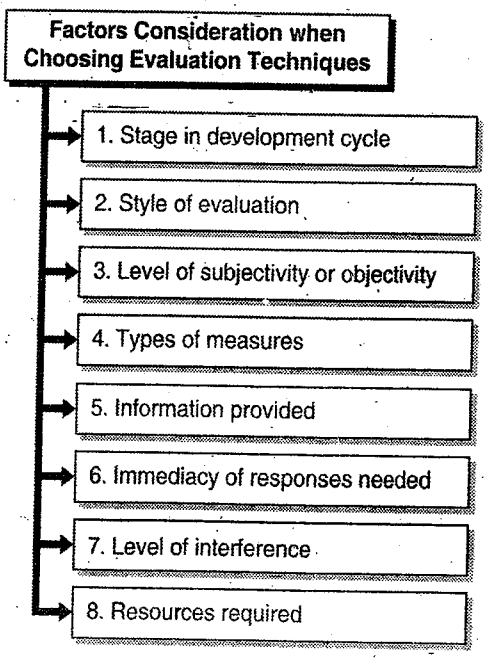


Fig. 5.12.1 :Factor Consideration when choosing the Evaluation technique

➜ **1. Stage in development cycle i.e design vs implementation**

- **Design** (early) versus **implementation** (late) stage is considered.
- Early stage should be quick and cheap
- In design stage involves experts only, but at the implementation stage developer and needs users participation.
- This factor reduces cost and time

➜ **2. Style of evaluation**

- Laboratory versus field study are used.
- Laboratory studies are in controlled environment for experimentation and observation at user's environment.

➜ **3. Level of subjectivity or objectivity**

- How much will results rely on the (subjective) interpretation of the evaluator?
- Subjective techniques are used for cognitive walkthrough and think aloud.
- It is depends of evaluator knowledge and expertise. Subjective techniques are powerful evaluation techniques, if used properly. It also provides information to objective techniques.
- Objective techniques may produce repeatable results, which are not dependent on the persuasion of the particular evaluator.
- Ideally, both objective and subjective approaches should be used

➜ **4. Types of measures**

- Quantitative versus qualitative versus mixed methods are used.
- The type of measure is related to the subjectivity or objectivity of the technique.
- Subjective techniques are provides **qualitative measures** and objective techniques are provides **quantitative measures.**

➜ **5. Information provided**

- The level of information required from an evaluation may also vary from low level to high level.
- The low-level information enables evaluator to take a design decision at design stage such as which font is most readable.
- In higher-level information enables the evaluator to which interface is required, such as 'Is the system usable?'.
- For this purpose would require interviews, questionnaires, etc.
- Low-level information evaluation technique, such as controlled experiments is excellent and higher-level information techniques are used to gathered information using questionnaire and interview techniques, which provide a more general impression of the user's view of the system.

➜ **6. Immediacy of responses needed**

- Are evaluation results needed immediately, at the time of the experiments? then use something like a "walkthrough" or interview
- Are results needed later? then use techniques that require analysis, such as computer logs or user logs

➜ **7. Level of interference**

- How intrusive is the evaluation process?
- The evaluation should NOT impact how the user uses the interface.
- Most immediate evaluation techniques are **intrusive**, with the exception of automatic system logging.

➜ **8. Resources required**

- The final consideration when selecting an evaluation technique is the availability of resources.
- Resources to consider include equipment, time, money, participants, expertise of evaluator and context.
- How much time, money, personnel is required to conduct the evaluation?

5.12.2 A Classification of Evaluation Techniques

Using the factors discussed in the previous section we can classify the evaluation

☞ **Techniques based on this**

- Classification of analytic evaluation techniques
- Classification of experimental and query evaluation techniques
- Classification of observational evaluation techniques
- Classification of monitoring evaluation techniques

The summary of each classification techniques are shown in below tables.

☞ **Classification of analytic evaluation techniques**

- It contains four evaluation techniques cognitive walkthrough, heuristic evaluation, review based and model based
- Cognitive walkthrough and heuristic evaluation applicable to all stages of software development.
- Review based and model based applicable only design phase.
- All are done in Laboratory.
- Cognitive walkthrough and heuristic evaluation are measure by qualitative and review based at source.
- All requires medium time to complete
- Less equipments are required
- Expert developers are needed cognitive walkthrough and model based

☞ **Classification of experimental and query evaluation techniques**

- It contains three evaluation techniques: Experiment, Interview and Questionnaire
- Experiment can be done in laboratory and interviews and questionnaire as actual field Experiments evaluation measure by quantitative and other are measure by qualitative as well as quantitative
- For evaluation requires high level information

Classification of observational evaluation techniques

- It contains three evaluation techniques: Think aloud, protocol analysis and post-task walkthrough
- It can be evaluated either laboratory or field
- It can measure evolution through qualitative
- It can be evaluated in low information also

Classification of monitoring evaluation techniques

- Two types of monitoring evaluation techniques: eye tracking and physiological measurement
- This is used in implementation time
- It uses laboratory type style
- It uses quantitative measure for evaluation
- It works on low level information
- Time required medium for development and expert evaluators are required.

❑❑❑

UNIT VI

CHAPTER 6

HCI Models and Theories

Syllabus Topics

- Goal and task hierarchy model
- Linguistic model
- Physical and device models
- Cognitive architectures,
- Hierarchical task analysis (HTA)
- Uses of task analysis
- Diagrammatic dialog design notations
- Computer mediated communication
- Ubiquitous Computing
- Finding things on web Future of HCI.

6.1 Introduction

- The objective of the unit is to learn, understand and apply HCI model representation to interdisciplinary applications. The representations of models are given for understanding, design and apply. Representation of differs from
  1. Application to application
  2. Technique to technique
  3. Methodology to methodology
  4. Model of high level goal to result of problem solving activities i.e. motor level activities such as keystroke, touch screen or mouse click.
- The basic foundation of models has been developed by computer scientist, computer researchers and by psychologists.
- The cognitive models are classified based on features such as **Competence Model** and **Performance Model.**
- **Competence Model** : These models represent expected behaviour but they provide very little help for analysing of behaviour of system. They can predict expected behaviour sequence of activities but without reference to actual sequence of activities executed by user.
- **Performance Model:** It is used to represent and analyse routine behaviour of model. It describes user needs, behaviour sequences activities and how this is employed in actual task execution.

☞ **Cognitive models are represented following ways**

1. **Hierarchical representation of the user's Task and Goal Structure Model**

2. **Linguistic and Grammatical Models**
3. **Physical and Device-Level Models**
4. **Cognitive Architectural Model**

Syllabus Topic : Goal and Task Hierarchy Model

6.2 Goal and Task Hierarchy Model

→ **(SPPU - Dec. 2017)**

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

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

(ii) To close a window in a graphical text editor

SPPU - Dec. 2017, 9 Marks

- The basic of this model understands the given problem or task, through mental processing user achieves sub goals. To solve sub goals by using divide-and-conquer method.

☞ **Goals, Tasks and Actions**

- **Goal :** state of a system that the human wishes to achieve using some device
- **Tasks :** activities required to achieve a goal. The device selected to achieve the desired goal determines the tasks and their level of complexity
- **Actions :** physical interaction with a device. Task involving no problem solving

☞ **For Example**

- Goal is to produce sales report of Data structure book or any book
- How achieve this goal
  1. Divide the goal in to several sub goals
  2. Gather all data related to sub goal
  3. Produce the layout of table and histogram
  4. Write the description
  5. Continue still end of all sub goals

- Pseudo code structure of example

```
produce report
    gather data
  find book names
  do keywords search of names database
  ... further sub-goals
  Sift through names and abstracts by hand
  ... further sub-goals
  search sales database - further sub-goals
        layout tables and histograms - further sub-goals
write description - further sub-goals
```

6.2.1 Issues for Goal Hierarchies

- Granularity issues are Where do we start? and Where do we stop? of goal hierarchies.
- Second issue is routine behaviour of model and solving problem of unit task.
- Another issue is conflict of goal achievement in more than one way.
- Last issue is generally not good predictors of imperfect use of the system or generates errors.

6.2.2 Techniques for Goal and Task Hierarchies

Three techniques are used :

1. **GMOS :** Goals, Operators, Methods and Selection
2. **CCT :** Cognitive Complexity Theory
3. **HTA :** Hierarchical Task Analysis

1 GMOS

- Card, Moren and Newell (CMN- GOMS) gives theory of GOMS for human information processing, user's behaviour are analyzed in four elements : Goals, Oprators, Methods and Selection.
- Objective of GOMS model is to built a cognitive task analysis and to compare user interface design.

(i) Goals

- These are users goal
- What the user wants to achieve
- Goals are memory points for user, it used to remember which user can evaluating, what should be done and which error should be return.

(ii) Operators

- Operators are used for performing basic operations or actions by user.
- Operators are the lowest level of analyst and it affects the user's mental state or the system.

(iii) Methods

- Decomposition of a goal into sub goals/operators
- For example windows manager close the current window or dialog box may ways such as close option from pop up menu or pressing the function key.
- GOMS has two goal decompositions methods
  1. CLOSE-METHOD
  2. L7-METHOD

```
GOAL : ICONIZE-WINDOW
  [Select GOAL : USE-CLOSE-METHOD
  MOVE-MOUSE-TO-WINDOW-HEADER
  POP-UP-MENU
  CLICK-OVER-CLOSE-OPTION
                    GOAL : USE-L7-METHOD
  PRESS-L7-KEY]
```

- For a particular user, U1:So here we have one Goal with either of two Methods, one of which requires a sequence of three Operators, the other requires just one Operator; for U1 we have 2 Selection rules

Rule 1 :	Select USE-MENU-METHOD unless another rule applies
Rule 2 :	If the application is GAME, select CTRL-W-METHOD

(iv) Selection

- Selection rules allows users to pick a solution among available options. Selecting an appropriate solution depending on scenario is more useful than methods and events.

GOMS Example

➢ **Example 1 :** Three alternative methods: drag-to-trash, delete-key, or right-click. Within the delete-key method we have alternative sub-goals: confirm with keyboard or confirm with mouse

```
GOAL: DELETE-FILE
  LOCATE-FILE
  MOVE-CURSOR-OVER-FILE
  [SELECT GOAL : DRAG-TO-TRASH-METHOD
  HOLD-MOUSE-BUTTON-DOWN
  LOCATE-TRASH-ICON
  MOVE-CURSOR-TO-TRASH-ICON
  VERIFY-TRASH-IS-REVERSE-VIDEO
  RELEASE-MOUSE-BUTTON
  GOAL: USE-DELETE-KEY-METHOD
    CLICK-ON-FILE
    PRESS-DELETE-KEY
    LOCATE-CONFIRM-YES
    [SELECT GOAL : CONFIRM-YES-KEYBOARD
                   -METHOD PRESS-Y-KEY
    GOAL : CONFIRM-YES-MOUSE
                   -METHOD
    MOVE-CURSOR-OVER-YES
                   -BUTTON
    CLICK-ON-YES-BUTTON]
  GOAL : USE-RIGHT-CLICK-OPTION-METHOD
    RIGHT-CLICK-ON-FILE-AND-HOLD-DOWN
    LOCATE-DELETE-OPTION
    MOVE-CURSOR-OVER-DELETE-OPTION
    RELEASE-MOUSE-BUTTON
    LOCATE-CONFIRM-YES
    ...
```

Selection

- It is used as to choose competing methods.
- GOMS predict methods based on state of the system, goals and user.
- For example, a user, U1, never uses the L7-METHOD, except for one game, 'blocks', where he mouse needs to be used in the game until the very moment the key is pressed. GOMS captures this in a selection rule for user U1:

Rule 1 : Use the CLOSE-METHOD unless another rule applies.

Rule 2 : If the application is 'blocks' use the L7-METHOD.

➢ **Example 2 :** Three Alternative Methods To A Close A Window: Press-Icon To-Close-Mousekey-Method, Use-Alt+Space+C-Key-Keyboard-Method, Use-Alt+F4-Key-Method.

GOAL: CLOSE-WINDOW
LOCATE-WINDOW
MOVE-CURSOR-OVER-CLOSE ICON
[SELECT GOAL : PRESS-ICON TO-CLOSE-MOUSEKEY METHOD
HOLD-MOUSE-BUTTON-DOWN
RELEASE-MOUSE-BUTTON.
[SELECT GOAL : CONFIRM-YES-KEYBOARD-METHOD
PRESS-Y-KEY
GOAL : CONFIRM-YES-MOUSE-METHOD
MOVE-CURSOR-OVER-YES-BUTTON
CLICK-ON-YES-BUTTON]
GOAL : USE-ALT+SPACE+C-KEY-KEYBOARD-METHOD
CLICK-ON-FILE
PRESS- ALT+SPACE+C-KEY
[SELECT GOAL : CONFIRM-YES-KEYBOARD-METHOD
PRESS-Y-KEY
GOAL : CONFIRM-YES-MOUSE-METHOD
MOVE-CURSOR-OVER-YES-BUTTON
CLICK-ON-YES-BUTTON]
GOAL : USE-ALT+F4-KEY-METHOD
CLICK-ON-FILE
PRESS- ALT+F4-KEY
[SELECT GOAL : CONFIRM-YES-KEYBOARD-METHOD
PRESS-Y-KEY
GOAL : CONFIRM-YES-MOUSE-METHOD
MOVE-CURSOR-OVER-YES-BUTTON
CLICK-ON-YES-BUTTON]

Advantages of GOMS

- Gives qualitative & quantitative measures
- Model explains the results
- Less work than user study
- Easy to modify when UI is revised
- tools to aid modeling process since it can still be tedious

Disadvantages of GOMS

- Takes lots of time, skill, & effort
- Only works for goal-directed tasks
- Assumes tasks performed by experts without error
- Does not address several UI issues such as readability, memorizability of icons, commands

2. Cognitive Complexity Theory (CCT)

- This is an extension of the GOMS model which provides improved prediction
- Goal of CCT is to decompose goals and provide details of improved prediction. The main aim of CCT is to measure the complexity of the interface.
- It allows user to model GOMS like hierarchies and model concurrent goals since more than one rule can be matched at the same time.
- It is used to predict the difficulties when translating from the user's model to the system model.
- It provides two parallel descriptions
  - Of the user's goals
  - Of the system
- The descriptions of goals consist of a series of production rules of the form, if **condition** then **action.** Production rules are sequence of rules and they are stored in long term

memory. Here, if condition is true then fire action and actions may be keystrokes or change in memory.

- For writing rules a LISP-like language are used.
- Let's look at the description of how we would insert a missing space in text using the *vi* text editor. The production rules are :

```
(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) ))
```

- How these rule works : User has just seen the typing mistake but contains of working memory are

```
(GOAL perform unit task)
(TEXT task is insert space)
(TEXT task is at 7 27)
(CURSOR 7 9)
```

Here

- **TEXT:** It is manuscript text for editing.
- **CURSOR:** It is the position on the line where is typing mistake.

☞ **Four Rules for inserting a Space**

SELECT-INSERT-SPACE

INSERT-SPACE-DONE

INSERT-SPACE-1

INSERT-SPACE-2.

- In above example first rule is used it is fire and action is performed. Action adding more information to working memory shown in Fig. 6.2.1.

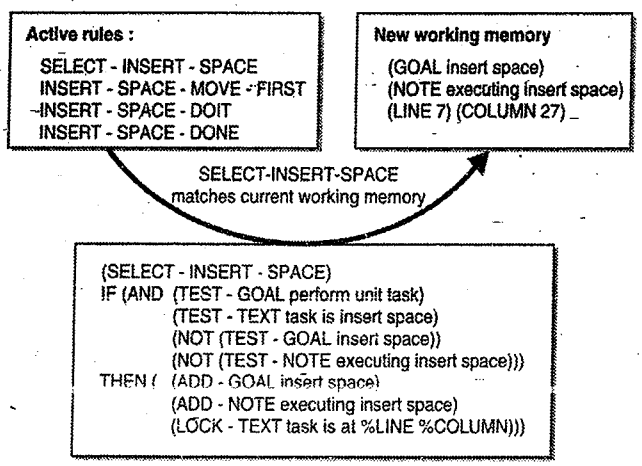


Fig. 6.2.1 : Contents of working memory after action

6.2.3 Problems and Extensions of Goal Hierarchies

- It is uses a post hoc technique: It generates goal structure based on preexisting manual procedure.
- Expert users versus novice users
- **For example :** The early ATMs gave the customers the money before returning their cards. Unfortunately, this led to

many customers leaving their cards behind. This was despite on-screen messages telling them to wait. This is referred to as a problem of ***closure***.

- The user's principal goal is to get money; when that goal is satisfied, the user does not complete or close the various subtasks which still remain open :

```
GOAL: GET-MONEY
    GOAL: USE-ATM
    INSERT-CARD
    ENTER-PIN
    ENTER-AMOUNT
    COLLECT-MONEY
        <<outer goal now satisfied goal stack popped >>
    COLLECT-CARD – subgoal operators
                missed
```

Syllabus Topic : Linguistic Model

6.3 Linguistic Model

- Linguistic model is used to understand the user's behaviour and cognitive difficulty based on analysis of language between user and system. It is user's interaction with a computer is similar to a language.
- Therefore, several modeling techniques have been built on interaction as a language and similar in emphasis to dialogue models such as
  - Backus–Naur Form (BNF)
  - Task–Action Grammar (TAG)

6.3.1 BNF (Backus–Naur Form)

- Backus-Naur Form was originally developed to describe the syntax of programming languages
- It gives a purely syntactic view of the dialogue.
- It can be used equally to describe the interaction between a user and a computer.
- BNF represents the users action but not the systems responses
- The complexity of the description provides a crude measure of the complexity of the task
- BNF is also a good way to unambiguously specify how a user interacts with a system
- It has mainly two parts : Terminals and Non-terminals.

☞ **Terminals consists of**

- shown in upper case letters
- lowest level of user behaviour

  e.g. CLICK-MOUSE, MOVE-MOUSE
- Non-terminals consists of
- shown in lower case letters
- ordering of terminals
- higher level of abstraction

  e.g. select-menu, position-mouse
- Only non-terminals may appear on the left of a definition

- **For example,** consider the case of drawing a line in a graphics system.

☞ **Basic syntax**

Non-terminal ::= expression

☞ **An expression**

- contains terminals and non-terminals
- combined in sequence (+) or as alternatives (|)

Rules for above examples are

```
draw-line        ::= select-line + choose-points + last-point
select-line      ::= position-mouse + CLICK-MOUSE
choose-points    ::= choose-one | choose-one + choose-points
choose-one       ::= position-mouse + CLICK-MOUSE
last-point       ::= position-mouse + DOUBLE-CLICK
                     -MOUSE
position-mouse   ::= empty | MOVE-MOUSE + position-mouse
```

Where

'::=' symbol is read as 'is defined as'.

In above example,

- Rule 1 express that the non-terminal **draw-line** is defined to be **select-line** followed by **choose-points** followed by **last point**. All of these are non-terminals, that is they do not tell us what the basic user actions are.
- Rule 2 express that **select-line** is defined to be **position mouse** followed by **CLICK-MOUSE**. This is our first terminal and represents the actual clicking of a mouse.
- Rule 3 called **choose-points** recursively. In this **choose-one** is express that **position-mouse** followed by **CLICK-MOUSE**.
- Last rule **position of mouse** has two possibilities first one is **empty** and another one is **MOVE-MOUSE** action followed by **position-mouse.**

Measurements with BNF

- Number of rules (not so good) defined, more number of rule means more complicate the model.
- Count number of + and | operators, if operators are more it complicates signal rule.
- Another complexity measures is for the language as a whole.
- Other than this other complications in BNF are
  - same syntax for different semantics
  - no reflection of user's perception
  - minimal consistency checking
- Limitation of BNF is no reflection of user's perception

6.3.2 Task–Action Grammar

- BNF can represent the structure of a language, it cannot represent the consistency in commands or any knowledge the user has of the world. The task-action grammar (TAG) addresses both of these problems.
- TAG deals with problem like consistency and user world knowledge.

Example of Consistency in TAG

- Write a consistency for unix CP, MV and Ln command. Consider each command has two forms and each form has two arguments, a source and destination.
- BNF and TAG representation are

Description of the UNIX commands for BNF is.

```
copy    ::=  'cp' + filename + filename
         |   'cp' + filenames + directory
move    ::=  'mv' + filename + filename
         |   'mv' + filenames + directory
link    ::=  'ln' + filename + filename
         |   'ln' + filenames + directory
```

Description of the UNIX commands for TAG is

```
file-op[Op] := command[Op] + filename + filename
             | command[Op] + filenames + directory
command[Op=copy] := 'cp'
command[Op=move] := 'mv'
command[Op=link] := 'ln'
```

TAG description prediction the complex better than actual learning and performance also better than BNF. In TAG, this consistency of argument order can be made explicit using a parameter, or semantic feature for file operations. Other features of TAG are, for talking about 'world knowledge' and users existing knowledge.

Syllabus Topic : Physical and Device Models

6.4 Physical and Device Models

It has two models:

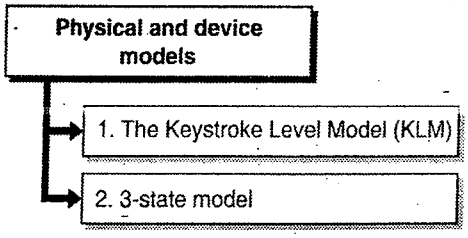


Fig. 6.4.1 : Physical and device models

6.4.1 The Keystroke Level Model (KLM)

This model working based on empirical knowledge of human motor System. The User's task first acquisition and then executed. Based on understanding, it details the predictions about user performance. These only address execution and it is complementary with goal hierarchies.

- **KLM decomposes physical, cognitive and perceptual actions during a task into fundamental keystroke sequence.**
- It measures the time required for each keystroke and we can predict the total time of completing a task.
- Multiple methods can be compared based on the total time to complete a task in order to determine which is the most efficient method for accomplishing the task is.
- KLM is used for modeling simple interaction sequences on the order of a few seconds.
- It does not extend to more complex operations such as producing an entire diagram.
- The model decomposes actions into 5 motor operators, a mental operator and a response operator

In this the task is split into two phases : Acquisition of the task and Execution of the task.

The model decomposes the execution three phases into seven different operators are:

Physical motor operators

- **K – keystroking operator**, i.e. striking keys, including shifts and other modifier keys.
- **B- Button** i.e. Pressing a mouse button.
- **P – pointing**, i.e. A mouse button.
- **H – homing**, switching the hand between mouse and keyboard.
- **D – drawing** lines using the mouse

A mental operator

- M - mental preparation for a physical action.
- A system response operator
- R – System response which may be ignored if the user does not have to wait for it, as in copy typing.

For Example : Consider using a mouse based editor to correct a single character error.

