Human psychology (cognitive psycology).

Chapter 1:

Humans are considered as the center of interaction system. Basically a system is designed to assist (help) humans (users). Therefore the requirement of users are first priority. For designing something for someone, we need to understand their capabilities & limitations. For designing something, we must keep in mind cognitive psycology like how people sees the object around them, how they manipulate it, how they process, store and solve problems.

In 1983, Card, Moran & Newell described Model human Processor (simplified view of human processing involved in interacting with computer system.

- There are 3 components of any system:
1) Input-output 2) memory/store 3) Processing
- Processing includes problem solving, leaning and consequently making mistakes.
- We are focusing on human's input-output channels, the senses and responders/effectors.

1.2 Input Output channels:

Sight may be used for providing information to the system (eyegaze system) and also for recieving information from the system.

Scanned with CamScanner

Three primary senses : Sight, touch, hear.

- Input in human occurs mainly through senses and output through motor control of the effectors.
- Taste & smell doesn't play any important role in HCI. However smell can be use for specialized system like (smells to give warning of malfunction or in augmented reality system).
- There are number of effectors which plays an important role in HCI like limbs, fingers, eyes, head & vocal system.
- Fingers used for typing or mouse control with some use of eye, head and others.

- For example we are using a system in PC, you may recieve information by using sight of what going on to the screen. Or you may recieve by ear of what going on "beep" if you made any mistake, sound of "click". Touch plays vital role in moving of mouse, sending information by typing. Sight & hearing doesn't directly use but it may we by recieving information from third party & then transmitted to computer.

Scanned with CamScanner

1.2.1 Vision:

Human vision is highly complex activity with a range of physical & perceptual limitations. It is divided into two parts:

1) physical reception of stimulus from outside world
2) processing & interpretation of that stimulus.

1) The description of first point is like that vision begins with light. When the light falls onto an object, the image is focused on the back of eye and receptors in the eye transform it into electrical signals which are passed to the brain.

- Our retina is light sensitive and contains two types of photoreceptor: rods and cones.
Rods are highly sensative to light therefore allow us to see under a low level of illumination. Therefore we experience temporary blindness when we move from dark room to sunlight, the rods have been active & saturated by sudden light.
Cones are less sensitive and helps in color vision.

2) The image we recieved through vision is filtered and passed to processing which helps in determining coherent scenes, distance of objects & differentiate color.

Scanned with CamScanner

Perception of vision → size, depth, brightness & color.

Visual acuity is the ability of a person to percieve the detail.

Getting notice: If you want to show user an error message or something that must be noticed quickly so it had better be flashing or the clever moving icons.

- Perceiving size & depth:
  Visual angle is the angle of an object placed on an angle formed by eye.
. Objects of same size at different distances have different angles
. Objects of different size place at different distances may have same visual angle.
. If a visual angle of an object is too small we could not precieve it all.

Law of size constancy states that our perception of size relies on factors other than visual angle.
Means that the perception of objects' size remain constant even if they have move futher from you. enample that the person's height is precieved as constant even if they have move futher from you.

Scanned with CamScanner

- Perceiving brightness:

Brightness is effected by luminance. luminance depends on amount of light emitted by an object. luminance gives noticeable difference in brightness. Visual acuity increases with increased luminance.

- Perceiving Color:

Color is made up of three components:

1) Hue → It is spectral wavelength of light. red > green > blue

2) Intensity → brightness of color

3) Saturation → Amount of whiteness in color.

By varying these two, we can percieve 7 million different