- Point at the error
- Delete the character
- Retype it
- Return to the previous typing point

The following notation will capture this

1.	Move hand to mouse	H[mouse]
2.	Position after bad character	PB[LEFT]
3.	Return to keyboard	H[keyboard]
4.	Delete character	MK[DELETE]
5.	Type correction	K[char]
6.	Reposition insert point	H[mouse]MPB[LEFT]

- Timings for individual operations can be measured and these timings can then be summed to create the total time for the overall operation time.
- Alternative ways of performing an action can have their times computed and compared to find which one is more efficient.
- For example, if the time taken for one keystroke is t_K, then the total time doing keystrokes is $T_K=2t_K$.
- Similar calculations for the rest of the operators give a total time of

$$T_{execute} = T_K+T_B+T_P+T_H+T_D+T_M+T_R$$
$$= 2t_K+2t_B+t_P+3t_H+0+2t_M+0$$

6.4.2 3-state model

- Buxton has developed a simple model for input devices such as mice, trackballs, and light pens are called three-state mode.
- These mice, trackballs, and light pens all behave differently as far as the user is concerned.
- The three-state model is used to capture the behaviour of these devices
- **State 1**
  - Moving the mouse with no buttons pressed
  - This usually moves the pointer on the screen
- **State 2**
  - Depressing a button over an icon and then moving the mouse
  - This is usually thought of as dragging an object
- **State 0**
  - This is for a light pen when it is not touching the screen
  - In this state the location of the pen is not tracked at all

Fig. 6.4.2 shows 2 state model.

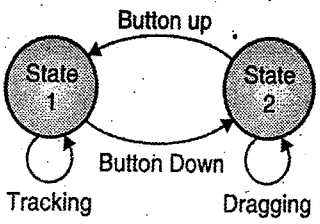


Fig. 6.4.2 : A simple 2 state model

Fig. 6.4.3 shows 0-1 state model..

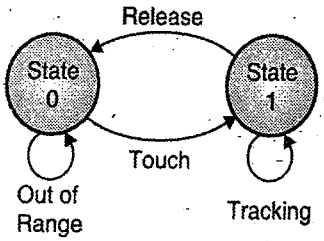


Fig. 6.4.3 : State 0-1 Transaction

- A touch screen behaves like a light pen with no button to press
- This means that a touch screen is in state 0 when the finger is off the screen
- When the finger touches the screen, it can be tracked and is in state 1

Thus,

- a touch screen is a state 0-1 device
- A mouse is a state 1-2 device

Assume a graphics tablet with stylus. In State 0, the stylus is off of the tablet and the tip switch in its open state. Moving the stylus has no effect since it is out of range (OOR). When the stylus is in range, the tracking symbol follows the stylus' motion (State 1: tracking). Extra pressure on the stylus closes the tip switch, thereby moving the system into State 2.

There are, however, transducers that are capable of sensing all three states. A graphics tablet with a stylus would be one example.1 This is illustrated in Fig. 6.4.4.

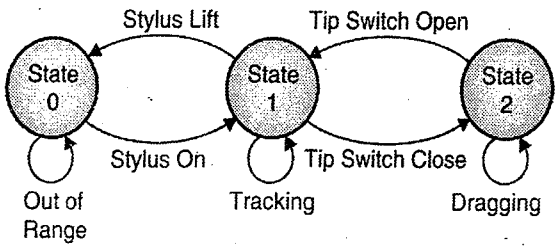


Fig. 6.4.4 : State 0-1-2 Transaction

Syllabus Topic : Cognitive Architectures

6.5 Cognitive Architectures or Architecture Model

- The models we have looked at up to this point have implied a model of the mental processes of the user
- For example, GOMS used a divide and conquer approach
- Task model has three components: **the architecture, task knowledge, and a dynamic task environment** shown in Fig. 6.5.1.

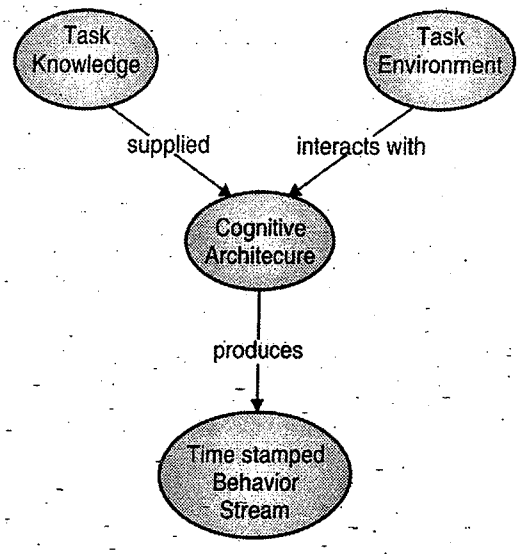


Fig. 6.5.1 : Structure of a model based on a cognitive architecture

It has two architectural models as follows :

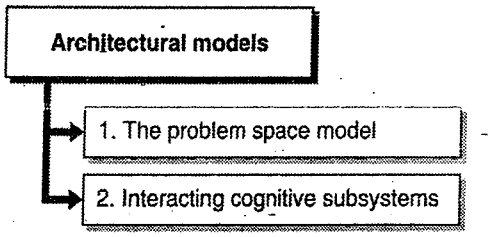


Fig. 6.5.2 : Architectural models

6.5.1 The Problem Space Model

- Problem solving is a search for a goal using available operators like GOMS. The problem space theory was important to AI in the 70's.
- Rational behaviour is defined as behaviour directed to achieving a specific goal.

- This is the behaviour you would expect of a human or a **knowledge based system.**
- This is in contrast to the problem solving modeled as a search of a solution space until a solution is found
- This search is performed by traversing the space until a solution is found.
- This is a brute force search and is not rational behaviour in seeking a solution to a goal
- This model can be adapted to the rational behaviour of humans
- A problem space consists of
  - A set of states
  - A set of operations to go from one state to another
  - A goal is a subset of states which must be reached for the goal to be achieved
  - To solve a problem in this model
  - Identify the current state
  - Identify the goal
- Devise a set of operations which will move from the current state to the goal state
- This model is inherently recursive
- If you cannot find the operations to achieve the goal then this becomes a new recursive problem to be solved

6.5.2 Interacting Cognitive Subsystems(ICS)

- ICS is model of perception, cognition and action of the resources underling human cognition
- This model is based on 9 subsystems, each with its own type of coding.
- Some deal with sensory perception - auditory and visual. Some deal with language processing.
- The mind is simultaneously individual, and reaches beyond the individual, when the implicational sub system is dominant.
- This happens at high and at low arousal and there is a constant balancing act between logic and emotion – human fallibility
- Mindfulness is a useful technique to manage that balance.
- There are two higher order systems: the propositional and the implicational shown in Fig. 6.5.3.

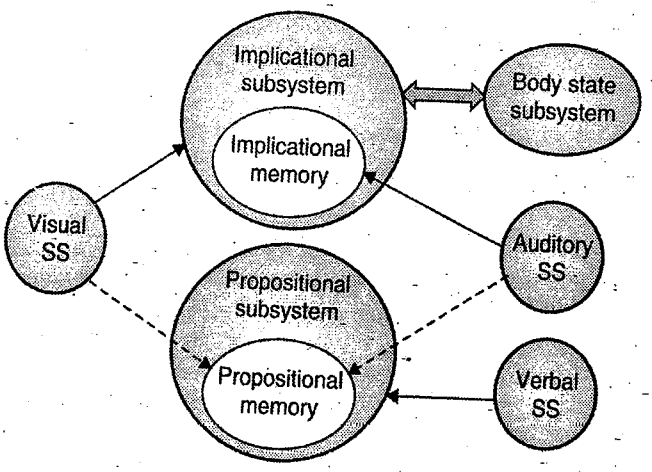


Fig. 6.5.3: Higher order systems

The Propositional Subsystem

- It uses Verbal coding and manages logical thought called "cool cognition"
- Verbally coded memory store integral to the subsystem.
- Communicates directly only with the other language subsystems.
- Intercommunication between it and the implicational subsystem = "Central Engine of Cognition

Implicational Subsystem

- It coded in all modalities - memory and current processing. It concerned with meaning and significance.
- Information about threat and value
- Particularly concerned with the status of the self.

- Directly connected to sensory and body subsystems
- The IMPLICATIONAL Subsystem manages emotion – and therefore relationship.
- The verbal, logical, PROPOSITIONAL sub system gives us our sense of individual self.

Syllabus Topic : Hierarchical Task Model (HTA)

6.6 Hierarchical Task Analysis (HTA)

(SPPU - Dec. 2017)

Q. A hierarchical task analysis (HTA) provides an understanding of the tasks user need to perform to achieve certain goal. Perform HTA of the task to cook food (rice). Illustrate using diagram.

SPPU - Dec. 2017, 9 Marks

- HTA was developed by John Annett & Keith Duncan 1967.
- It is most suitable for analysing tasks that have a well-defined structure – that is, tasks which tend to be performed in similar ways every time, rather than those that have a very loose structure.
- HTA involves describing the task in terms of a task-subtask hierarchy and a set of plans that define in what order subtasks may be performed, or under what circumstances particular subtasks are performed at all.
- HTA involves breaking a task down into subtasks, then sub-sub-tasks and so on. These are grouped as plans which specify how the tasks might be performed in practice.
- HTA focuses on physical and observable actions, and includes looking at actions not related to software or an interaction device.
- It starts with a user goal which is examined and the main tasks for achieving it are identified.
- For example: You want to buy DVD from market. Hierarchy description as follows:
- Textual Representation of HTA
  1. Buy a DVD
  2. Locate DVD
  3. Add DVD to shopping basket
  4. Enter payment details
  5. Complete address
  6. Confirm order

  Plan 0 : If regular users do 1-2-5.

  If new users do 1-2-3-4-5.
- Graphical Representation of HTA.

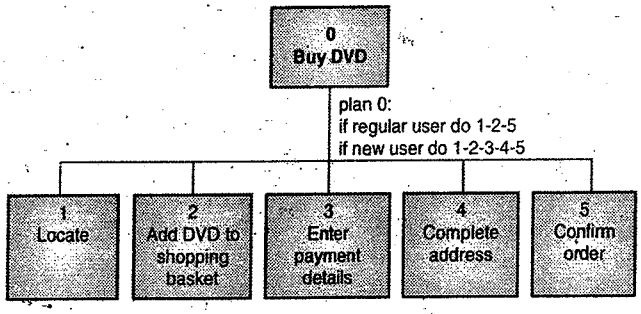


Fig. 6.6.1 : Graphical Representation of HTA

Another example : Prepare HTA for cook food rice

- Textual Representation of HTA.
  1. Cook a rice
  2. Locate rice and cooker
  3. Take a one bowl of rice
  4. Wash rice
  5. Take two bowl of water
  6. Start gas stove
  7. Put two bowl of water
  8. Put washed rice
  9. Close cooker
  10. Off the gas stove after 3 whistle.
  11. Rice is ready

☞ **Plan 0 : All steps**

- Graphical Representation Of HTA For Cook A Food Rice
- As HTA involes in describing the task

0: Cook A Rice

into sub tasks, numbers assigned to subtask shows sequence to perform the task :

1. Locate Rice and Cooker,
2. Take a one bowl of rice,
3. Wash rice,
4. Table two bowl of water,
5. Start gas stove,
6. Put two bowl of water,
7. Put washed rice,
8. Close cooker,
9. Off the G as Stove after 3 whistle,
10. Rice is ready

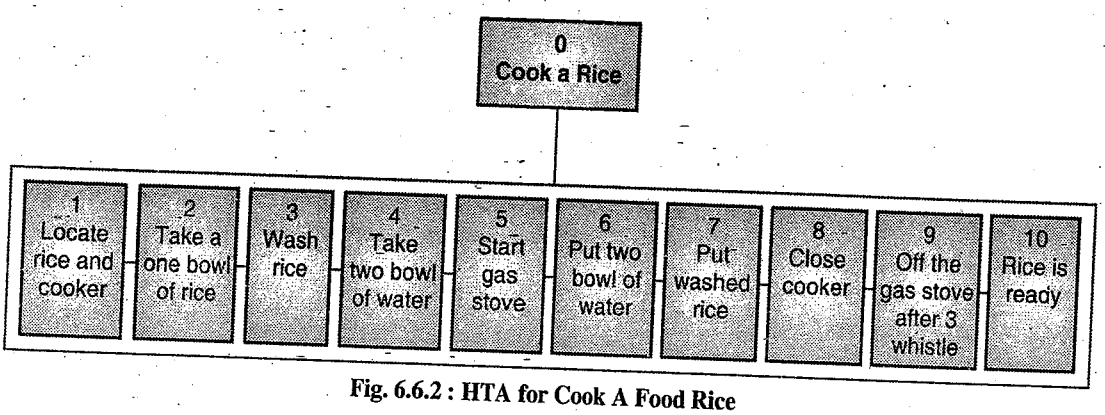


Fig. 6.6.2 : HTA for Cook A Food Rice

Syllabus Topic : Uses of Task Analysis

6.7 Uses of task analysis

☞ **Task analysis is used to**

- Predict the time taken to learn a new task and become a proficient user of the particular application / machine. Task analysis may reveal how difficult one method is to learn compared to another.
- Predict the time taken for a proficient user to accomplish the set task - this can reflect whether the interface is good at supporting exploration. Is it quicker to simply explore by trial and error or attempt to find out through help ?
- It is used for requirements capture and systems design.
- It lifts focus from system to use and suggests candidates for automation.
- It is used for detailed interface design for menu layout, object/action for interface objects, guide got task frequency and task sequence.
- It is used to making manuals and training materials
- It guiding system design and grouping tasks for the interface design.
- It predicts the use of the system.

The Production of Manuals and Tuition Material

- It is made from knowledge or entity–relations based analysis.
- It is useful for new user training.

Requirements Capture and Systems Design

- Requirements capture change the focus from system to use.
- It suggests candidates for automation and may uncover user's conceptual model.

Detailed Interface Design

- It is used for detailed interface design for menu layout, object/action for interface objects, guide got task frequency and task sequence.
- It guiding system design and grouping tasks for the interface design.
- It predicts the use of the system.
- dialogue design

Syllabus Topic : Diagrammatic Dialog Design Notations

6.8 Diagrammatic Dialog Design Notations

- Dialogue is used as a general term for the pattern or structure of interaction between the user and the system. It is not just conversing but also instructing, manipulating etc.
- Dialogue linked to the semantics of the system and the presentation of the system.
- Dialogue notations are used to provide precise, formal specifications of interactions, which can be used for exploration of alternatives, testing and analysis, communication to programmer or users.
- It is used to analyzed for inconsistent actions, for difficult to reverse actions, for missing actions and for potential miskeying errors.

Graphical dialog design notations

There are different dialog design notations. These are classified into two categories, i.e diagrammatic and textual.

Diagrammatic

- State transition networks
- Petri nets
- State charts
- Flow charts
- Jackson structured design (JSD) diagram

Textual

- Grammar
- Production rules
- Process calculi

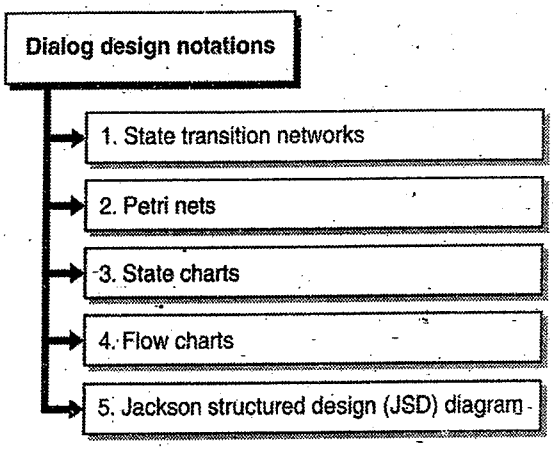


Fig. 6.8.1 : Dialog design notations

Following section describes each one in details

6.8.1 State transition networks (STN)

- *State transition networks* (*STNs*) have long been used for dialog description and it is like finite state machine with input output.
- STNs can represent a sequence of user actions and system responses – user choice and iterations. It can't represent dialogues with several concurrent parts.
- STN for a full system would be big- to manage complexity use Hierarchical STNs
- STN can use to check consistency, do similar actions have
- similar effects? And visibility does the user have any way to recognize the current state.

- The syntax of an STN consists of the following two entities –
  - **Arc or edges:** It shows actions/events/Response from system
  - **Circles:** It shows states of system. Single circle means simple state and double circles mean start and end state. Tool bar or menu is the state where the system is waiting for the user to select either 'circle' or 'line' from the menu.

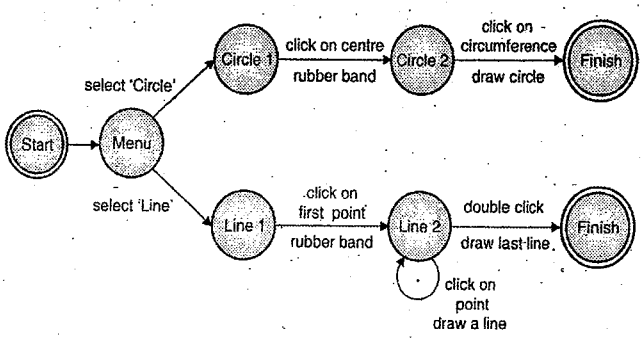


Fig. 6.8.2 : state transition network for menu

- It checks Checking that all possible user actions are accounted for. E.g. what happens if user re-selects menu before completing the circle or line?. Is 'do nothing' the right default for all possible alternatives? Or ensure user only attempts viable alternatives?

1. Hierarchical state transition

- Hierarchical state transition is used for managing complex dialogues.
- It is uses named sub-dialogues to structure multiple operations to reduce the complexity.
- Drawing tool may have a main menu, from which we can select one of three submenus:
  - A graphics menu: It is used for circles and lines.
  - A text menu: It is used for adding labels.
  - A paint menu: It is for freehand drawing.
- Fig. 6.8.3 shows the hierarchical STN.
- It can also use to indicate pervasive actions such as escape or help without creating separate dialog.

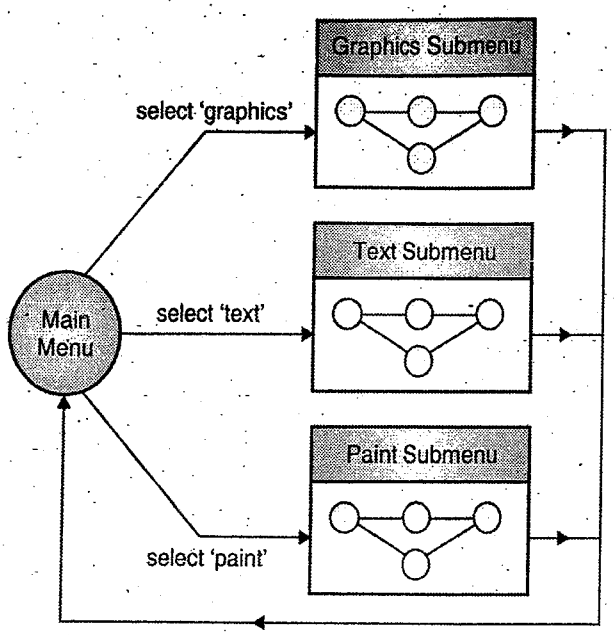


Fig. 6.8.3 : Hierarchical STN for complete drawing tool

2. Concurrent dialogs and combinatorial explosion of states

- In this same functionality combined in single dialog box and it works concurrently.
- For example bold, italic and underline styles functionality used in single dialog box, shown in Fig. 6.8.4.

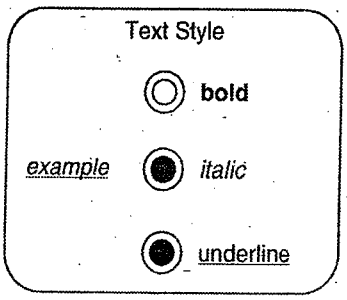


Fig. 6.8.4 : Dialog box with three toggle functionality

- Combinatorial explosion of states means combination of multiple functionality in single state or single or neither functionality in a single state.
- Fig. 6.8.5 shows combinational explosion of states.
- It facing problem of direct manipulation interfaces.

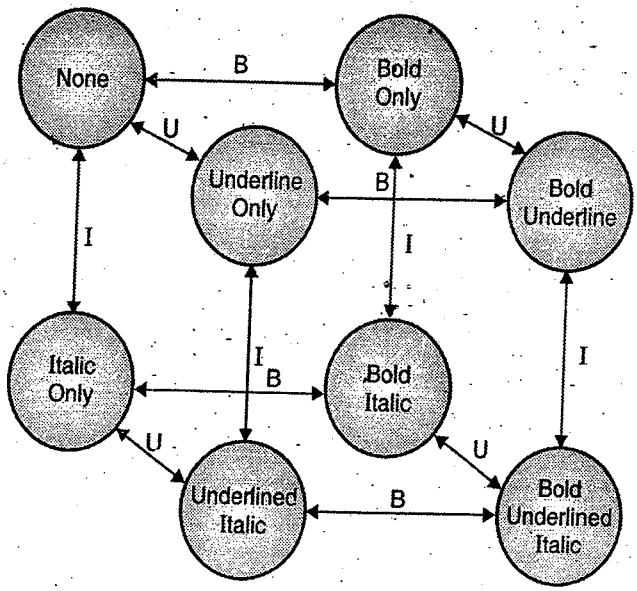


Fig. 6.8.5 : Combinational explosion of states

3. Escapes and help

- Escapes and help systems introduced in STN to resolve issues of wrong selection of menu options.
- It helps to come out from such problems.
- Escape is used to come out from dialog when user selects wrong action; it cancels selected action and return to main menu.
- It requires direct an arc from every state back to main menu.
- For example, Fig. 6.8.6 shows STN for drawing tool with escapes.

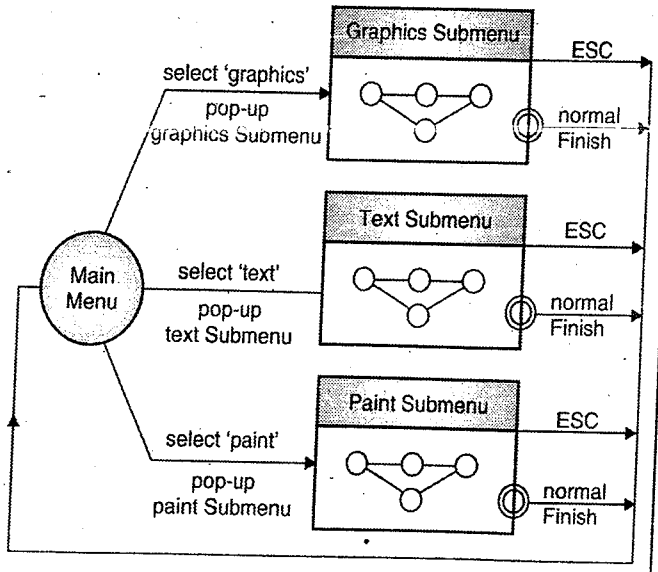


Fig. 6.8.6 : STN drawing tool with escapes

- Help systems is used to provide help to user at any point of time.
- Fig. 6.8.7 shows this for two states of the dialog:

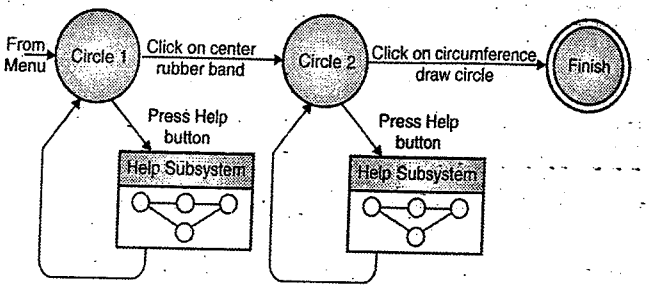


Fig. 6.8.7 : Help system for STN

- Help system is easy to interpret next action and allow choosing and iterating to different modules, but it uses concurrent dialogs structure.

6.8.2 Petri nets

Petri Nets were developed originally by Carl Adam Petri, and were the subject of his dissertation in 1962. Since then, Petri Nets and their concepts have been extended and developed, and applied in a variety of areas.

It is a simple model of dynamic behavior

- Just four elements are used to represent behavior: **places, transitions, arcs** and **tokens**
- Graphical and mathematical description for easy understanding
- Formal semantics allow for analysis of the behaviour

Elements of Petri nets

Petri net has four elements such as :

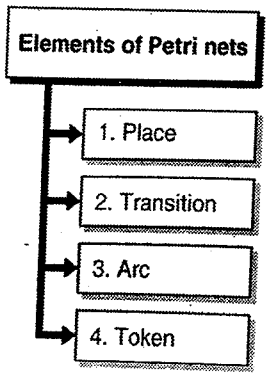


Fig. 6.8.8 : Elements of Petri nets

➜ **1. Place**

Place used to represent passive elements of the reactive system and represented as circles.

➜ **2. Transition**

Transition used to represent active elements of the reactive system and represented by squares/rectangles.

➜ **3. Arc**

Acc used to represent causal relations and represented by arrows.

➜ **4. Token**

Token elements subject to change and represented by small filled circles (•)

- Fig. 6.8.9 shows petri net for Bold/Italic selection. In this three counters are used:
  1. **'Bold On'**: It showing that the bold toggle is currently on;
  2. **'Italic Off'**: It showing that the italic toggle is currently off;
  3. **Slightly elliptic**: It shows 'user presses Bold'.
- An object-oriented variant of Petri nets called Interactive Cooperative Objects (ICO) has been used extensively by the HCI Research Groups.

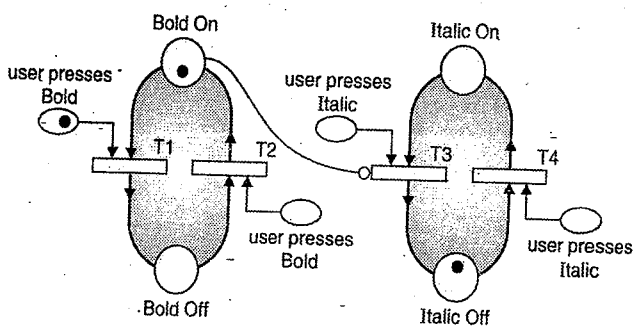


Fig. 6.8.9 : Petri net for Bold/Italic selection

6.8.3 State Charts

State Charts Proposed by David Harel (1987) to represent complex reactive systems that extends Finite State Machines (FSM), handle concurrency, and adds memory to FSM. It also simplifies complex system representations. State Charts has the following states –

- **Active state** – The present state of the underlying FSM.
- **Basic states** – These are individual states and are not composed of other states.
- **Super states** – These states are composed of other states.
- For each basic state b, the super state containing b is called the ancestor state
  - A super state is called OR super state if exactly one of its sub states is active, whenever it is active.

➢ **For example :** Coke vending machine: Suppose you have a coke vending machine, When turned on, the machine waits for money. When Rs. 5/- coin is deposited, the machine waits for another Rs. 5/- coin. When the second coin is deposited, the machine waits for a selection , When the user presses "COKE," a coke is dispensed, When the user takes the bottle, the machine waits again or When the user presses either "SPRITE" or "DIET COKE," a Sprite or a diet Coke is dispensed and When the user takes the bottle, the machine waits again. Draw the state chart diagram.

Ans. :

Fig. 6.8.10 shows diagram of State Chart for Bottle Dispenser

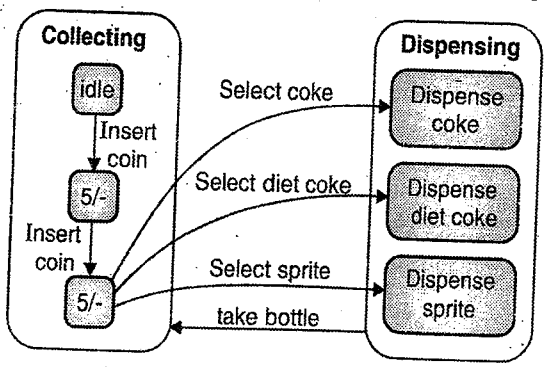


Fig. 6.8.10 : Shows State Chart for Bottle Dispenser

6.8.4 Flow charts

Flowcharting is same as used for programming languages. Meaning notation same you learn in programming languages. For examples: Draw a flowchart for car fuel filling.

For example : Car fuel filling flowchart

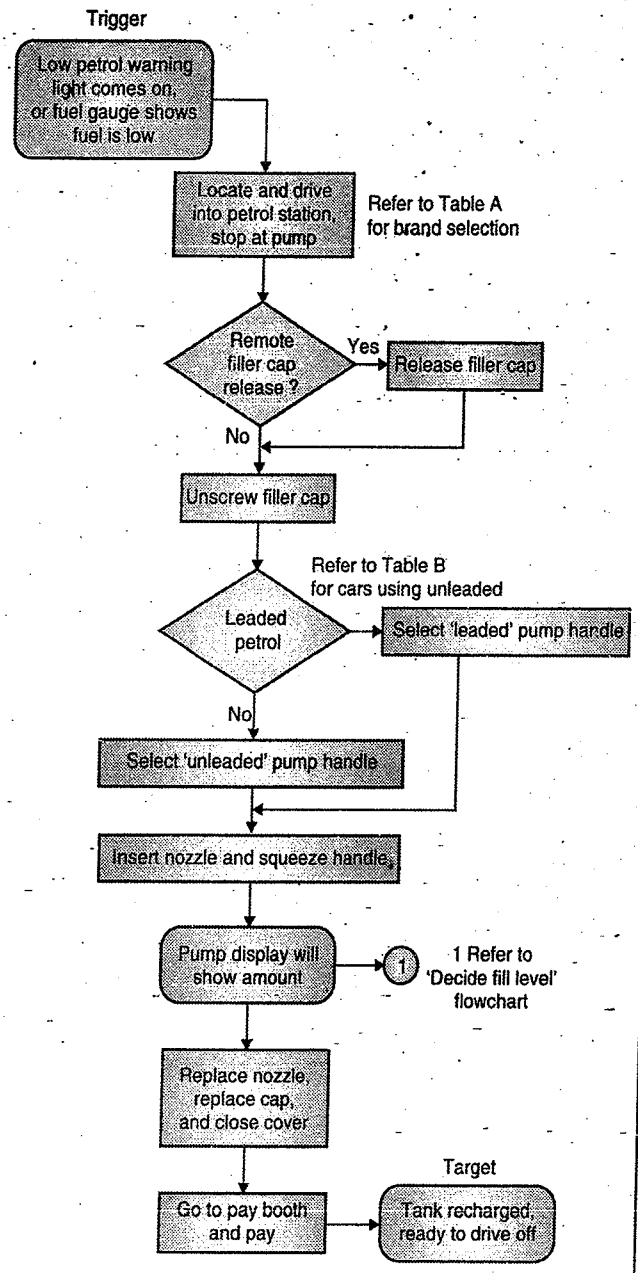


Fig. 6.8.11

6.8.5 Jackson structured design (JSD)

- Jackson structured design used for task analysis and dialog design.
- This isuseful way of representing the structure of a program, when a program is large and complex, it is important to plan out the solution before attempting to write any program code.
- By using a Jackson structured diagram your system can be documented and given to a programmer to aid the development of the program.
- It represents diagram in tree structured form, so it gives greater clarity. IT is less expensive system for drawing dialog.
- Fig. 6.8.12 shows JSD diagram for employee personnel system.
- The system provides functionality to user such as adding new employees, displaying, altering and removing existing ones.
- Personnel system is decomposed into three parts: **login, transactions and logout.**

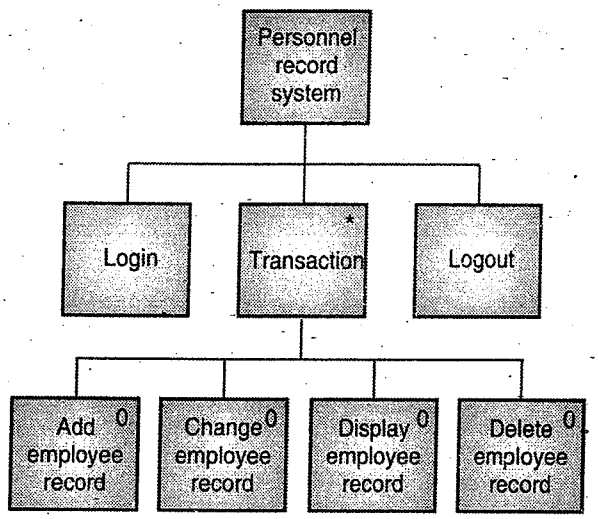


Fig. 6.8.12 : JSD diagram for employee personnel system

- These are implicitly in sequence left to right. That is, you are not allowed to do any transactions until you log in.
- The login and logout are assumed to be quite simple, so the diagram only expands the transaction node.
- Under this are listed the various transaction types: add, change, display and delete.
- JSD diagram describes that : a login followed by any number of add, change, display or delete transactions, and finally a logout.

Syllabus Topic : Computer

6.9 Computer Mediated Communication

- Computer-Mediated Communication (CMC) is any form of communication between two or more individual people who interact and/or influence each other via separate computers

through the Internet or a network connection - using social software.

- CMC does not include the methods by which two computers communicate, but rather how people communicate via computers.
- There are two primary modes of CMC: synchronous and asynchronous.

☞ **For example**

- **Asynchronous :** E-mail, Listserv, bulletin board
- **Synchronous :** instant messaging, SMS, Chat, video-based systems
- Asynchronous communication activities are independent of real-time and are comprised of activities, such as, viewing a web page, composing an Electronic Mail (e-mail), watching a video clip, or downloading a file.
- Synchronous communication activities occur concurrently between two or more users including such real-time applications as chat rooms or instant messaging which allow users to interact simultaneously through text, audio, and video with other users located anywhere in the world

☞ **Computer Mediated Communication Applications are**

- Email and bulletin boards
- Structured message systems
- txt is gr8
- Video conferences and communication
- Virtual collaborative environments

6.9.1 Email and Bulletin Boards

- Every user using any form of computer communicated media for communication such as email system, bulletin board or electronic conferencing system.

☞ **Following are the stages of email system :**

- Mail preparation
- Dispaching mail
- Delivering mail
- Notification of mail
- Recipt of mail

- In the simple email example, sender sending email to one or multiple senders. Like letters, these recipients may be divided into the direct recipients (often denoted by a To: field) and those who receive copies (Cc:).
- These two types of recipient are treated no *differently* by the computer systems – the distinction serves a social purpose for the participants. This is a frequent observation about any groupware system – the system should support *people* in their cooperation.
- Often users will be able to set up *distribution lists*, named groups of other users to whom mail is often sent. There is only a small difference between the use of such lists and fully fledged bulletin boards or electronic conferencing systems.
- In these systems you address your message (or contribution) to a particular conference or newsgroup, and then anyone who has subscribed to that newsgroup receives the message.
- An electronic message center. Most bulletin boards serve specific interest groups. They allow you to dial in with a modem, review messages left by others, and leave your own message if you want.
- Email distribution lists are private to the sender. Bulletin board or news systems, it is the recipient who decides which news groups to subscribe to.

6.9.2 Structured Message Systems

- Structured message system provides the solution to the problems of email system such as overloaded email, unwanted emails.
- It has ability to sort messages in different categories based on domain.
- It organize, classify, filter and manage messages and provide better solution as compared to email system.

6.9.3 txt is gr8 or Informal Text Messaging Systems

- It is next generation textisms as shortcuts in electronic communication. It is many form such as SMS, instant messages through internet.
- It is becoming very popular among young generation.
- Words may be shortened to the minimum syllable length, often by removing vowels.
- Articles and conjunctions may be omitted, and numbers or letters may be substituted for graphemic units e.g., gr8 for 'great,' 4 for 'for,' 2 for 'to,' c for 'see,' or sum1 for 'someone,' l8r for 'later', or w8 for 'wait'.
- Common phrases may be represented by acronyms (e.g. LOL, 'laugh out loud'). Capital letters might be omitted or used for emphasis. End-message punctuation may be absent or uses emotions ☺ or smilies.

6.9.4 Video Conferences and Communication

- Video conferences and communication it a modern high-tech communication tool used for business as well as personal communication.
- It increasing business efficiency, optimizing business processes, accelerating the decision-making process and saving money on travel.
- It requires high speed internet connection and web cam.
- Video conferencing and communication has two types: personal video conferencing and group conferences.
- It is synchronous and remote communication system.
- It uses for video conferences, pervasive video for social contact and integration with other applications.
- It is cheaper than face-to-face meetings, but it is not a substitute for face-to-face meetings.
- In video conferring small field of view, lack of reciprocity and poor eye contact. One solution for lack of eye contact is the video-tunnel.

6.9.5 Virtual Collaborative Environments

- In virtual collaborative environment several people interact with each other, often over several locations. The aim is for these people to share ideas and experiences in a co-operative setting – hence the name.
- Virtual reality techniques are used in video games, it allows players to meet virtual world. Virtual space in virtual reality is called embodiment.

Syllabus Topic : Ubiquitous Computing

6.10 Ubiquitous Computing

- "Ubiquitous computing enhances computer use by making many computers available throughout the physical environment, but making them effectively invisible to the user.
- **Ubiquitous computing** (ubicomp) integrates computation into the environment, rather than having computers which are distinct objects.
- The idea of ubicomp enable people to interact with information-processing devices more *naturally* and *casually*, and in ways that suit *whatever location* or *context* they find themselves in.
- Ubiquitous computing communication happened through linked objects. Ubiquitous computing devices available anywhere, any time.
- The main aim of ubiquitous computing is to create a smart product.
- Ubiquitous computing facing different challenges for the human-centred. these are :
  1. Defining the appropriate physical interaction experience
  2. Discovering general application features
  3. Theories for designing and evaluating the human experience within Ubiquitous computing
  4. Evaluation challenges for Ubiquitous computing

6.10.1 Defining the Appropriate Physical Interaction Experience

Ubiquitous computing, it may accepts input from :

- Sensor-based input
- Extends traditional explicit input (e.g., keyboard and mouse)
- Towards "awareness"
- Use of recognition technologies
- Introduces ambiguity because recognizers are not perfect

Toward Implicit Input

- Traditionally inputs are given explicitly through keyboard or pointing devices.
- Varieties of devices are developed, so inputs also change to implicit. Implicit input interact with physical environment sufficiently to access various services, without any user intervention.
- Computer interfaces that support handwriting, speech and gestures of human forms communication to graphical user interface interaction paradigm.
- The Implicit input changing to sensor-based input. These sensors sense the signal of human activity and interpret its meaning.
- There is many number of sensors are available to interpret meaning of people and environment activities or changes.
- The union of explicit and implicit input defines the ***context*** of interaction between the human and the environment and from this we can develop many emergent applications.

Toward multi-scale and distributed output

- Ubiquitous computing supports many screen sizes from very small to very big, older to newer
- Devices are support to move information from one device to another device and to support multiple displays.

Seamless integration of physical and virtual worlds

- It Merging Physical and Digital Worlds. It must support actions on physical objects transfers into electronically, and vice versa.
- Output from electronic world superimposed on physical world.

6.10.2 Application Themes for ubicomp

- Currently ubiquitous computing has three themes

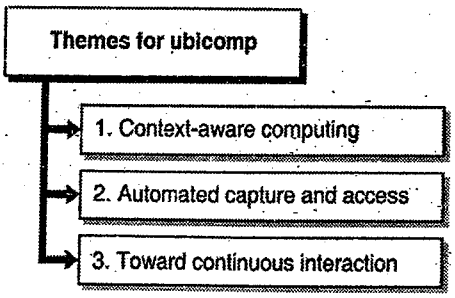


Fig. 6.10.1 : Themes for ubicomp

1. Context-aware computing

- **It refers** a general class of mobile systems that can sense their physical environment, and adapt their behaviour accordingly.
- **Context-aware** systems are a component of a ubiquitous **computing** or pervasive **computing** environment.
- It Sensed phenomena and facilitate easier interaction.
- Examples of context-aware computing include the new design of mobile devices that switch between a vertical and a landscape orientation depending on how they are positioned.
- Another example is devices that change their screens and backlighting according to the amount of light in the room where they are being used.
- One very new concept that could be called context-aware computing is the inclusion of mechanical and sensory elements in future mobile devices that help them adjust themselves to minimize damage when they are dropped.
- Context-aware computing seeks to anticipate the ways that computers will need support from users in specific situations, whether it is indoors or outdoors, on manufacturing floors or in offices, or in any other kind of situation where a person relies on a piece of hardware to complete a task.
- This is a major element in the design of cutting-edge technology for today's consumer and business markets

➜ **2. Automated capture and access**

- Automated capture and access works on live experiences stored for future access. It records all experiences for future use. It uses automated tools for this purpose.
- The tools that record experiences are the **capture devices**; and the tools used to review captured experiences are the **access devices**.

➜ **3. Toward continuous interaction**

- When designing towards continuous interaction must consider following activities:
- Everyday activities have no clear begin-end conditions.
- Interruption is allowed by user when required.
- Support to multiple concurrent activities.
- Must support associative model, so information can reuse in multiple applications.

6.10.3 Understanding Interaction in Ubicomp

- Shift the focus from desktop to ubicomp. It generates new Opportunities for Theory:
- Knowledge in the world
- Ubicomp places more emphasis on the physical world
- Activity theory
- Goals and actions fluidly adjust to physical state of world
- Situated action and distributed cognition
- Emphasizes improvisational/opportunistic behavior versus planned actions
- Ethnography
- Deep descriptive understanding of activities in context

6.10.4 Evaluation Challenges for Ubicomp

- The challenges are, how can we adapt other HCI techniques to apply to ubicomp settings?
- Ubicomp activities not so task-centric
- Technologies are so new, it is often hard to get long-term authentic summative evaluation
- Metric of success could be very different (playfulness, non-distraction versus efficiency)

Syllabus Topic : Finding Things on web and Future of HCI

6.11 Finding things on web and Future of HCI

- HCI is a multidisciplinary research area focused on interaction modalities between humans and computers
- It is also called human-machine interface (HMI). It is used to refer to the user interface in a manufacturing or process-control system.
- HCI investigates and tackles all issues related to the design and implementation of the interface between humans and computers.
- HCI involved in multiple computer science disciplines such as image processing, computer vision, programming languages, and so on. It also involves in disciplines related to human sciences such as ergonomics, human factors, cognitive psychology, and so on.
- Research about HCI primarily concerns the design, implementation, and assessment of new interfaces to improve the interaction between humans and machines.
- An intuitive, natural, efficient, robust, and customizable interface can greatly reduce the gap between a human's mental model and the way a computer, machine, or robot can accomplish a given task.
- HCI studied from 1975 and recent technological advances in consumer electronics have opened exciting new scenarios: gestures, hand and body poses, speech, and gaze are just a few natural interaction modes that can be used to design affordable natural user interfaces (NUIs).

□□□

Questions and Answers for In Semester Examination

Chapter 1 : Introduction to HCI

Syllabus Topic : What is HCI ?

Q. 1.1 What is HCI?

Ans. :

- The activity performed among man-made-machine, i.e. computer and a human beings in an interactive session wise manner.
- Particularly human-computer-interaction can be partitioned into three distinct items for better understanding.
- The human computer interaction foundation can be observed with the help of:
  - (a) Human's psychological nature and physiological activity
  - (b) Computer Input and Output Channels (e.g.: visual, auditory, haptic, movement along with their characteristics), Computational power and memory
  - (c) Models of interaction, Interaction styles and design
- Model Human Processor' by Card, Moran and Newell in 1983 which describes about a simplified approach of a human processing towards interaction with computer systems.

Q. 1.2 What are the reasons behind black border and stretched pixels on monitor screen?

Ans. :

- (different types of display screen, 3D visualizations, printer, scanner, optical character recognition)
- Computer Monitor is mainly considered in case of display devices rather than ATM, Car and Mobile Screen.
- Monitor used for computer as display device has travelled a long journey of monochrome, black and white – gray scale, colored screen as well as CRT, FT, LCD, LED, HD, 4K UHD on the basis of technology and pixel quality.
- Screen display quality is all about maximum number of pixels per inch i.e. pixel density.
- Generally, computer display is about 4:3 aspect ratio, 1024 pixels across by 768 down. On other hand horizontal 3840 pixels by max vertical 2160 pixels resolution with 16:9 aspect ratio found in few recent monitor
- It happens as the screen has good resolution (i.e. LCD, LED monitor) and computer system provides less resolution quoted than monitor specification in such scenario black screen black color border appears on screen.
- **For example:** Screen has 1200 × 900 resolution setting along with 96 pixels density and computer provide 800 × 600 resolution.
- Two pixels get squashed to one or one get into two due to inappropriate computer systems supplied resolution than the projector resolution and pixel density. Further, it leads in forming thick or thin line of pixel line which gets disappeared from the screen.
- Anti-aliasing is useful to get more accurate display in such scenario.

Q. 1.3 Explain working of the CRT? Enlist disadvantages and precaution for computer monitor user in perspective of HCI.

Ans. :

- Cathode Ray Tube (CRT) technology based monitor is more popular since late 90s. Now a day a flat LCD screen is mostly used as a computer monitor. CRT and LCD both work on the same technique.
- Electrons were emitted by an electron gun which is focused and directed by magnetic fields. Beam reaches on phosphor coated screen which turn into a set of pixels.

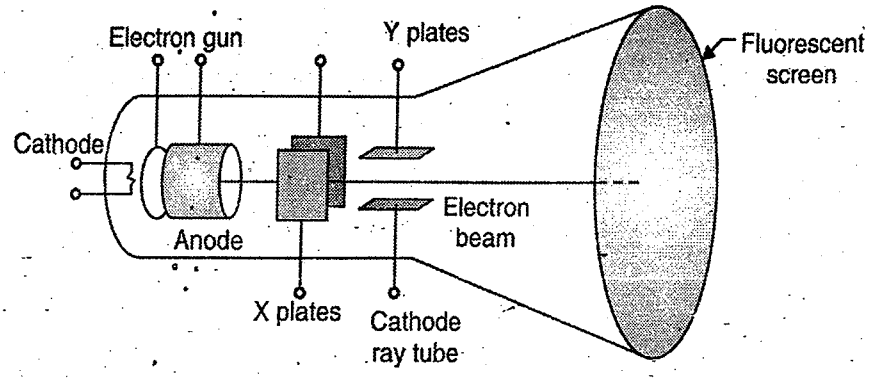


Fig.1-Q.1.3 : Cathode Ray Tube

- The electron beam traverse from right to left side of the screen starting from top left of the screen and flicked back to rescan for the next line and repeating same from top to bottom.
- This action is quite faster approx. 30 times per second (30Hz) per frame, higher scan rate is used to reduce flickering of the screen used to display. Use of high persistent phosphor also practiced to reduce flickering.
- Interlacing is an approach used to reduce flicker in which firstly all off lines are scanned later even lines.

Disadvantages

(a) X-rays emission (Mostly absorbed by screen)

(b) Use of phosphor lead to ultraviolet and infrared radiation

(c) Emission of radio frequency

(d) Emission of ultrasound (16KHz)

(e) Conducive material Enfield with induced current due electromagnetic field

Precaution

(a) Avoid close sitting from the screen

(b) Avoid use of small fonts

(c) Avoid continuous monitoring activity (continuous stare at the screen)

(d) Avoid excessive brightness or contrast screen

(e) Avoid direct sunlight or windows facing monitor screen arrangement

Q. 1.4 Why eyestrain occurs with monitor use? How LCD is useful in HCI ?

Ans. :

- Liquid Crystal Display (LCD) monitor is more popular due to flat screen, lighter in weight, less consumption of power.
- LCD monitor was formed by the sandwich of liquid crystal between the two glass plate, i.e. transparent and polarized plate on top, reflective plate at bottom.
- In LCD, a beam of light is passed from the top plate, it gets polarized i.e. get oscillated in one direction. Beam later passes through crystal which makes cells, white by reflecting off the bottom plate. Post is applying voltage to crystallize with the help of conducting glass plate crystal get twisted.
- Slow response of crystal of even though refresh time is required at usual rates leads to the very negligible flicker of the screen.
- Emission of light at low intensity, negligible flickering helped to reduce monitor user's eyestrain

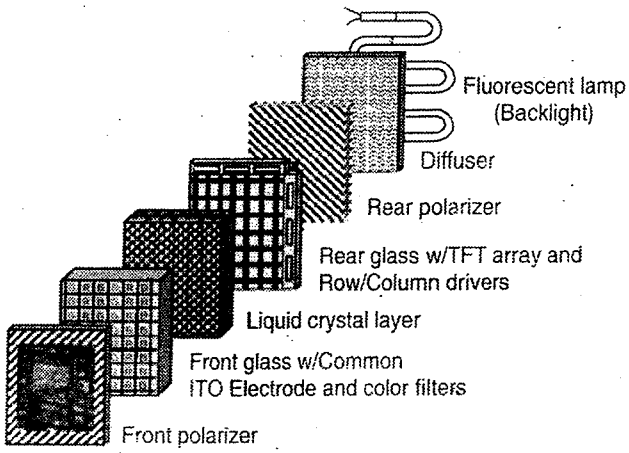


Fig.1-Q.1.4: Liquid crystal display layer structure

Advantages

(a) Less consumption of electricity

(b) No eyestrain compared to CRT

(c) Flat screen, light in weight and compact in size

(d) Very less flickering on screen

Design goals for display screen in concern with HCI are as follows

(a) Less flickering screen

(b) Good pixel dense

(c) Less power consumption

(d) Appropriate aspect ratio

(e) Installation of display device should be in an appropriate manner so that entire screen can be monitored easily.

(f) There should be adequate distance and height (mostly for desktop computer) of the screen for all types of user.

Q. 1.5 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 specification, assuming the new system will be a replacement of old paper-based system. What assumption you need to make about its user ?

Ans. :

- Paper and sound, both are input as well as an output source for interaction.
- The sound is output of the speakers while for device like microphone and mike sound is input.
- Sound is used to alarm for a different indication like different beeps patterns from CPU inform about its CPU status, some text to speech tool also used as interaction among computer and user like pdf has Read out loud option.
- It is also used to pass information in form instruction with the help of speech to text tool like siri application of iPhone or some cloud based API.
- Paper used for printing text, images with an output device like a printer.
- While Optical Character Recognition (OCR) technology uses paper as input for devices like a scanner.
- The idea behind a paperless or digitized work is about eliminating paper based work, all transactions of data through digitized form, but it doesn't appear in true manner as a record keeping activity required paper or hard copy in the draft.
- Few software for handling meeting or calendar are used to replace dairy or paper-based system.
- An appointment scheduler software should consider some assumption like:
  (a) Appointment scheduler will be more user friendly if it syncs with Google calendar, Outlook or iCal it will keep notifying as per settings
  (b) Allow users to sign up and apply for an appointment online
  (c) Appointment timeline
  (d) Accept online appointments
  (e) Display time available for booking or update notifications about scheduled or rescheduled appointment
  (f) Use an online booking calendar for events, conferences or workshops for better interaction
  (g) Post meeting evaluation
  (h) Review or Feedback Form
- A task which can be organized and managed by software are as below:
  (a) Appointment scheduler
  (b) Meeting invitation
  (c) Meeting scheduler
  (d) Calendar bookings on weekly-monthly- Tri monthly etc.
  (e) Update notification for books, events participants

Q. 1.6 What is Memory ?

Ans. :

- Memory talks about RAM – Short term memory (STM), Disks and Long term memory (LTM), storage, compression, capacity and speed.

- Memory keyword refers to a component within our computer which allows us to access data which is stored for a short term.
- Few of such components known as DRAM or dynamic random-access memory (RAM). The computer performs various operations by accessing data which are stored in its short-term memory. For example editing a document, surfing via web browser, installing any application depends on the memory of your computer system. Like items which frequently required place on the desk, but there is limitation of space to put things on desk, similarly in case of memory of the computer.
- Storage is another component of data which can be accessed from memory on a long term basis, usually it comes from magnetic disks like HDD, DVD, Blu-ray disk, pen drive or any portable storage devices.
- Usually a hard disk drive is used as a prime long term memory (LTM) in the computer. It consists of a disk platter, many disk together creates a disk cylinder. Each disk has a track, tracks has small, virtually separated memory storage compartment known as a sector. Read/Write head assembly is attached to a rotatory position assembly which is helpful to change R/W head position from one track to another while disk were rotating. Generally, such six disk cylinder observed in SATA HDD technology.

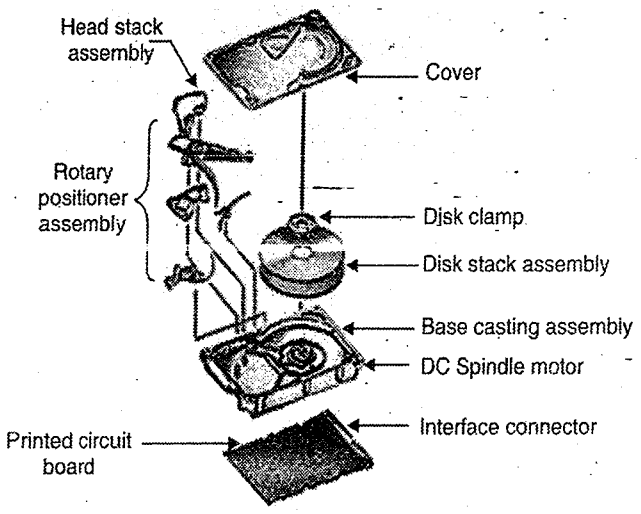


Fig. 1-Q.1.6 : Illustration of Hard Disc Drive (HDD) components

- In storage device, average seek time or average access time is nothing but the amount of time taken by device takes to attain a position for read/write heads over a spot in the medium.
- Measurement is an average taken as access times get varied as per distance between the heads original location and head designated location. In case of storage devices seek times is counted in Milliseconds. In case of memory devices, seek times are counted in Nanoseconds.
- In case of a disk drive the seek time affected due to a combination of 2 things: Revolutions per minute (RPM)and time required for head movement among the tracks.
- Different device along with their access time mentioned below :

Q. 1.7 Explain Donald Norman's seven stages of interaction? SPPU-Aug. 2017 (In sem), 5 Marks

Ans. :

- Interaction models help us to know the interaction takes place in human and the computer with help of Interaction Design, Interaction Styles, Interaction design process.
- Social and organizational interaction context are also equally affecting factor for system and user.
- Norman model suggests 7 stages of interaction as mentioned below:
  - (a) Establishing the goal.
  - (b) Forming the intention.
  - (c) Specifying the action sequence.
  - (d) Executing the action.
  - (e) Perceiving the system state.
  - (f) Interpreting the system state.
  - (g) Evaluating the system state with respect to the goals and intentions.

Q. 1.8 List of disciplines contributing of Human Computer Interface.

Ans. :

- Psychology – understanding the user
- Sociology – groupware
- Art – aesthetic appeal
- Design – user interface layout
- Engineering/Computer Science – faster machines – faster systems – means of building better interfaces

- Linguistics – language for commands
- Anthropology – user body shape
- Ergonomics – equipment design
- AI – help facilities – modelling the user
- Philosophy – creating consistency

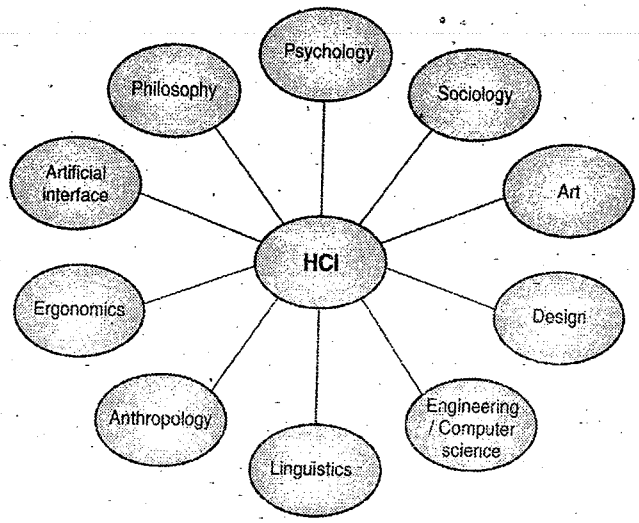


Fig. 1-Q.1.8 : HCI Discipline

Q. 1.9 What is Ergonomics?

SPPU - 2017 (In Sem) 5 Marks

Ans. :

- It is suitability between technology and environments. It ensures that information and environment suits each other. It monitors performed activity of the user and demands of the user. Ergonomics can be studied in details with

(a) Physical Ergonomics

It is generally about human anatomical process. It describes about how a human (user) prefer his sitting arrangements i.e. physically interaction with computer like appropriate use of chair height, wrist rest, neutral wrist position, height of keyboard from the ground, angle of sight within monitor screen and eyes, distance between user and monitor , sitting posture for back, footrest etc.

(b) Cognitive Ergonomics

Mental process like reasoning, memory and motor response.

(c) Organizational Ergonomics

Socio technical systems in policies and work design in teamwork, community ergonomics.

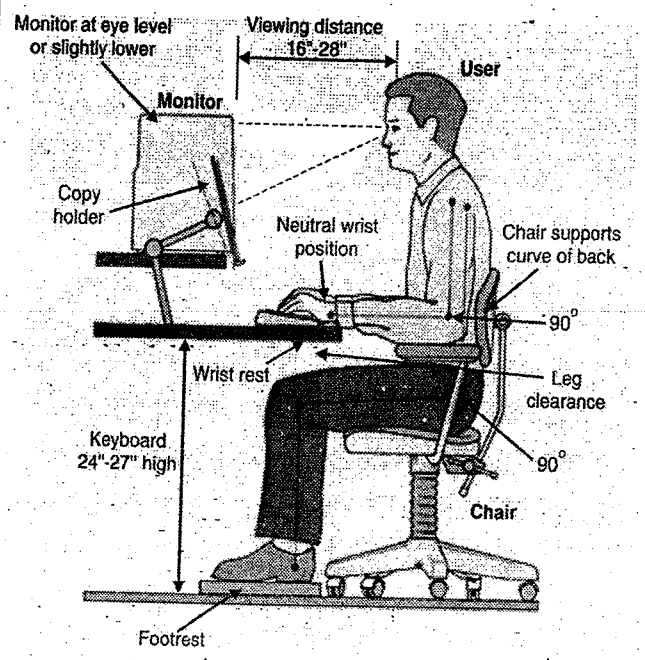


Fig. 1-Q.1.9 : Discipline of HCI : Physical Ergonomics

- ISO 9241 : Ergonomics of Human Computer (System) Interaction, adopt a traditional usability category means of specific measures, Example:

Usability Objective	Effectiveness Measures	Efficiency Measures	Satisfaction Measures
Task suitability	Goal achieved (In %)	Task Completion time	A scale based ratings for satisfaction
Appropriate for experienced users	How many functionalities used effectively	Expert user's efficiency	A scale based rating for easy learning
Learnability	Functions learned (in %)	The time required to learn criteria	Scale based rating for easy learning
Error Tolerance	Error correction (in %)	Error correction time	A scale based rating for error handling

Q. 1.10 What is Important of HCI?

Ans. :

- HCI is important to:
  - Recognize the User Goal
  - Understanding the Problem (Design Research)

- Modeling Users (Persons and Goals)
- Setting The Vision
- Design Product
- Teamwork

1. Recognize the User Goal

- Developer and designer should keep in mind that all users are not same, their privileges change over time. Goals are different from the overall functionality of task to do.
- Business goals, user's goal and/ or personal goals may get varied as per environment of the company, depending on whether it is product based, service based company.
- The designer should think about designing goals and need to think differently about achieving goals.
- The designer should follow some design principal of goal:
- User interfaces should be based on the user mental model rather than implementation models.
- User mental model should get reflected in goal directed interaction.
- Interaction design is not like a guesswork

2. Understanding the Problem

- A designer has to choose among an available quantitative data or qualitative data. Both data have own strength and weakness.
- Qualitative data give behaviours, social context of user and system. It helps to make a decision making design.
- Quantitative data lead to guesswork, user observation or ethnographic readings which can be used to make some decision segment or pattern.

3. Modelling Users

- Like a car manufacturing company design a car, but few users wants a stylish looking car with maximum interior features, few want safe and comfort and few want reliable but should travel with a number of people, luggage, etc., similarly a model for a user has to be made keeping different user group should be satisfied with maximum requirements completion.
- HCI is useful in modelling a user with the help information it carries about the user's Psychology, Philosophy, Sociology, Ergonomics of user etc.
- Some models which help in HCI are Physical model, Artifact model, Work flow model etc.
- Modelling users mainly deal with
  - Determining user requirement
  - Communication with stakeholder
  - Build consensus and commitment to design
  - Measure of design effectiveness

4. Setting the Vision

- As per business perspective HCI set the vision with centre designed approach with the core experience vision.
- Few visions centred method based framework as well as structured scenario based design method also suggested to set vision.
- Tools are used which are helpful to design vision to help of conveying vision of the future.
- Value scenario, interaction scenario and activity scenario are considered in Structured Scenario Based Design Method (SSBDM).
- Human Centred Deign (HCD) was used to address the issues in the design of services, products and systems based scenario.

5. Design Product

- Generally design of product is user centred a more user friendly design is more important than other issues.
- More interactive designs are considered as good design and become popular compare to others design like :

- The peanut shape of the TV remote is preferred as better design than a rectangular shape TV remote.
- An appropriate Font Face, Size, Text Effects, Color, Text Highlight, Alignment, proper Capitalization of an Alphabets, Numbering, Line and Paragraph Spacing, Shading, Indent, Sort, Style, Editing (Find, Replace, Select),Picture, ClipArt, Shape, Smart At, Chart, Links, Header and Footer , Symbols, Tables, Page Setup (margin, Orientation, Size, Columns, Breaks, Line Number, Hyphenation), Page Background-color-border, Theme etc. should be considered in case of display of text on website page or software or tool, any installation manual etc.

– Combining necessary graphical and textual representation improves GUI while the unnecessary use of an Image, .gif file, Flash screen, the use of horizontal or vertical sections in between the text lead to bad design.

6. Teamwork

– The team is a collective representation of members from distinct portfolio. In team its more 'we' than 'me' or 'we did this' than 'I did this'.

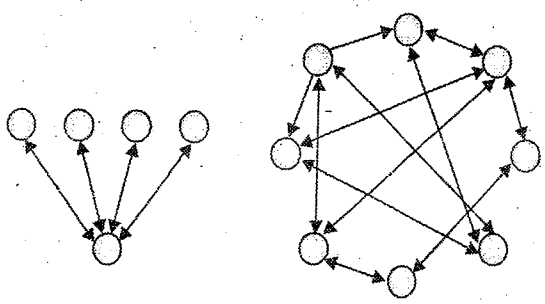


Fig. 1-Q.1.10 : Representation of Group, Teamwork

– A group has the same purpose to work, but each user has its own linking and ideology to group lead or representative at the individual level.

– In a Team each member has coordination with other members of a team; together they work for achieving some task.

– James: Everyone should be quick to listen, slow to speak and slow to become angry.

Q. 1.11 Explain everyday design things with example?

SPPU - Aug. 2017 (In Sem), 5 Marks

Ans. :

– Everyday things are required with good design, essential characteristic of good design is understanding i.e. What does it mean? And Discoverability i.e. looking for probability of performing acting in How? What? Ways it can be achieved.

– One famous example of doors good design known as 'Norman Dorrs' where a user is confused with operating the door at the entrance and exits.

– Some door required to Pull for entrance and push for exist and some door required Push for entrance and Pull for exist, it means it operate in either direction.

– Some door function in both the ways Push-Pull in either side. Some door doesn't help on Pull or Push they required to slide.

– Again, few sliding door slides from left to right and few from right to left while some door slides from middle to either side. Even though, instruction return on the door like a push or pull, but some design of door handles makes confusion in such small things to open and close door.

– Some other design issues in similar example category like microwave oven, coffee vending machine, washer dryer machine, etc., devices from the same manufacturer have a different operating process.

– All such devices are not used with all of its functionality. Most of the user, uses few functions and keep self restricted unnecessarily from many other functions.

– Generally approx. 100 of recipes availed in the auto function mode in microwave oven, approx 15+ function in the washer dryer machine, approx. 10 functions on coffee machine, but very few user usability is more than a half of function available with devices.

– All such devices come up with a user manual or an instruction set and purpose behind it to help user to utilize all functions of the device.

– Rarely, users prefer to read (most of the time they found it as confusing) and all purposes behind design get lost.

Q. 1.12 Explain Shneiderman's eight golden rule of interface design with suitable example.

Ans.:

- Ban Shneiderman provide general guideline for computer software or user interface developer (1987) also known as Shneiderman's 8 Golden Rule :

1. Strive for consistency

- Consistency is observed in sequence of an action, terminologies, layout and command used etc.

2. Enable frequent users to use shortcuts

- Use of macro for repeatedly required context, key sequence for specific functions, abbreviation and short cut for more familiar and frequently used operation.

3. Offer informative feedback

- Availability of feedback for each user action with an appropriate feedback platform.
- Design dialog to yield closure.
- User knows at what time task is completed.

4. Offer error prevention and simple error handling

- It is to awake user from getting introduce to error.
- It informs user if step leading to an error, bug or fault are followed by user with the help of informative instructions or cue, hint messages so mistakes can be avoided at early stages.

5. Permit easy reversal of actions:

- User got encouraged to exploration.
- User become more flexible with the environment by acknowledgement of user can be returned to previous position sage as per required.

7. Support internal locus of control:

- Control helps user activity in control, which keep responding to his action.

8. Reduce short term memory load:

- With the help of multiple panel in a window or panel with multiple page display.
- Time for learning action sequence.

Q. 1.13 Explain Don Norman's Principle of Design

Ans. :

- Don Norman's Principle of Design in HCI

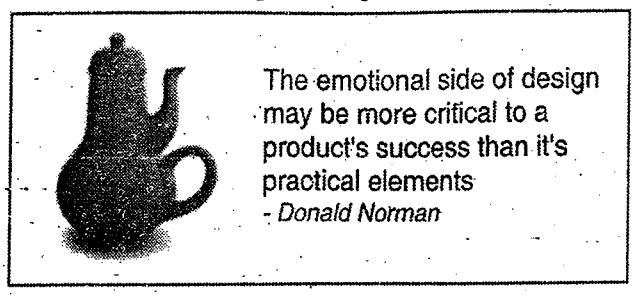


Fig. 1-Q.1.13 :Example of Design : A Tea Pot

1. Visibility

- More visible more user friendly.
- Hidden or semi hidden, overlapping based, icon based design lead to out of sight and reduce usability.

2. Feedback

- Interaction design, interaction audio, interaction tactile, verbal and so on feedback mechanism, used to collect stakeholder approach towards design.

3. Constrains

- Constraints should be applied to a various user types as they may lead to error sometimes.
- Constraints to user are helpful for design purpose and it can be achieved with the help of multiple ways.

4. Mapping

- It is relationship among controls and effects like top-bottom buttons, left – right side indicators, jump to particular page from a series of pages, directly to homepage of website or information uploading websites WebPages or software tool without losing data. etc

5. Consistency

- Interface of design remain consistent to lead to a good design. Relevant and relevance information should remain in a consistent it help to improve usability, user friendly quality of design.

6. Affordance

- It is act of providing cue or basic idea to perform task. Give a journey of features and advantages of design with small video or animated clips of design with help of arrows and pop-up messages.
- It helps to inexperienced user.

Q. 1.14 Explain Nielson's 10 heuristics.

Ans. :

– Jakob Nielson together with Rolf Molich(1994) gives some design interface guideline , popular as Nielson's Usability Heuristics:

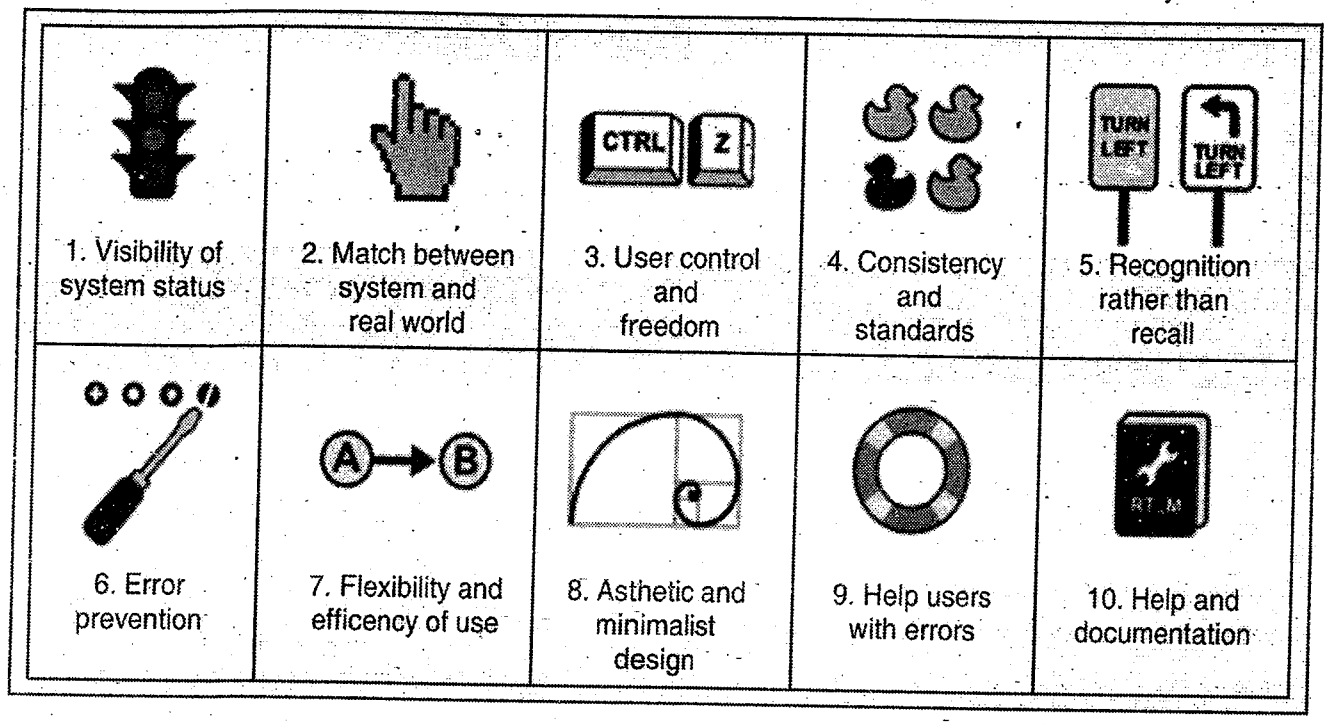


Fig. 1-Q.1.14 :Nelson's Usability Heuristic

1. Visibility of System Status

System should be informing about performance to user and act on user feedback within specific time bound.

2. Match Between System and Real World

System should be design in a fashion where it ensemble with users language, words, concepts etc. which lead to a proper logically ordered design.

3. User control and Freedom

– User require necessary exist option at most of critical time, as user come to know proceeding ahead may lead to an error , user check for available exist which may protect from near future error in a task.

– Some options undo , redo are useful but these not help when data submitted and processed in such case design should provide exist from last saved data or current window without losing previous data, its better to exist without losing a data than to face a system's kill process.

4. Consistency and Standard

– A same word stands for a different meaning and in some cases different words are leading to a same meaning.

– Design should maintain synchronization among design with consistency and without tampering standards.

5. Error Prevention

An error should prevented from occurrence, user should be intimated before the proceed action which may turn into an error.

6. Recognize Rather Than Recall

– Design should be highly interactive so a user can easily find options and objects, option with symbolic appearances help more better way.

– Instruction set should be highlighted , design should made user to remember less information while interacting.

7. Flexibility and Efficiency of Use

- System has to interact with both experienced and inexperienced user.
- It should be efficient for experienced while flexible for inexperienced users.

8. Aesthetic and Minimalist Design

- Relevant dialog should be there, unnecessary information from dialogue lead to disturbances in useful information.
- Design should be more comfortable to view, read, search and other activities where users are involved.

9. Help Users Recognize, diagnose and recover from error

- Error, warning, exception, message should be pop-up or display with efficient information. It should not cover all script of code or operating system bug report etc. unless it is required. Even if large information provided it should remain hidden , if user need then user should avail it from same dialog box with the help of hitting any extra key.
- Exception, informative, successful, warning, error messages dialog box should represent adequate data.

10. Help and Documentation

- Help is useful to user who is inexperience with interaction to design. Help utility work like guide at tourist place.
- Documentation is not really getting importance what it deserve but it may lead to consume user time in exploring things without proper interaction with documentation.
- A properly documented things gives a user maximum usability, robustness, flexibility among interaction design.

Chapter 2 : Understanding the Human

Q. 2.1 List human input output channel and describe it briefly. SPPU - Aug. 2017 (In Sem.), 2 Marks

Ans. :

- A computer gives some output which is accepted by human as a part of an input in the interaction.
- While human provides instruction to computer or devices which are recognized as an input for it in the interaction i.e. users' output becomes computer input.
- Mechanism of providing input and output with the help of some media will be changing as per device like sound from the speaker is an output while sound received from in mile or microphone is an input to the system.
- Input for human are mainly controlled of effectors were used to provide output.
- Major five senses of human sight (eye), hearing(ear), haptic (touch), smell(nose) from interaction purpose sight, hearing and touch are important.
- Few scents (fragrance) based technology are in demand in communication technology from users of web surfing, gaming, music and movies, etc.
- As if A Paper scent is one of the devices which instant dispense, scented perfume strips.
- Scent and taste both not much significantly used in interaction.
- Fingers, eyes, head, vocal system, limbs these are effectors in the interaction.
- Fingers were mainly used to provide input via keyboard and mouse, eyes to observe computer output as well as input wherever retina used as biometric credentials. Some use of voice, head and body position in HCI.
- Hearing is helpful to come to know about system functioning status via beeps from the CPU.
- Various beeps patterns are used to show the status of working, error message of the system.
- Apart of this hearing is used to know about press of keys on keyboards.
- Hearing is used in entertainment, communication via internet based calls, recording etc.

Q. 2.2 Explain Visual Channel and vision of human?

Ans. :

Vision

The Eye is one of the prime source of information for human. Human vision is made up of many sequential actions based process, it is a less complex activity too.

(A) Eye

- Human vision can be grouped into two for better understanding; first the physical reception stimulus from the outer environment, second visual system and physical properties of the eye along with many universal properties of functioning eye.
- Many things can be visually perceived while few things cannot be visually perceived by the human eye.
- Light is an important aspect of the human eye. Eye mechanism begins with light only.
- The eye receives light and transform it into electrical energy, that is reflected or emitted from an object in the environment.
- With light-based reflection of an object in the human eye is focused upside down on the back of the eye. It gets transformed into an electrical signal by the receipt or in the eye. These electrical signals produced by receptor are passed to the brain.

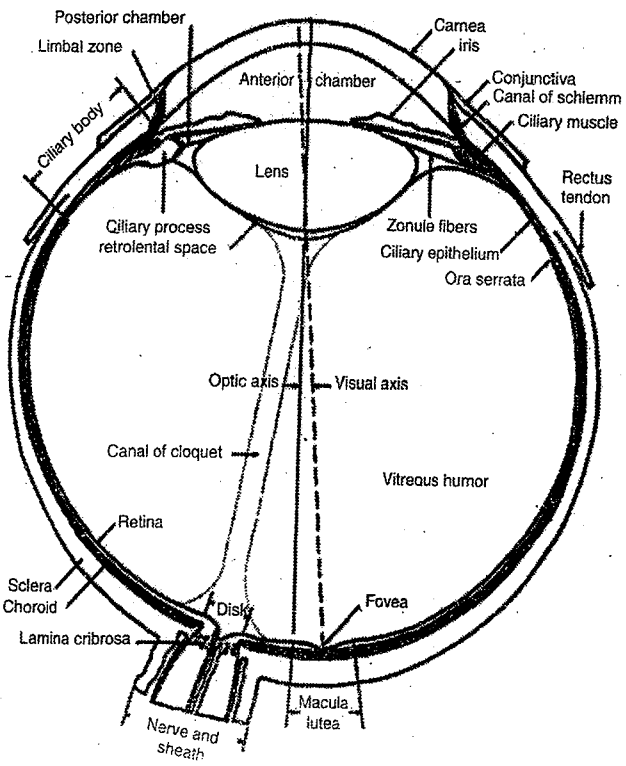


Fig.1-Q. 2.2 : Human Eye (Horizontal Section)

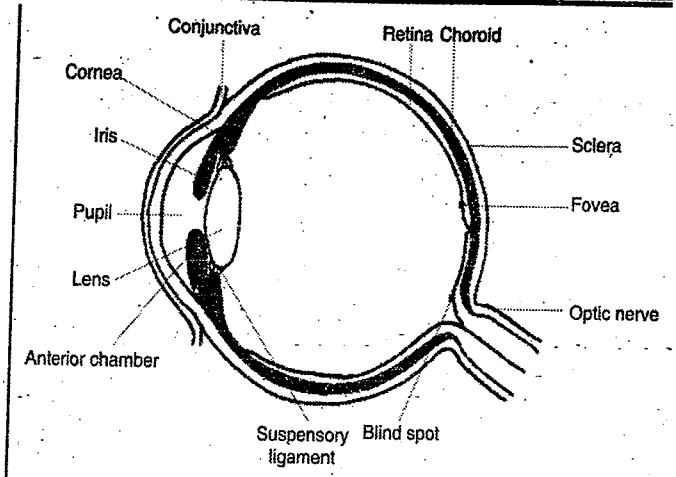


Fig. 2-Q. 2.2 : Human Eye

- The human eye consists of Cornea, Iris, Pupil, Lens, Blind spot, Fovea, Retina(rods, cones), Sclera, Conjunctiva, Anterior chambers, Suspensory ligament, Optic nerve etc.
- Light reflected from the object firstly appear on the cornea to the lens to a sharp and from the lens to a sharp image upside down onto the retina. The retina is highly sensitive in the case of light shades.
- Rod dominates peripheral vision. Approx. 120 million rods were present in a normal human eye situated towards the edge of the retina.
- The rods are the photoreceptor based at the retina which are more sensitive to light and provides a low level illumination.
- Saturation of the light may occur due to unresolved fine details at the rods edge of the retina. Sometimes makes a temporary blind spot.
- **Example :** After walking into the dark light sudden appearance of sunlight. The cones cannot function as those were suppressed by rods, normally we are unable to see anything for a while.
- Another receptor of human eye from the retina are cones. Compare to rods these are not much sensitive to light, hence it can have more light.
- According to wavelength and sensitive cones are divided into here types. This helps in color vision.
- Approximately 6 million cones are available at fovea i.e. a tiny area of the retina where images get fixated.

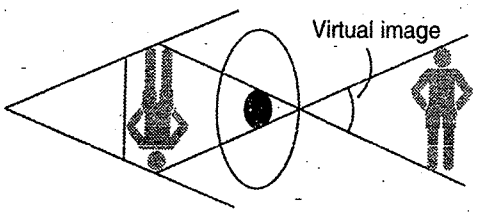
- Optic nerve extends in the eye via blind spot – Blind spot does not contain rods and cones like the retina.

(B) Visual Perception

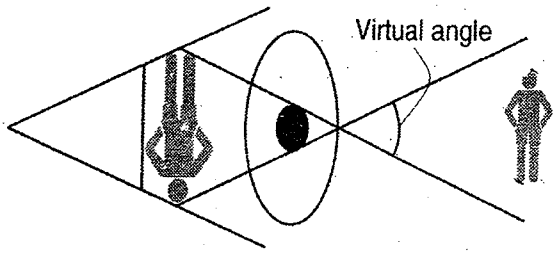
- Pictorial information input received by the visual apparatus must have to be filtered before passing it towards processing elements which allow us to recognize distance, color, scenes with their variations like disambiguate relative distance size, depth, differentiate to colors, coherence among scene brightness.

(C) Perceiving Size and Depth

- Consider you are on top of a hill and surrounded by a few trees at that top of a hill. You can easily observe road track from hilltop towards small villages or market on the downside, vehicle like bikes, car, buses, etc. moving to and from hillside road to the nearby marketplace.
- It means even though trees near to you are big enough closer compared to other, vehicles like car, buses looks comparably smaller than original size you can recognize the objects apart of sizes. Just by the size, depth, relative distance of an object we can recognize.



(a) Visual angle



(b) Visual angle remain some for different size and distance object

Fig. 3-Q.2.2 : Visual Angle

- As we discussed an image of an object formed upside down on the retina. Apart of relative distance, the depth of an object, it has same visual angle with retina.
- Degree t minutes of arc unit for visual angle measurement are as follows :

  1 Degree = 60 min of arc

  1 min of arc = 60 sec of arc
- If the visual angle made by an object is very tiny, we cannot perceive the object at all.
- An ability of a human to perceive fine details is by its visual acuity. The large number of eye test was available to measure visual acuity.
- In case of rotating or moving object, once you can see objects, i.e. perceive the object and even it went away, our perception about that object remain same even its passing away even though a visual angle changed.
- Similarly a person's height once perceived, remain constant even if its visual angle changes.
- This phenomenon known as 'law of size constancy' it tells about the perception of size depending upon factors other than visual angle.
- Perception of depth is an important factor to determine relative position and distance of an object. Generally size, and height parameter help to clue about distance of an object.

(D) Perceiving Brightness

- Brightness is another important factor like size and depth. Brightness is directly concerned with level of lights and luminance i.e. light excreted or emitted by the object.
- Luminance depends on surface properties of an object and light falling upon it. Photometer is unit to used measure the physical characteristic.
- Contrast and luminance are relating factor, its luminance of an object background and it's the function of a reflecting object respectively.
- As per amount of luminance, brightness changes. In case of dim light, the rods of the human eye predominate vision.

- As very few rods present at fovea objects in dim light can be seen less easily when fixed upon and these objects were visible in peripheral vision.
- The Rods take over charge in case normal light. With increasing luminance, visual acuity increases. Flickering also increases with increased luminance.
- More than 50Hz switching light ON and OFF will treated as light perceived as ON. But if speed reduced or less than 50Hz light perceived as flicker.
- Flicker over 50Hz can be perceived in case of high luminance. Flicker is noticed in peripheral vision, i.e. more larger the display, the more chances about its flickering.

(E) Perceiving Colors

- Color is made up of three component Hue, Intensity and Saturation. An average person can discriminate 150 different hues. Spectral wavelength of light is used to measure hue factors of the color.

Table 1-Q.2.2 : Color with respective wavelength

Color	Wavelength
Blue	Short
Green	Medium
Red	Long

- Brightness of color depends on the intensity and whiteness of color depends on the saturation. By varying brightness and whiteness in the color 7 million perceivable colors can be obtained.
- A human eye easily perceives color with the help of cones. Cones are highly sensitive to light as per distinct wavelength.
- There are here types of Cones for three different types of colors Blue, Green, Red.
- Best color vision is due to fovea while worst color periphery due to Rod predominately activity.
- Most of people are unable to discriminate between Green (medium wavelength) and Red (long wavelength) colour 3 - 4 % area covered by fovea is sensitive to blue light and make blue acuity lower.
- It should be noted approximately 8 % male and 1 % female are having problem in discriminating colors or suffer from color blindness.

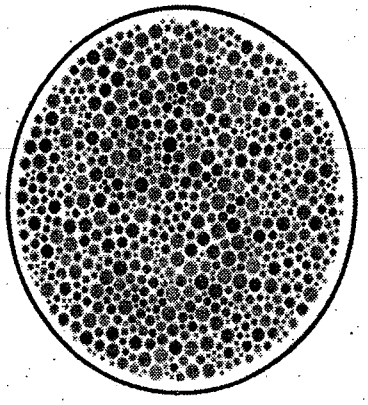


Fig. 4-Q.2.2 : Gray-Black Color Test: A Normal Human Can Observe Digit 5 Like The Pattern

Q. 2.3 What is Human Memory ? Explain its hierarchy.

Ans. :

- Memory is like hard disk drive we store and retrieve information but from memory few things can not be recalled as human forget.
- Forgetting information from memory happen due to some reason. Memory has several abilities like encode, store, retain, recall information, stored past evidences used to recall information some times.
- On pattern of store, recall information human memory grouped into three types

(1) Sensory Memory

(2) Short Term Memory (STM)

(3) Long Term Memory (LTM)

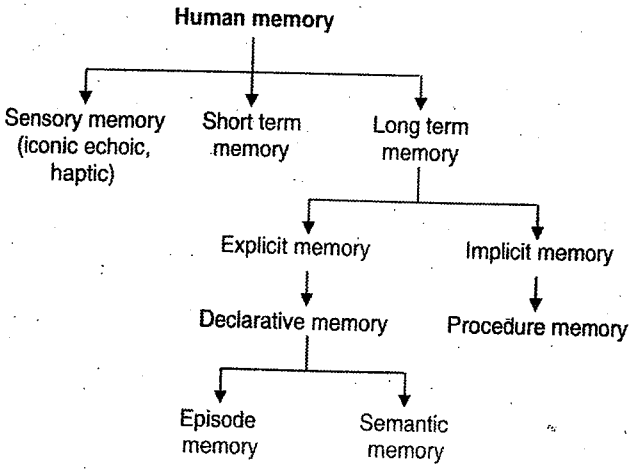


Fig. 1-Q.2.3 : Human memory hierarchy

Q. 2.4 Explain Sensory Memory

Ans. :

- Sensory memory works like buffer for memory system. Its buffer get input from stimuli received via senses.

Table 1-Q. 2.4 : Sensory Memory Channel and Stimuli

Sensory Channel	Stimuli	Approx Duration
Iconic memory	Visual	0.5 sec long
Echoic memory	Aural	3 – 4 sec long
Haptic memory	Touch	< 1 sec long

- Iconic memory has some persistency issue i.e. appearance of image even after removal of stimuli.
- **Example :** Fireworks a moving sparkling fire crackers leave persistent image.
- Echoic memory is experienced by the human ability for existence, direction of origination of sound.

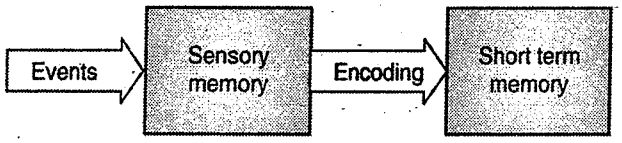


Fig. 1-Q.2.4 : Sensory Memory Model

- With help of past experiences it try get newly information of rare sense information sensation.
- In case haptic sense, few things touch we recall at any time while most of haptic stimuli we forgotten depending on our concentration, recall to it repeatedly.
- We can recognize some face, voice, sometime touch even we are in noisy, crowded place, even we are not much familiar, How ? Just like earlierly discussed cocktail party evidence.
- It is because we are able to keep our focus on selective manner with the help of very short capacity based sensory and mental processes.
- Aurosal decide to which stimuli should be used to attend sense.

Q. 2.5 Design and explain an experiment of investigate the decay aspect in human short term memory.

Ans. :

Short Term Memory (STM)

- Short term memory also called as working memory, it as a scratch pad as used for temporal recall.
- To recall a long sentence of calculation which you do orally i.e. with pen and paper, we used intermediate stage of storage i.e. short form memory.
- Short term memory has a rapid access approx 70 ms. similarly its decay factor is also rapid. It's capacity is less.
- There are two types of methodologies for measurement of memory capacity. In one approach length of a sequence needed in on order while another approach items can be recalled randomly.
- With first approach an average person can recall 7 ± 2 digits from the experiments of miller. If you can recall digits from a pattern of digits around five to nine, it means your digit span is average.

Try it out pattern I :

5 6 2 4 9 1 7 8 3 2 6 9

And now try this pattern II :

562 491 783 269

- Recalling digit from pattern II is little more easy and number of digit recalled is comparably more because pattern II digit arranged in group or chunk.
- 7 ± 2 rule is nothing but 7 ± 2 chunks you can recall (information retrieval).
- The successfully created chunks are known as closure. Chunks and closure helps to improve short term memory.
- From a sentence, we can recall last word more easily than middle (as per some experiments) is called recency effect.

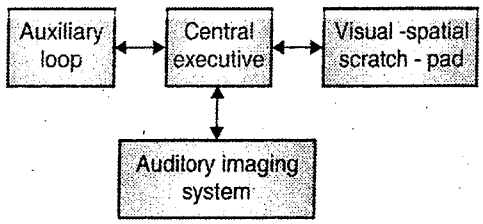


Fig.1-Q.2.5 : Model for short term memory

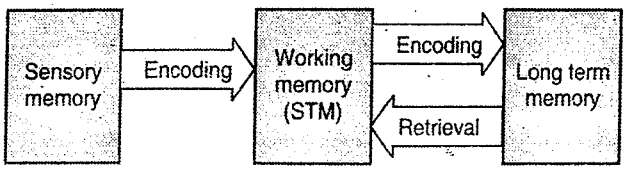


Fig.2-Q.2.5 : Short term memory operation

- Rehearsal improves working memory. Generally, 20 sec. duration is considered for working memory.
- Interference, and decay are two distinct factor which are concerned to working memory made it efficient for short term memory.

Q. 2.6 Write a long term memory model script for case given below: An owner went veterinary hospital along with dog. (Textbook considered other cases as example).

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Ans. :

Long Term Memory

- It is a more vital part of human memory, it is main storage of information what so ever we know by our stimuli, reading, writing, observation, listening activity, past experience and so on.
- Long term memory is with large capacity storage of information with a potentially unlimited duration.
- Episodic memory and semantic memory are the two types of declarative memory which comes under explicit memory. Procedural memory is branch of implicit memory. While explicit and implicit memory combinely form a long term memory.
- Episodic memory has information of events and experiences in serial approach. It is made from our lives daily experiences.
- Semantic memory is factual experiences, skills which person posses. Data or information to semantic memory is derived episodic memory as past experience used by semantic memory.
- Semantic memory works like linked list in data structure, it accesses information along with relationship between pieces of information.
- Semantic memory information model appears like a network structure parent class, child class, attributes in association.
- A model for semantic memory was postulated by Allan Collins and Ross Quillian. It is suggested that linking based sets of superordinate and subordinate were used to represent knowledge of objects, person, concept, events etc in a hierarchical manner.
- For example, a property which categories fish (gills and swimming) are kept at one level. Gills and other similar featured types fish (like shark, salmon) not kept with different types fish. Similarly with appropriate properties birds also kept in structure where birds were super ordinate of canary is an animal.

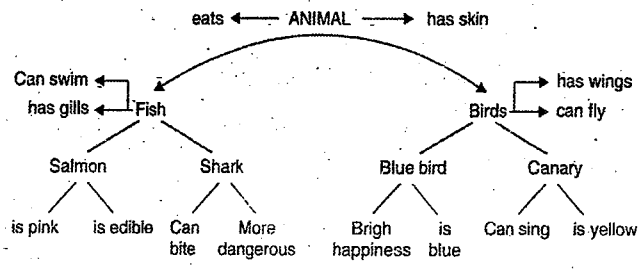


Fig. 1-Q.2.6 : Collins and Quillian's model of portion of hierarchically organized memory structure

Q. 2.7 What is reasoning? Explain different types of reasoning with examples.

SPPU - Aug. 2017 (In Sem.) 5 Marks

Ans. :

- Thinking is an ability carried with the help of memory past experiences, knowledge, information, etc., to achieve a goal or to solve some puzzle or problems. It is cognitive function ; a meaningful mental representation.
- Reasoning is selective and controlled approach of thinking at higher level in a systematic and with the help of stepwise meaningful metal capabilities.
- Decision making is an art of choosing best policies among a wide set of policies, it is also a cognitive function.
- Problem solving is an ability to define a problem (with related sub problems), understand problem, thinking on reason to arise problems, remedies to be applied to solve problem and precaution for non-existence of the same in near future.

Inductive, Deductive and Adductive reasoning are the three types included in reasoning.

(A) Inductive Reasoning

- Inductive reasoning is a process of continuous learning from the environment a part of its unreliability issues. Like all Elephants has a trunk , all Monkey has a tail

we observed it many times. But if anyone asked to prove it, we need to collect evidence or even if someone has to prove it is not true, then that user needs to collect evidence for the same.

- Wason suggested a theory about inductive reasoning, will see it with the help of an example: Each card has a letter on one side and number to another. Which card you prefer to pick the truth of the test of a statement ' If a card has an odd number on one side and a vowel on the other'?

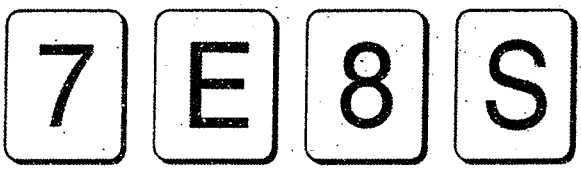


Fig.1- Q. 2.7 : Wason's Card : An Example

- What will be your answer, a common response will come with 7 and E, it used only positive evidence. To check with negative evidence we must check a card with odd numbers and what is a letter on behind of it, even we preferred 7 and it may have a vowel at back side or not? i.e. if it has a vowel, then also as per statement, we chose correct card. Checking with this approach is negative evidence.

(B) Deductive Reasoning

- It is a type of a general statement, logic to a specific conclusion.
- Syllogism arguments are written in the form of A is B, C is A therefore B is C.
- Example :
  - It uses a general statement
  - General Statement: All men are mortal
  - With the help of specific reference
  - Specific Reference: Socrates is a man
  - It reaches to a conclusion
- **Conclusion :** Socrates is mortal
- The Table shown below is with major and minor premises and conclusion brought from both premises.

Sr. No	Major Premise	Minor Premise	Conclusion
1.	All men are mortal	Socrates is a man	Therefore, Socrates is mortal
2.	All apples are fruit	A Johny Smith is an apple	Therefore, Johney smith is a fruit.

(C) Abductive Reasoning

- It is based on the fact or action of the object concerned. For example: Esha drives vehicle fast when she has been drinking.
- You know her for such habits. If we see Esha driving a car with high speed, an observer may infer that she has been drinking.
- It may be very unreliable; as she may have been called for some emergency.
- Such infer may lead to confusion, even error as action are unrelated. Without any evidence or support theory, unreliable reasoning was made.

(D) Problem Solving

- It is process of solving a problem with the best of human past experience, knowledge and reasoning ability.
- Few information processing theories are proposed in problem solving i.e. Gestalt Theory and Problem Space Theory by Newell and Simon.

(E) Gestalt Theory

- According to psychologist Gestalt problem solving is reproducing known responses or an approach of trial and error.
- While few behaviorists suggested problem solving is productive and reproductive both, reproductive problem solving approach requires previous experience and productive problem solving approach requires insight and restructuring of the problem.
- Psychologist Gesalt backed up his approach with very few experimental evidence and it is attractive as concern to solve the problem. But due to insufficient evidences and not providing information about when and how restructuring occurs, it remains bit restricted.

- Another popular example with merely similar approach from Maier's pendulum problem (1931) i.e. based on productive restructuring.

Example based on Maier's Pendulum Problem

- The two strings dandling from ceiling are too far apart for a lady decorator to grasp them both a the same time; How can she (user) use the objects in the room to help her to tie them together?
- She used weight of pliers as a pendulum to swing the string. When experimenter brushed few things she found solution in problem itself. The string movement had given insight which allowed the her to look at the problem in a completely new way. This example also illustrates fixation: She (user) were initially was not able to see beyond use of pliers.

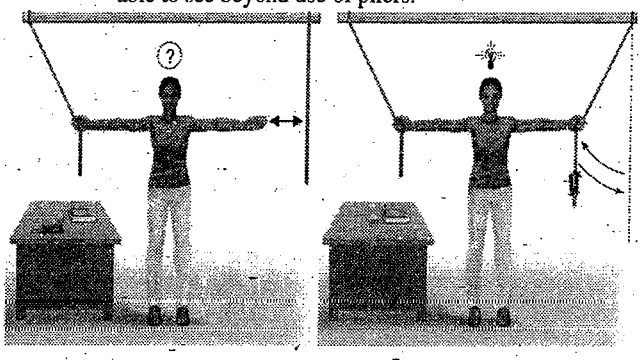


Fig.2-Q. 2.7 : Example based on Maier's Pendulum Problem

(F) Problem Space Theory

- The Problem solving center is based on problem space suggested by Allen Newell and Herbert Simon (1972). Generation of states is required in problem solving with the help of legal state transition operators.

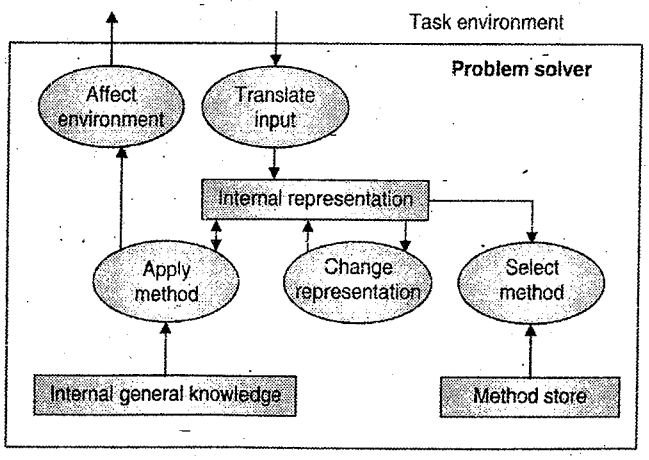


Fig.3-Q. 2.7 : A Schematic Newell and Simon's (1972) General Theory of Problem Solving

- A problem is the perceived difference between the current object and desired object.
- An object is a thing, where the problem is related.
- An operator is a thing which is applied to produce a different object. A heuristic information is used to relate operators to reduce differences in between them.
- Theory of problem solving is discovered and to understand the system of heuristic.
- A problem has two states, one is the initial state and other goal state, an appropriate operator required to reach the goal.
- Heuristic in means-end analysis is the initial state compares with goals state to chose operator to reduce differences between two.

Q. 2.8 Define Human Emotions

Ans. :

- According to James-Lange theory, emotions are the interpretation of the human psychological response. Psychologically we try to respond to a stimulus and try to interpret the same in emotion.
- Common sense says, we lose our fortune, are sorry and weep; we meet a bear, are frightened and run; we are insulted by a rival, are angry and strike.
- The hypothesis here is that we feel sorry because we cry, angry because we strike, afraid because we tremble.
- Emotion is generated with the help og cognitive and physical events.
- Donald Norman says : Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks.

Q. 2.9 Explain Emotion Influences Human Capabilities

Ans. :

- Emotion has a powerful impact on our daily decision making, reasoning and thinking ability. Human capabilities are influenced by emotions.

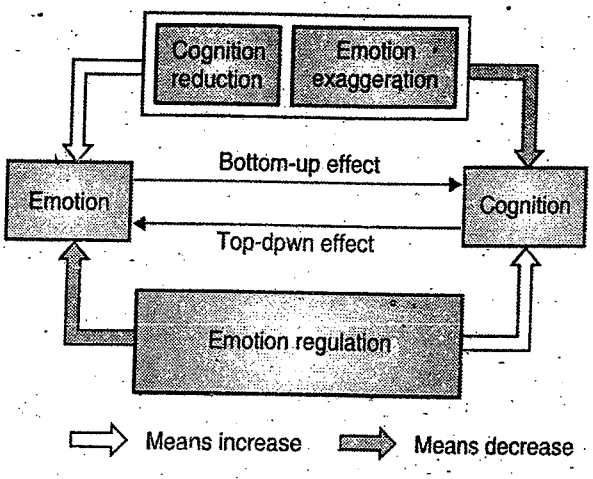


Fig.1-Q.2.9 : The Interactive Influence Model of Emotion and Cognition

- Our environment is full of our past experiences like achievements, failures, relationship, etc. and current scenarios like education, career, friends, family, job, business, culture and so on.
- Environment can be distributed in cognitive, behavioral, emotional, physiological aspects.
- Where cognitive is thoughts, belief, self talk; behavioral is behaviors, actions; emotion is feeling, mood; physiological is genetic, physical, biology, etc.

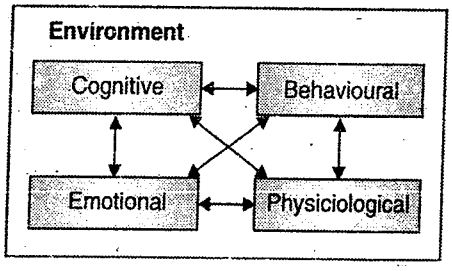


Fig. 2-Q. 2.9 : Human Emotion- Cognitive- Behavior- Physiology Elements Interaction

- Human thoughts were affect with his emotions, physiological state and behavior.
- Human behaviors affect with his thoughts, physiological state and emotions.
- Human emotions affect due to thoughts, behaviors and physiological state.
- Human physiological state affects on his thoughts, behaviors and feeling.

Q. 2.10 Explain Psychology and Design

Ans. :

- Psychology and design of system is one of the popular domain from Human-computer interaction (HCI). It works as a bridge between user thinking and reasoning capability with the technology, which is used to solve a problem.
- Users are observed on system. Psychological design aims to make an explicit consequences of design for its users.
- Psychological designers identify task which will be supported by the system. Few scenario are suggested to took test of task.
- Psychology help to identify target to design and provide few concerned perspective guidance. It is helpful for concluding design as succeeded or failure.
- Mainly three goals are in consideration at the time of interaction design:
- **Interaction Design:** For young age group users like students and learners who want to design highly interactive applications, social networking web sites, interfaces, and digital products.
- **Strategic Design Planning:** Its like beginner stage of learners and experts of human computer interaction, such users needs own design consultancies, digital technologies
- **Creative Activity:** For researcher and developers who deeply interested in every user with their own psychology or distinct and different thinking ability to create a new interface or object. Accordingly they try to communicate with those object. As each user has its own set of requirement in a system, they try to each user a more accurate interaction.

Chapter 3 : Understanding the Interaction

Q. 3.1 Explain Donald Norman's stages of Interaction.

SPPU -Aug. 2017 (In Sem.), 5 Marks

Ans. :

It constitutes four stages of execution, three stages of evaluation.

Chris Heatwole described Donald Norman's stages of interaction along with a few scenarios mentioned below :

➜ **Stage 1 : Forming a Goal**

This is what you want. As an example, I might want a place that I can relax outside that won't get muddy and that I don't have to move my outdoor furniture around to mow.

➜ **Stage 2 : Forming the Intention**

This is what would satisfy the goal. A deck would satisfy my goal of a place to relax outdoors that won't get muddy or be in the way of mowing.

➜ **Stage 3 : Specifying an Action**

What do I have to do to achieve the intention? I would need to build a deck to meet the requirement set in my goal.

➜ **Stage 4 : Executing the Action**

Here I would do the steps of the action. I would build the deck.

➜ **Stage 5 : Perceiving the State of the World**

Using the senses to gather information. My finished deck would be off the ground and have my outdoor furniture on it.

➜ **Stage 6 : Interpreting the State of the World**

What has changed? My furniture is off the ground away from the mud and no longer has to be moved to mow the lawn.

➜ **Stage 7: Evaluating the Outcome**

Did I achieve my goal? I can relax outdoors now without worrying about mud or moving furniture. I achieved my goal.

Q. 3.2 Using Norman's terms describe and provide specific examples of how current user interfaces on these mobile devices succeed or fail in applying effective design. Refer specifically to AT LEAST FOUR of Norman's following terms, describe how the preferred computer interface capitalizes on :

Scenario : Today's portable computers and mobile devices include use several features to enhance us ability including a pointing device such as a mouse, overlapping windows and icons that represent different types of functions, audio cues and touch screens.

Ans. :

- The iPhone has several successful designs. Physical constraints constrain the possible operation. The touch screen of the iPhone changes to what the user needs, and limits the options available.
- When the phone rings, a button appears to answer the call, and another appears to decline. Those are the only two options available, so those are the only two buttons that appear on the screen.
- There is no confusion on what to do, or how. You simply select one or the other.
- A similar scenario appears if a call comes in while the user is on the phone. Options are limited on how to handle the situation, but the user doesn't need to have memorized a routine.
- The screen clearly lists the options and the only buttons to select are for those options. There are no extra buttons to distract or confuse. Semantic constraints deal with meaning in the situation.
- Norman uses the example of a LEGO motorcycle. The driver must sit facing forward and the windshield must be in front of the driver. On an iPhone the screen is one side.
- The user interacts with this side and the camera is the only thing on the back because the user does not interact with the camera, but it points away from him/her to take a picture.
- The speaker for listening is on the top of the screen and the microphone is on the bottom because a person's ear is on top and their mouth is on the bottom. These things need to go where they are.

- Visibility is making relevant parts visible. The iPhone has very few interfaces besides the screen.
- The Home button has important functions and is clearly located on the front of the phone beneath the screen. It also has a square printed on it, and it is depressed so it is easily seen and felt.
- The switch on the side of the phone that can be used to turn the ringer off has a red strip printed on it that is visible only when the phone has been silenced.
- Buttons that appear on the screen, such as the open button or the answer button, are create large, placed centrally and are often a color to make them noticeable.
- The unlock button has lettering that scrolls to draw attention to it. Feedback occurs when the silence switch has been moved to the silence position.
- The phone vibrates when this occurs to signal that the phone has been placed in silent mode.
- Changing the volume on the phone gives a visible cue on the screen abuts also an auditory cue that lets the user know how loud the volume has been set to. And logical constraints happen when options are not available.
- The user knows that information needs to be input using gestures on the screen when the keyboard is not available. This happens when setting the time on a calendar event.
- These are no instructions on how to use the image on the screen, but since the keyboard have not appear the user knows that touching the screen will be necessary to input information. Here the iPhone falls a little short.
- The graphical interface for inputting information on the calendar is something that needs to be learned. It relies on the fact that it resembles a real-life object, but not everyone may be familiar with those objects. Cultural constraints are not satisfied with this feature.

Q. 3.3 Norman uses doors as frequent design examples. Do you agree that one design is clearly better than the other? At what point do you think designers should settle on a learning curve as opposed to being able to use the item the first time? Or should they never settle ?

Ans. :

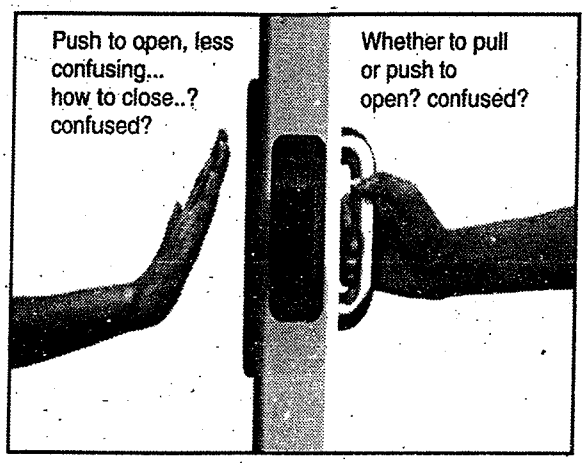


Fig. 1-Q.3.3 : An Example of a door design for better illustration of a problem statement

- One problem with the design is that the bar to open the door does not indicate which side of the door needs to be pushed to open the door.
- The bar can be pushed from anywhere. The appearance of the handle is uniform and balanced, so it looks aesthetically pleasing. The other bar is designed so that the user should push on one side, the side that the door opens.
- While it would be possible to try and push on the other side, logic should tell the user that the handle is on one side and that side should be used. This makes it less likely that the user will attempt to open the door from the wrong side. It is a better design.
- Designing something so that users get it correct the first time should be the goal of the designer. To say that most will get it correct isn't enough?
- As Norman points out, just one percent of the population is still millions of people. It may not be possible to get it so that no one opens the door incorrectly, but that number should be extremely small, certainly not millions of people.
- However, there are times when a learning curve is going to have to happen. But this should only occur when a device is completely new.
- The introduction of the mouse to control a GUI operating system was not like anything before it and was going to have to be learned. But in these cases the learning curve should not be extreme.

- It should not take long to learn the new skill. The device should also be limited in its abilities to minimize the learning curve.
- Unnecessary features should not be added. The features that later showed up the mouse, like multiple buttons, wheels, and track balls would have been too much of a learning curve on the first mouse models.

Q. 3.4 Explain the term Ergonomics

Ans. :

- If ergonomics is studied at the special level than concerned with HCI only then it is more about human psychology and system constraints.
- It is more in details with arrangements of controls, displays, health issues, use of color, physical environment etc.
- In case of arrangements of controls and displays:
  - A set of frequently used controls and some part of displays should be arranged logically so user can get easily rid of it.
  - Controls and displays should be grouped with the help of functional control, sequential control and frequency control.
  - Inappropriate arrangements and sequence of controls in a tool, display of icons leads to inefficiency and frustration both in daily practices.
    - For example: if a tool allows Esc key to back from any pop up notification on a screen, it should be uniformly work within all modules, it should not happen user needs to use click event of a mouse or enter key at sometimes.
  - Critical display should be placed at eye level, while a use of proper light to avoid reflection and glare.
- In case of physical environment of interaction:
  - Who will be the user? Where it is going to be in use? Whether users interacting by sitting, moving or standing position with the device? Likewise, more question arise will come into picture as per discussion within a specific domain.
  - Ergonomics focuses on the physical environment along with the layout and arrangements.
  - For a long period of works user should sit comfortably, it has a proper space to move around all the controls easily. Improves efficiency of the user.
- In the case of Health issues: It arises due to poor design, layout and arrangements of devices. The improper quality of physical interaction leads to health issues:
  - **Physical Posture :** It is needed in a way to get a proper display without any efforts as well as to reach all controls easily.
  - Some support should be allowed to rest the part of the body for a long time activity like mouse pad with wrist support for animation or design task where use of mouse is more, wrist support to keyboard tray.
  - A proper chair to rest back comfortably with the good hand rest with adjustable provisions.
  - **Temperature :** A extreme hot or cold will affect a performance. Let say some network efficiency tests are held in a shielded room, in such environment a normal human cannot work efficiently with a good concentration for a long time as its coldest. Similarly, in case of server room too.
  - Lighting should be in adequate form so a user can observe a monitor screen easily without any eye strain. It should be maintained to avoid glare and reflection.
  - The noise level should be maintained at a comfortable level.
  - Time spend on the system should be in a controlled manner. Excessive interaction with long time may affect issues with back pain, eye strain, care should be taken for in case of pregnant women for eyestrain and accessing controls etc.
- **In the case of colors :** Generally red, green and yellow color we follow in a daily practice for red to stop, green to go and yellow to standby or wait and watch, similarly red should be used to inform about emergency and alarms, yellow in standby or an auxiliary action, green to routine and normal activity.
- Use of blue color should be avoided to display critical information. Color has its own culture everywhere, it is not uniform like red is happiness and good fortune in China while rest of others think it as dangerous.

Q. 3.5 Explain the term WIMP Interface

Ans. :

- It is introduced at Xerox PARC and later popularized by Apple Macintosh and nowadays mostly used by Microsoft Windows OS and others.
- WIMP stands for Window, Icon, Menu, Pointer. There are some additional objects used in a WIMP interface like buttons, toolbars, palettes, dialog boxes etc.

(A) Windows

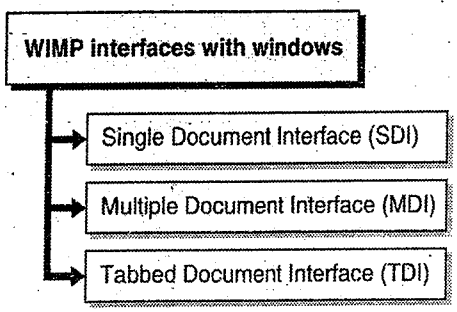


Fig. 1-Q.3.5 : WIMP interfaces with windows

- Windows are designed with text, icons and buttons. A user can view, edit, modify or update content on it.
- It has scroll bars for viewing large scaled documents. Buttons are used to maximize, minimize, close, resize, save, save all, compile, debug, run, stop, redo, undo, refresh, back, forward, print and so on activities depends on the window belonging to which application.
- Window uses frames to make groups of icons on the basis of operability and functionality.
- WIMP interfaces with windows in tiled or overlapping or cascading approach :

➜ (1) Single Document Interface (SDI)

- Each primary window is assigned to each instance of the application.
- **Disadvantage :** Task bar gets full when many documents are opened. Each primary window consists of program's toolkit and menu, moving from one window to another is difficult.
- **Advantage :** It is less complex in visual point of view as primary window and document window are connected.

  E.g. Notepad or text editor.

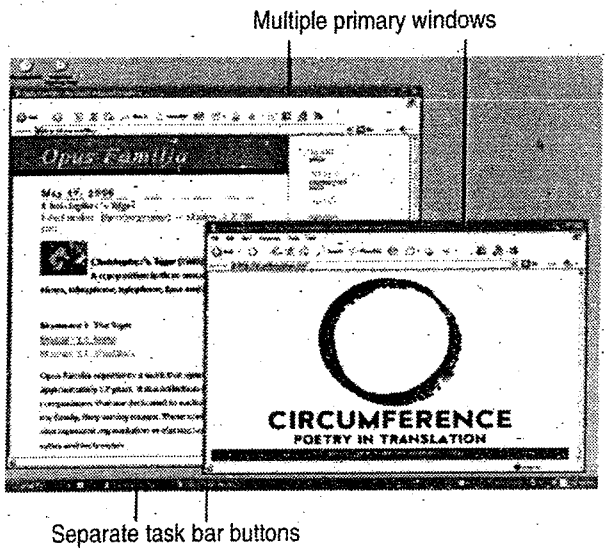


Fig.2-Q. 3.5 : An Example of SDI

➜ (2) Multiple Document Interface (MDI)

- Multiple windows are residing under one parent window, multiple documents can viewed at a time. E.g. Adobe Photoshop. A sometimes minimized child window in a parent window makes visual complexity.

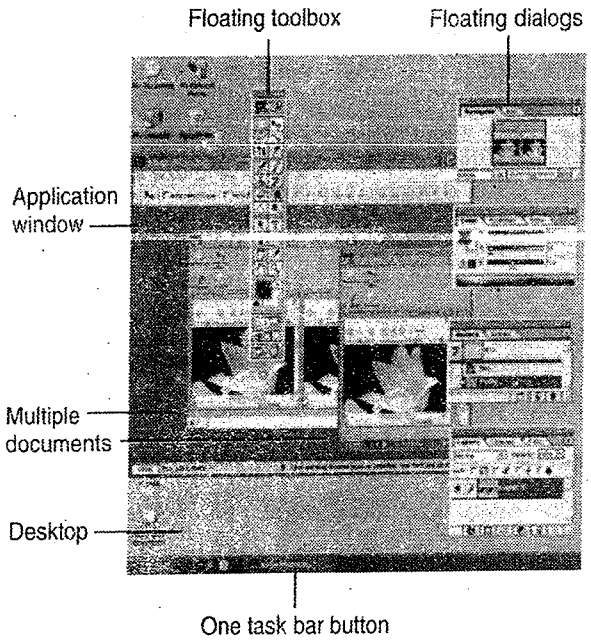


Fig.3-Q 3.5 : An Example of MDI - Adobe Photoshop

➜ (3) Tabbed Document Interface (TDI)

- Multiple windows can be accessed with help of arranging them in a tab, one tab can be viewed at a time. Multiple tab can appear in a sequence. E.g. Web Browser Applications.

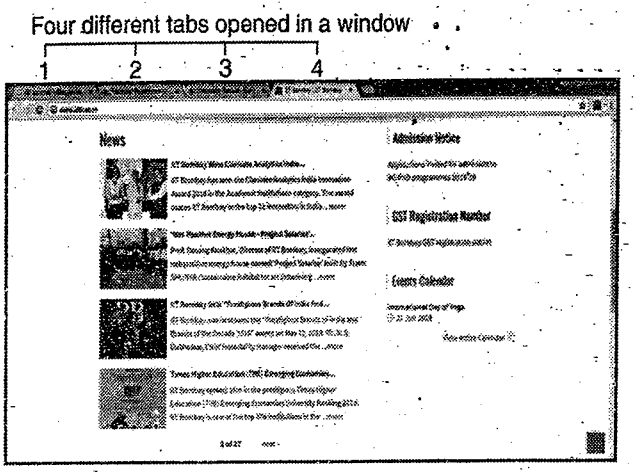


Fig.4-Q. 3.5 : An Example of TDI - Google Chrome® Web Browser Application

(B) Icon

- These are graphical representation with or without buttons, describe some actions or event or notify some information like warning, error, close, stop, go etc. Iconifying is shrinking of window or resizing of window with the help of some icon.
- Icon also used to give a reminder about some periodically activities like updates to install, battery status, LAN or Wi-Fi status, Speaker On or Mute.
- Different icons are used as per the nature of the file. Some set of icon represents a word or test file similarly for image file, application file, system file etc.

(C) Menu

- The Menu can be categorized into Pop up menu and pull down menu.
- Options in the menu can be arranged as per designer and user point of view.
- Some menu provides option in a list below to menu item, some menu and options are provided in a circular fashion too. depending on how interactive user interface you required, targeted user group.

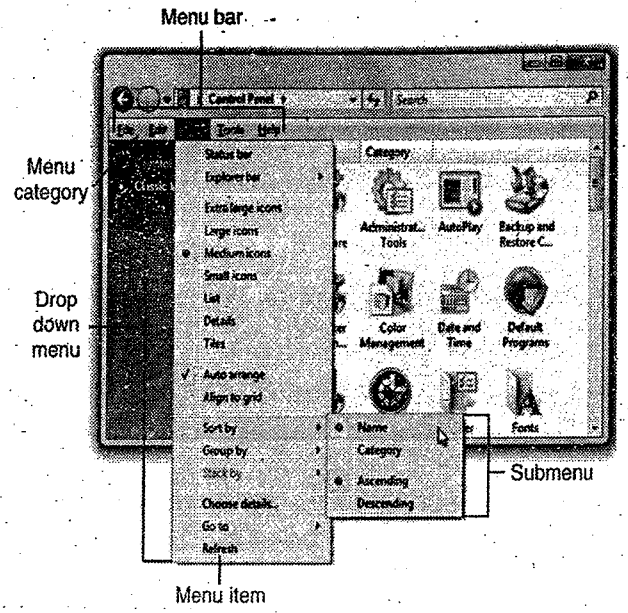


Fig.5-Q. 3.5: An Example of A Typical Drop Down Menu With Options From Control Panel, Microsoft® Application

- For mobile camera application menu is shown in a circular way and options in a list of few handsets.
- Some gaming application has menu and option both in a circular fashion.

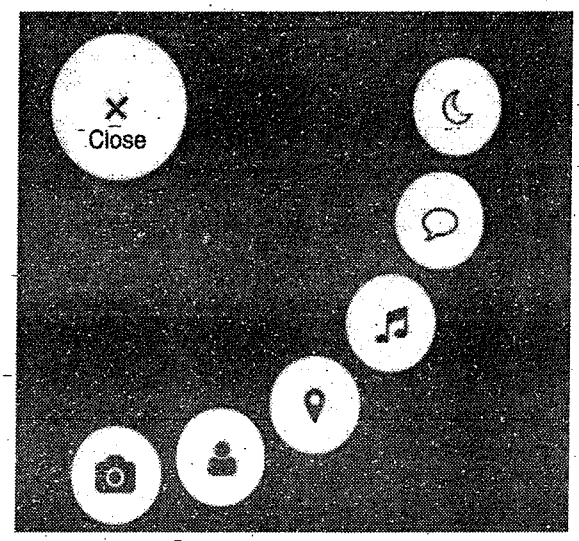


Fig. 6-Q. 3.5: A Circular fashion of Menu (close) and Options (camera, music, chat etc.)

(D) Pointers

- The pointer is an essential element drag and drop, selection of menu, options, buttons and icons.
- Various style pointer cursor is in use. Depending on tool set of the cursor is used. Like the Select tool and

Hand tool for pdf reader, blinking line pointer in a text editor or command prompt.

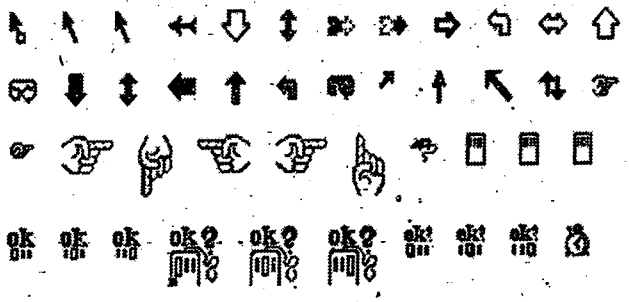


Fig. 7-Q. 3.5: A variety of pointer cursors. Source: Sun Microsystems, Inc.

- Cursor also helps to inform system status like an hour glass indicate the system is busy. Few cursor changes shape and size as per task associated.

(E) Other Interfaces

- Dialog boxes are used to interact with immediate interaction in case of urgent input are required or notifying information to users for a specific task.
- The Palette is a collection of icons made up of reminiscent of the purpose of the different modes. Palette can create with the help of some menu and option in some system.
- Toolbars with full option and icons are available in many tool placed horizontally or vertically on the sideline of the window of the tool.
- Buttons has own identity in the interface.
- It has effects of highlight on mouse above and mouse over, click etc. Buttons are designed with 2D or 3D effects, icons on it.
- It has a set of functions assigned to it depending on the system which work on a click button event in which push buttons are used.
- Option button, checkboxes, push buttons, radio buttons (toggle button)such types of buttons was in use.

(F) Develop a System Menu

- Basically, new user and inexperienced user are learners of the system, they keep learning from environment of system with the help of menus.
- The menu should be designed with an approach where a experienced and inexperienced both user should be satisfied.
- In properly designed system menus are most wide and frequently used, it assists users to work in environment. Menus need to be recognized, user cannot recall menus; hence it utilizes users capability.
- While designing a graphical system, it should be kept in mind that system they designate command, properties which are applied on documents, windows and objects.
- A graphical menu may lead to sub menu or a display some data on new window or perform some action within a same window.
- It may require menu like menu bar with push-ups, pull-downs, tear offs, cascaded, iconic menu etc.
- While designing a web system, it should be kept in mind that system they designate web pages are applied as text and multimedia based representation as well as interaction.
- Menu includes hyperlinks in textual or image format, command buttons, textual toolbar, graphical toolbar.

Q. 3.6 What parameters are considered at the time of developing a system menu at designer side?

Ans. :

- Menus can be studied with several parameters like :

(1) The Structure of Menus

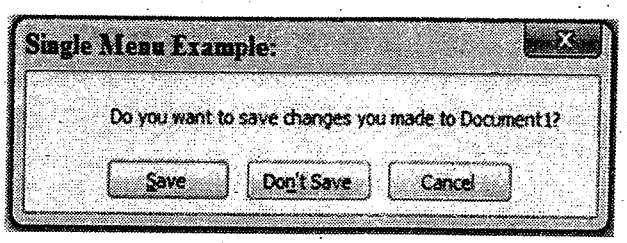
- Structure of menus provides flexibility to the user to access the menus via large or complex menu with the hierarchical order while a small menu can be organized with the help of dialog box.
- Here, we will see few structure of menus :
  - (a) Single Menus
  - (b) Sequential Linear Menus
  - (c) Simultaneous Menus
  - (d) Hierarchical Menus

(e). Connected Menus

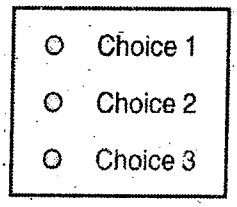
(f) Event Trapping Menus

➜ (a) Single Menu

- An immediate consequences of the option being selected should be concentrated. Even it has few more options it will be initiated in other menus.
- A single menu is concentrating on users single choice with a simple design. It is as simple as Yes / No questions.



(a)



(b)

Fig.1-Q. 3.6: Single Menu Example

➜ (b) Sequential Linear Menus

- It is a series of options need to select from a every small question arise or single menus.
- A long series of sequential menus is not good practice as user not remind exactly what answer submitted or chosen in very first menu, if some linked questions are asked in sequential linear menus.
- User found it tedious as menu after menu is presented. If user wants check what answer submitted or options selected in earlier menus then long or complex process needed to be completed.
- As all menus are important user need to attempt all without skipping as they are arranged in a sequence linear approach.

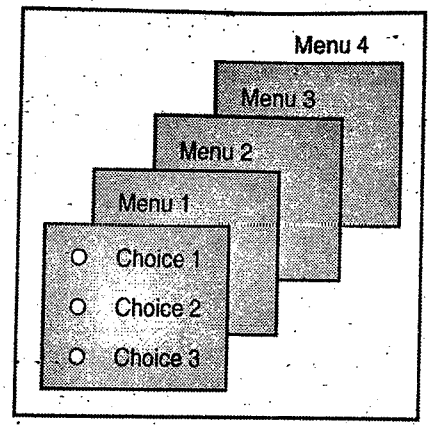


Fig. 2-Q. 3.6: Sequential Linear Menu Example

➜ (c) Simultaneous Menus

- All choices are at once available with different menus help to figure out possibilities and comparison, no need to remind choice or preferences for previously attempted or other menus.

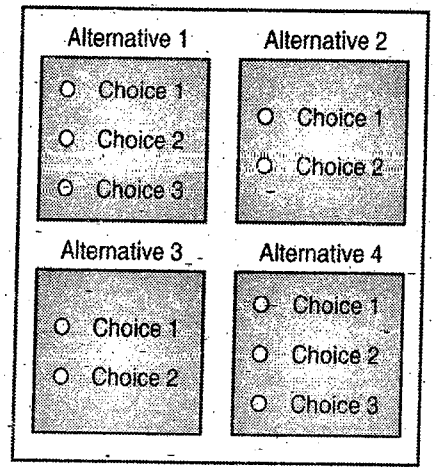


Fig. 3-Q. 3.6: Simultaneous Menu Example

- This kind approach makes easy representation of menu dependencies and relationship. Sometimes, it is helpful while improper or poor relationship leads to confusion.

➜ (d) Hierarchical Menus

- Use of the hierarchical structure to represent menus is the best structure to represent menus with possibilities of valid and eligible selection to allow to view sub menus and options.
- Depth and breadth are useful in hierarchical structure. Depth represents the level of menu and options while breadth represents the variety of different sub menu and sub option at same level.

- A top-down approach is mostly used where a parent node or root node has child node and sub child node. The Parent node or Root node is considered as level 0, at every next depth next level appears.

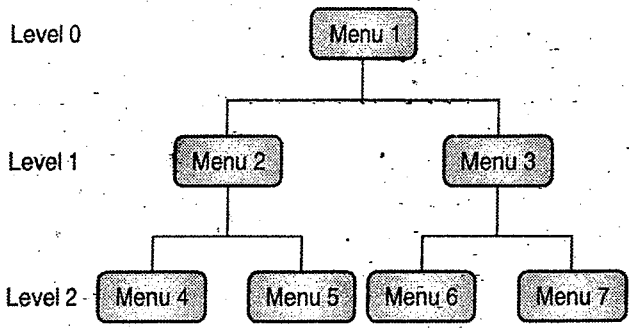


Fig. 4-Q. 3.6: Hierarchical Menus Example

➜ (e) Connected Menus

- It structure where menus are interconnected with each other. It seems like cyclic structure sometimes due to connectivity established among menus. It gives full control to user to traverse among menus.

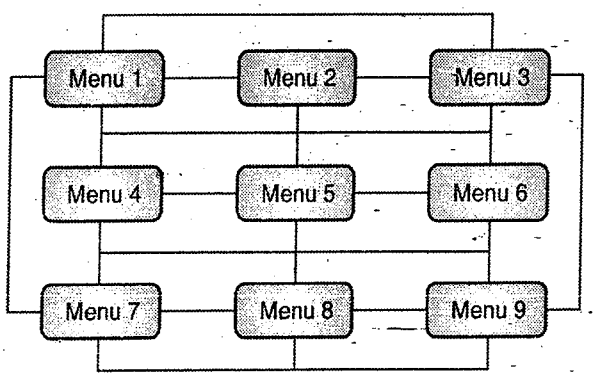


Fig. 5-Q. 3.6: Connected Menus Example

➜ (f) Event Trapping Menus

- It allows users to switch among foreground task to background task.
- It helps user to quick response to menus appeared from background task and rejoin earlier task without loosing any data or killing any process.
- For example, user selected some text from editor and applied copy function and switched to spreadsheet window and operated paste function.

(2) The Function of Menus

- Menu functions are navigation to new menu, execute an action or procedure, show cast some information, pass information or data to function.
- Navigation to a New Menu: Each user attempts to select some menu provides sub menus and options as per hierarchy made by the system.
- Execute an Action or Procedure: On traversing to expected menu, user select an appropriate menu among available options leads to execution of activities associated to the menu.
- Displaying Information: User's primary motive is to gain information, many times user need to reverse a long hierarchy of menu then only reach to expected information.
- Inexperienced user may spend more time but experienced user may retrieve expected information with the help following a proper sequence of menus.
- Data or Parameter Input: Certain sort of information is required from information to produce expected data, it is generally collected by dialog boxes of single menus structure.

(3) The Content of Menus

- It consists of context, title, choice description, completion instructions.
- A feedback from user is important to maintain the context as per user orientation. A verbal linkage or spatial linkage can be used to know the user's feedback.
- Verbal linkage provide a list of menus on screen which earlier preferred by user and on their selection user reach to recent menu or screen. Spatial linkage helps in graphical manner to express how previous choices made user to reach here in a single screen display.
- Menu title must reflect choice preferred on previously selected menus.

- Completion instructions are useful to inform the users how to indicate choices. Some explicit instruction may be need for inexperienced or new user but for experienced one such screen guidance seems time consuming.

(4) Formatting Menus

- A consistency is important in formatting which includes ordering choices, presentation and organization, navigation schemes choice selection methods.
- Display of menu which are frequently in use on screen for easy access. A grouping of menus should be done on logic and functionality basis to display on screen. Occasionally, required menus should pop-up on demand.
- Some common ordering policies should be maintained in formatting menus like :
  - Numeric ordering
  - Alphabetic ordering
  - Natural ordering
  - Small number of options
  - Separate destructive choices
  - Do not reorder menus
  - Consistency between menus.
  - Some common grouping policies should be maintained in formatting menus like :
  - Categorizing
  - Numbering
  - Ordering
  - Separation
  - Critical choices
  - Arbitrary visual grouping
  - Use of line separators in between groups.

(5) Phrasing the Menus

- Some common menu title policies should be maintained in formatting menus like :
  - Main menu
  - Sub menu
  - Keyword first
  - Capitalization
  - Task oriented wording
  - Parallel construction
  - Relationship to title
  - Consistency across menu
  - Numbering
  - Command language
  - Word as a command to computer.
- Use of keyboard keyboard equivalent (mnemonics, designation, keyboard selection), keyboard accelerators (ctrl+c: copy, ctrl+v: paste, cril+p: print, ctrl+n: new, ctrl+s : save, ctrl+x: cut, F1 : help, Esc: cancel, Shift+F10 : Display pop up menu) .

Q. 3.7 What are the Components of Windows ?

Ans. :

- Many types of elements are found on windows, for better practice same location should be used for elements which are common in different windows in a design layout.
- Few inconsistencies occur due to location of the element in different system like minimize, maximize and close button are placed at right top of the window in Windows while at left top of the window in Linux.

- A window can be distinguished in a primary window and secondary window or dialog box as a secondary window. An illustration of primary window is as shown below :

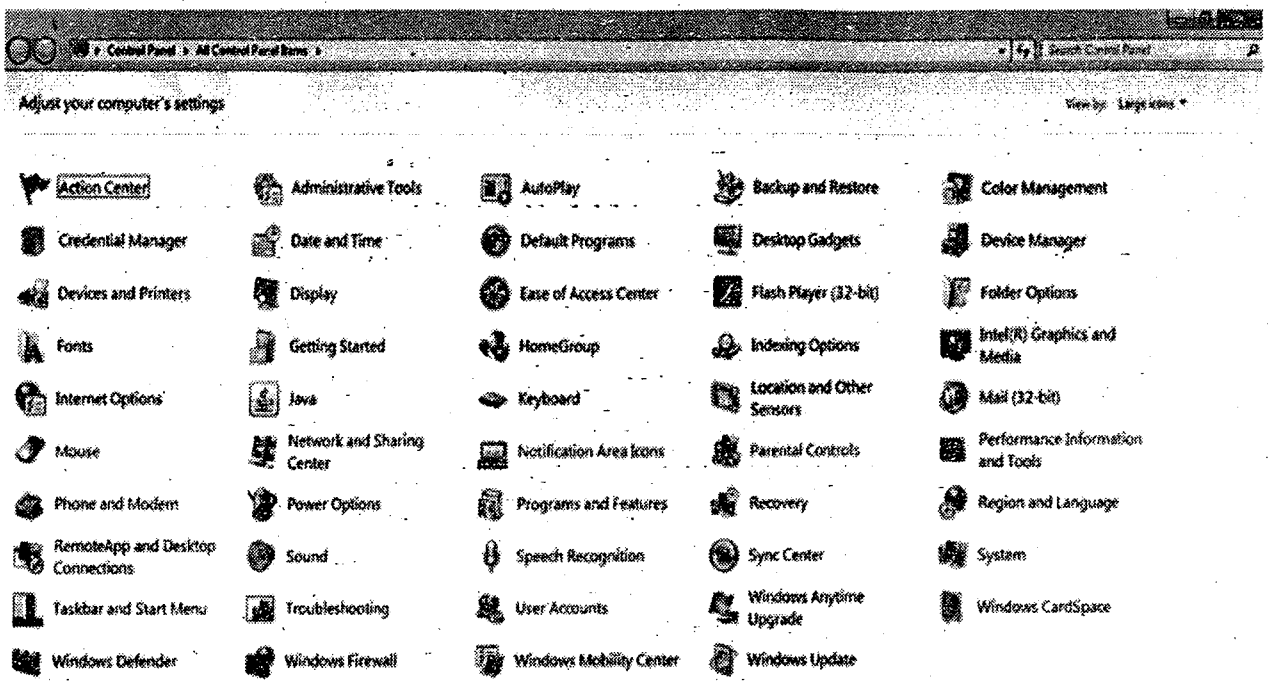


Fig.1-Q.3.7 : A sample for primary window (Microsoft Windows)

- An illustration of secondary window is as shown below :

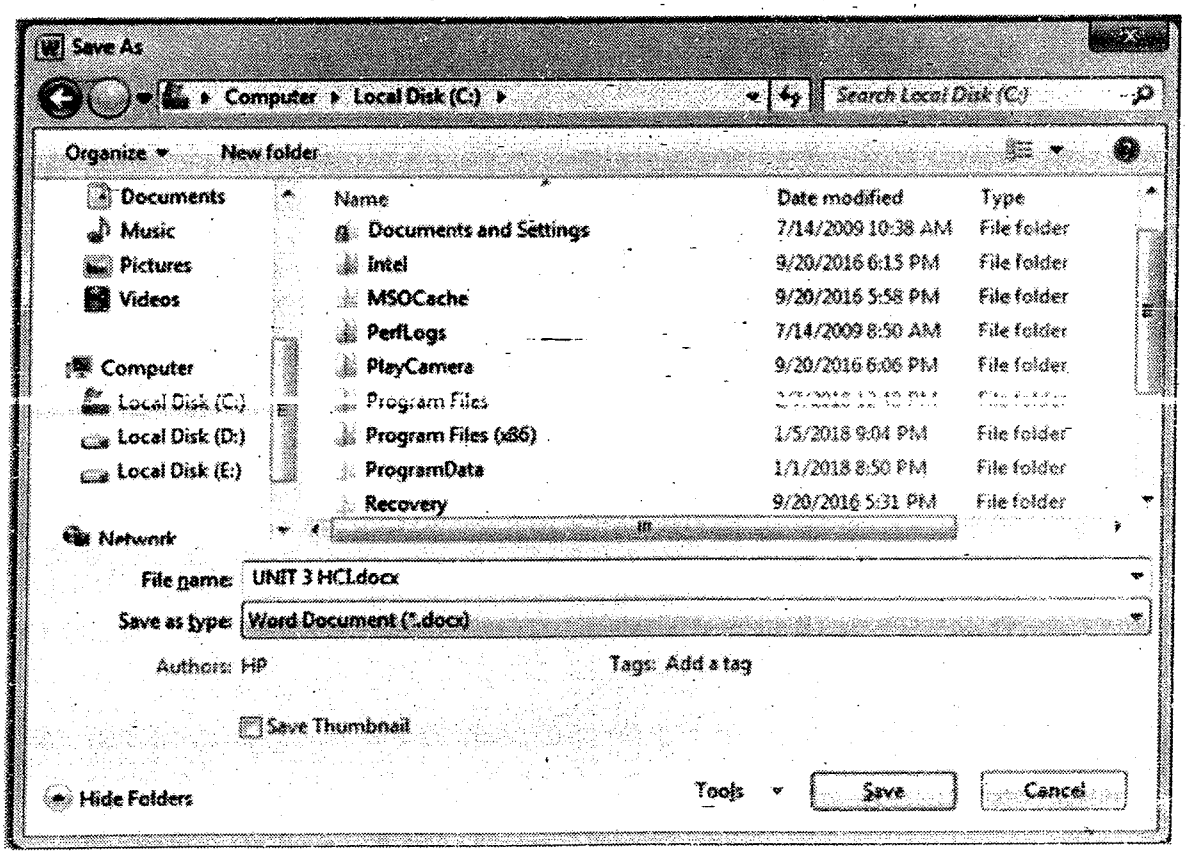


Fig. 2-Q.3.7: Microsoft Windows dialog box (secondary window)

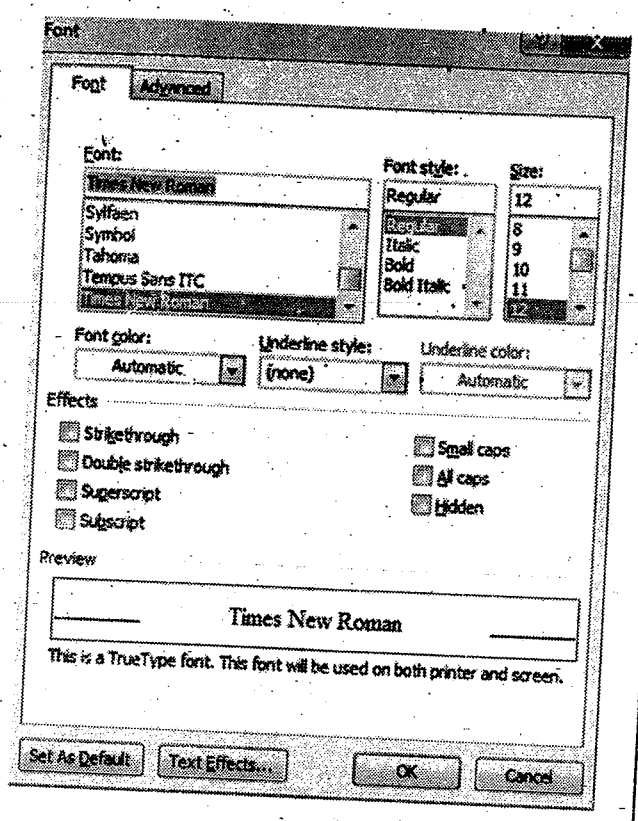


Fig. 3-Q.3.7: Microsoft Windows secondary window

➜ Frame

- It is mostly a rectangular shaped structure, it can be easily distinguishable from other similar frame on a window as it has a color and thick border. It can be resized. Text generally read from left to right fits in this structure. While a single frame occupies entire window edges of frame helps to know the border of a frame.

➜ Title Bar

- The top edge of window is a title bar. It is also known as caption bar or title area. It is used to display descriptive information about of the title. Few title bar also consists of extreme left, extreme right, some control buttons (close, maximize, minimize and system retrieving functions). It is also provides a useful control to move windows.

➜ Title Bar Icon

- It uses a left top corner of a primary window. It has pull-down menu with list of commands linked with objects applicable to window, appears on right click or second click of mouse. As per some standard design guidelines for title bar a small icon based utilities should be availed to user. A file icon should represent in either case of data saved and unsaved, a user should come to know easily on the basis of representation of an icon. A small icon should represent its distinct identity whether a file is creates, load or saves documents.

➜ Window Sizing Buttons

- These are buttons located at the right corner of the title bar of the window. Generally, a left most button is Minimize buttons represented with a short a line and it is used to reduce the size of the window to the minimum.
- Middle positioned button is a maximize button shown by two overlapped box representation and used for to enlarge a window to a maximize its size or to restore the window to the previous size.
- The right most button is a close button, it is inscribed by X and used to close he window. Few operating system's windows follow exactly reverse arrangements of buttons located at right of the title bar.

➜ Command Area

- It is used to provide an input of commands to the system.
- Windows provide a command area at bottom. It found below a horizontal scroll bar if it horizontal bar is used.

➜ Status Bar

- It is located at the top of screen also known as status area.
- Microsoft recommends status bar at the bottom of screen used to describe the current activity, the selected menu, toolbar button or user highlighted items etc.

➜ Work Area

- It is an actual area of text or command line interpretation to perform a task to user.
- It is also referred as client area.

Q. 3.8 What are differences between menu bar and tool bar ? Many times user face the problems in understanding /learning tool bar icons. How resolve issue?

Ans. :

➜ **Menu Bar**

– It is the horizontal representation of the menus a the top of window followed by a title bar. It is used to represent a various menu available to the user. Mostly, a pull down menu is preferred at menu bar.

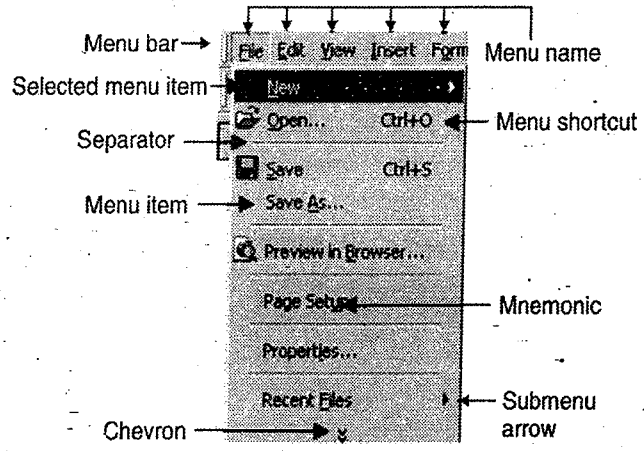


Fig. 1-Q.3.8: A Structure of a Menu (Microsoft ®)

➜ **Toolbar**

– It is permanently displayed panel consists of tools provided by that application. Tools icon are placed on toolbar having a link associated with the respective set of functions. Tools are grouped on logical basis on toolbar. Ribbons, rulers or palettes, toolboxes etc. are few specialized toolbar.

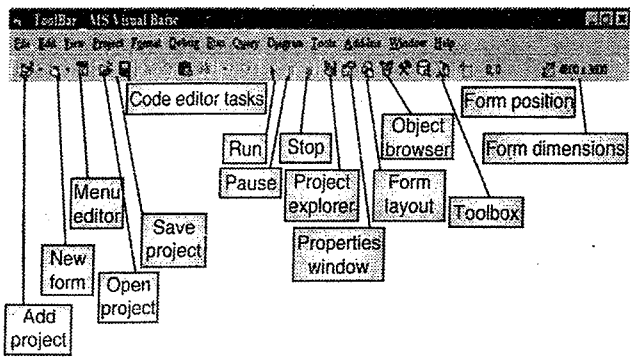


Fig. 2-Q.3.8: Toolbar (Microsoft Visual Basics ®)

– Differences between menu bar and tool bar :

(i) **Frequency :** Toolbars present only the most frequently used commands, whereas menu bars catalog all the available top-level commands within a program.

(ii) **Immediacy :** Clicking a toolbar command takes effect immediately, whereas a menu command might require additional input. For example, a Print command in a menu bar first displays the Print dialog, whereas a Print toolbar button immediately prints a single copy of a document to the default printer. Clicking the Print toolbar button immediately prints a single copy of a document to the default printer.

(iii) **Directness :** Toolbar commands are invoked with a single click, whereas menu bar commands require navigating through the menu.

(iv) **Number and density:** The screen space required by a toolbar is proportional to the number of its commands and that space is always used, even if the commands are not. Consequently, toolbars must use their space efficiently. By contrast, menu bar commands are normally hidden from view and their hierarchical structure allows for any number of commands.

(v) **Size and presentation:** To pack many commands in a small space, toolbars usually use icon-based commands (with tooltip-based labels), whereas menu bars use text-based commands (with optional icons). While toolbar buttons can have standard text labels, these do use significantly more space. Labelled toolbar buttons take at least three times as much space as unlabeled ones.

(vi) **Self-explanatory:** Well-designed toolbars need icons that are mostly self-explanatory because users can't find commands efficiently just using tooltips. However, toolbars still work well if a few less frequently used commands aren't self-explanatory.

Q. 3.9 Explain The Context of the Interaction

Ans. :

– Interaction is successful between user and system when the environment is featured with new modifications, user convince and challenging. Interaction turns useful on

involvement of primary stakeholder, secondary stakeholder, tertiary stakeholder and facilitating stakeholder.

- Context of interaction involves stakeholders i.e. various users of the system.
- For example, In an international airline, a travel agents selling flight tickets to customers directly.

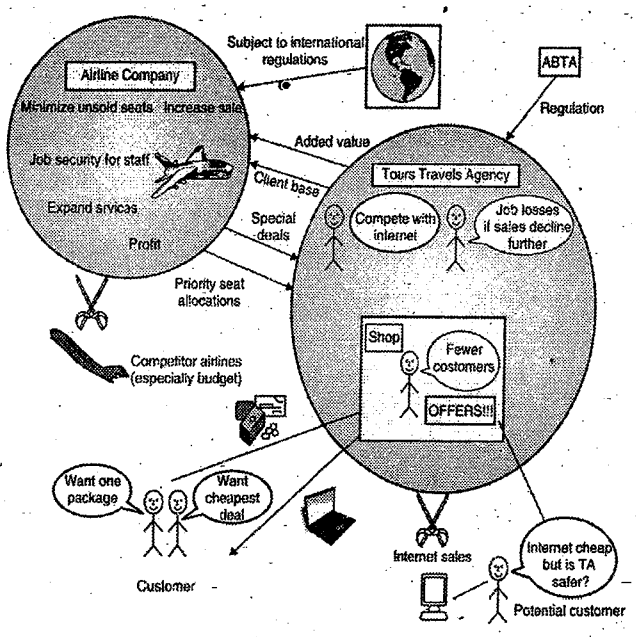


Fig. 1-Q.3.9: A Picture of Travel Agency

- Number of stakeholders can be grouped as follows for an airline booking system:

Stakeholders	Members of Team
Primary	Travel agency staff, Airline booking staff
Secondary	Customers, Airline Management
Tertiary	Competitors, Civil aviation authorities, Customers travelling companions, Airline stakeholder
Facilitating	IT department staff, Design staff

- Influence of socio-techno models and organizational factors observed on the interaction.
- A socio model describes the effect of formal and informal workgroups, supports transformation, upcoming trends of technologies and extended support mechanism for the same.
- A socio-technical model is focused on human and technical approaches within a system i.e. user and environment of interaction.
- Custom Analysis and Open System Task Analysis (OSTA) approaches used to check the impact socio-technical model.
- A Soft System Methodology (SSM) comes with the approach of organization as a system where people and technology are the components, developed by Checkland.

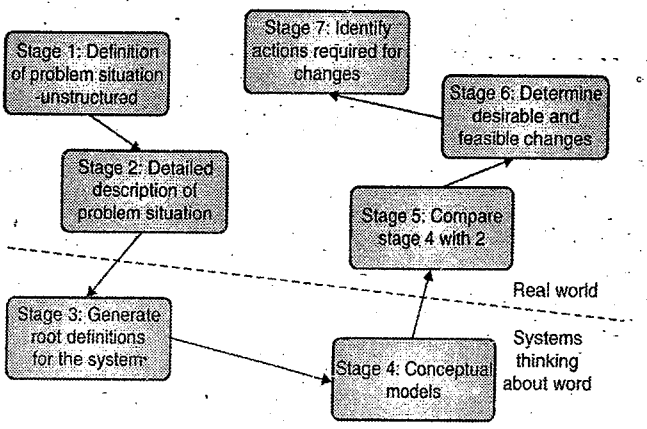


Fig. 2-Q.3.9: The Seven Stages of System Technology (Checkland)

Q. 3.10 Explain Paradigms of Interactions

Ans. :

- Successful systems are marked as systems with more usability, such systems are considered as a paradigms for the upcoming development in the field of interaction.
- Paradigms are in direct proportional relation with technological advances and application along with creativity to enhance the interaction.
- Techniques and design are the major area of improvement in the design. Few of paradigms of interaction are mentioned below:

➜ I. Time Sharing

- It is multiprogramming and multi tasking with the help of a user or group of users. A table with the records of IBM, Apple, Microsoft, Amiga etc. on year wise and technology basis are mentioned below :

Timeline (Year)	Technology Trends
1975	IBM 5100 OS APL/BASIC
1977	Apple II OS Woz integer basic in ROM
1980	IBM 5120 OS APL/BASIC

Timeline (Year)	Technology Trends
1981	Apple III OS SOS
1983	Apple Lisa OS Apple GUI First time using GUI
1985	Atari Amiga 1000 OS Amiga DOS 1.0.1.34 'Workbench' GUI
1986	IBM PC XT 286 OS PC-DOS v4
1989	Apple Macintosh Portable
1991	Apple Macintosh PowerBook OS Mac OS 7.01 – 7.6.1
1992	Amiga 4000 OS Amiga DOS 3.1
	Microsoft Release Windows 3.1
1993/2009	Microsoft release Windows NT
1995	Microsoft release Windows 95 (introduce internet explorer)
1997	Apple release Power Mac OS 8
1999-2004	Apple release Power Mac G4
2000	Microsoft release Windows 2000
2001/present	Apple release Mac OS X
2006/present	Apple release MacBook, MacBook Pro
2008	Apple release MacBook Air
2009/present	Windows release Windows 7
2012	Windows release Windows 8
2015	Windows release Windows 10
2018 (tentatively planned)	Windows release Windows 11

➜ II. Video Display Units

- Display screen shows a series of pictures to make an movie likewise effect in the past (specially for cartoon entertainment shows) and journey now goes beyond 3D image and movie screening, even some small screen sharing 4D and likewise.
- Video Display units journey on technology basis started from a Cathod Ray Tube (CRT) screen, Thin Film Transistor (TFT) screen, Liquid Crystal Display(LCD)screen, Light Emitting Diode (LED) screen.
- Earlier days video display units has problems like imbalanced light luminance, brightness and reflection, eye irritations etc. which are almost covered in recent technology with a good quality of display. Few video display unit works on touch sensation in the interaction.

➜ III. Programming Toolkits

- Douglas Engelbert looks technology as human problem solving capability. He thinks computers can be used to teach humans.
- Engelbert's team gives many human problem solving approach based tools developed at Augmentation Research Center like word processing and the mouse.
- Engelbart's dedicated research team at the Stanford Research Institute in the 1960s worked towards achieving the manifesto set forth in an article published in 1963:
  - By 'augmenting man's intellect' we mean increasing the capability of a man to approach a complex problem situation, gain comprehension to suit his particular needs, and to derive solutions to problems. We refer to a way of life in an integrated domain where hunches, cut-and-try, intangibles, and the human 'feel for the situation' usefully coexist with powerful concepts, streamlined terminology and notation, sophisticated methods, and high-powered electronic aids.

➜ IV. Personal Computing

- Seymour Papert and his colleagues (few from MIT) designed a computer controlled mechanical turtle, used to design geometry shapes like circle and square, it was designed for Childs.
- Further Alan Kay took inspiration from Engelber and Papert both and he realized the power of computational machine. In early 1970s gives a dedicated system for a single users i.e. personal computers. In mid 1970s a successfully handled personal computer was named as Dynabook by him.

V. Window System and WIMP Interface

- Window is common platform for interaction with many application. Multiple windows can be operated by a single user. Windows, Icon, Menu, Pointers helps to improves interaction among the system and user.
- In 1981, The Xerox Corporation introduced the 8010 star information system and it was the first system used as commercial interaction device based on WIMP interface.

VI. The Metaphor

- Papert used metaphor while LOGO language was in development process which is used to teach children.
- Metaphor are useful to knowledge transfer(KT) i.e. to teach new technology concepts or transferring technical details to someone who qualifies the perquisite for the same.
- The metaphor helps to improve and increases the familiarity between he user and system i.e. computer application.

VII. Direct Manipulation

- Features of direct manipulation are listed below :
  - (i) Direct manipulation gives visibility to interested objects
  - (ii) It provides rapid feedback to all actions on the basis of incremental approach while engaged with the interface
  - (iii) Reversibility of all actions, so that users are encouraged to explore without severe penalties
  - (iv) Correct actions as per syntactic manner, it helps to improve legal operation activities
  - (v) An action is replaced for complex command languages.
- Model World Metaphor gives in detailed description for directness with psychological justification, it is proposed by Ed Hutchins, Jim Hollan and Donald Norman. According to the collection of papers of Norman and Draper for user cantered design they write :
  - In a system built on the model-world metaphor, the interface is itself a world where the user can act, and which changes state in response to user actions.
  - The world of interest is explicitly represented and there is no intermediary between user and world.
  - Appropriate use of the model-world metaphor can create the sensation in the user of acting upon the objects of the task domain themselves. We call this aspect of directness direct engagement.
- Few other paradigms of interaction are mentioned below :
  - Language Versus Action
  - Hypertext
  - Multi-Modality
  - Computer Supported Cooperative Work
  - The World Wide Web
  - Agent-Based Interface
  - Ubiquitous Computing
  - Sensor-Based And Context-Aware Interaction

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Key Notes for Examination

Chapter 1 : Introduction to HCI

☞ Qualities of the human

(a) Vision

(b) Reading

(c) Hearing

(d) Touch (haptic perception)

(e) Movement.

(f) Thinking

(g) Emotion

(h) Individual Differences

☞ Types of Computer Devices

(A) Input Devices

(B) Output Devices

(C) Input and Output Device

☞ Donald Norman's seven stages of interaction

(a) Establishing the goal.

(b) Forming the intention.

(c) Specifying the action sequence.

(d) Executing the action.

(e) Perceiving the system state.

(f) Interpreting the system state.

(g) Evaluating the system state with respect to the goals and intentions.

☞ Disciplines Involved in HCI

- Psychology – understanding the user
- Sociology – groupware
- Art – aesthetic appeal
- Design – user interface layout
- Engineering/Computer Science – faster machines – faster systems – means of building better interfaces
- Linguistics – language for commands
- Anthropology – user body shape
- Ergonomics – equipment design
- AI – help facilities – modelling the user
- Philosophy – creating consistency

☞ Importance of HCI

- Recognize the User Goal
- Understanding the Problem (Design Research)
- Modeling Users (Persons and Goals)
- Setting The Vision
- Design Product
- Teamwork

☞ Shneiderman's 8 Golden Rule

1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Offer error prevention and simple error handling
5. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short term memory load

☞ Don Norman's Principle of Design

1. Visibility
2. Feedback
3. Constrains
4. Mapping
5. Consistency
6. Affordance

☞ Nielson's 10 Heuristics

1. Visibility of System Status
2. Match Between System and Real World
3. User control and Freedom
4. Consistency and Standard
5. Error Prevention
6. Recognize Rather Than Recall
7. Flexibility and Efficiency of Use
8. Aesthetic and Minimalist Design

9. Help Users Recognize, diagnose and recover from error
10. Help and Documentation

Chapter 2 : Understanding the Human

Visual Channel

(A) Eye
(B) Visual Perception
(C) Perceiving Size and Depth
(D) Perceiving Brightness
(E) Perceiving Colors

Human Memory

(1) Sensory Memory
(2) Short Term Memory (STM)
(3) Long Term Memory (LTM)

Chapter 3 : Understanding the Interaction

Donald Norman's Seven Stages of Action

Stage 1 : Forming a Goal
Stage 2 : Forming the Intention
Stage 3 : Specifying an Action
Stage 4 : Executing the Action
Stage 5 : Perceiving the State of the World
Stage 6 : Interpreting the State of the World
Stage 7: Evaluating the Outcome

Interaction Style

(i) Command Line Interface
(ii) Menus
(iii) Natural Language
(iv) Question Answer and Query Dialog
(v) Form-Fills and Spreadsheet
(vi) Point and click
(vii) Three dimensional effect
(viii) WIMP

WIMP Interface With Windows

(1) Single Document Interface (SDI)
(2) Multiple Document Interface (MDI)
(3) Tabbed Document Interface (TDI)

Menus can be studied with several parameters

(1) The Structure of Menus
(a) Single Menus
(b) Sequential Linear Menus
(c) Simultaneous Menus
(d) Hierarchical Menus
(e) Connected Menus
(f) Event Trapping Menus

(2) The Function of Menus

(3) The Content of Menus

(4) Formatting Menus

(5) Phrasing the Menus

Components of Windows

1. Frame
2. Title Bar
3. Title Bar Icon
4. Window Sizing Buttons
5. Command Area
6. Status Bar
7. Work Area
8. Menu Bar
9. Toolbar

Paradigms of Interactions

I. Time Sharing
II. Video Display Units
III. Programming Toolkits
IV. Personal Computing
V. Window System and WIMP Interface
VI. The Metaphor
VII. Direct Manipulation

Chapter 4 : HCI - Design Process

Interaction Design Process

1. What is wanted or Requirement
2. Analysis
3. Design
4. Iteration and prototyping
5. Iteration and prototyping

Types of Scenarios

1. Goal- or Task-Based Scenarios
2. Elaborated Scenarios
3. Full Scale Task Scenarios

Prototype Types

(1) Low fidelity prototypes
   - (i) Sketches
   - (ii) Storyboarding
   - (iii) Pictiv

(2) Medium fidelity prototypes
   - (i) Vertical prototype
   - (ii) Horizental prototype

(3) High fidelity prototypes

Rapid Prototyping Techniques

1. Offline Rapid Prototyping
2. Online Rapid Prototyping

Wireframe Structure components

- Title
- How to get here
- Concept/Purpose/Objective
- Content/Data
- If/Then
- Navigation Links/Buttons
- Error conditions

Chapter 5 : HCI - Design Rules, Guidelines and Evaluation Techniques

Types of Principles

Learnability

1. Predictability
2. Synthesizability
3. Familiarity
4. Generalizability
5. Consistency

Flexibility

1. Dialog initiative
2. Multi-threading
3. Task Migratability
4. Substitutivity
5. Customizability

Robustness

1. **Observability**
   - (a) Browsability
   - (b) Defaults
   - (c) Reachability
   - (d) Persistence
   - (e) Operation visibility
2. **Recoverability**
   1. Forward
   2. Backward
   3. Responsiveness
   4. Task conformance

Design Standards

1. Underlying theory
2. Slowly changing technology

Shneiderman's Eight Golden Rules of Interface Design

1. Strive for consistency
2. Enable frequent users to use shortcuts
3. Offer informative feedback
4. Design dialogs to yield closure
5. Offer error prevention and simple error handling
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short-term memory load

Norman's Seven Principles

1. Use both knowledge in the world and knowledge in the head
2. Simplify the structure of tasks
3. Make things visible
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

UIMS conceptual architecture

a) Portability of application

b) Reusability of interfaces

c) Multiple interfaces

Evaluation Through Expert Analysis

Cognitive walkthrough

Heuristic evaluation

Model-based

Based on prior studies

Chapter 6 : HCI Models and Theories

Techniques for Goal and Task Hierarchies

1. GMOS
2. CCT
3. HTA

Physical and Device Models

- The Keystroke Level Model (KLM)
- 3-state model

Diagrammatic Dialog Design Notations

- State transition networks (STN)
- Petri nets
- State Charts
- Flow charts
- Jackson structured design (JSD)

Application Themes for ubicomp

1. Context-aware computing
2. Automated capture and access
3. Toward continuous interaction

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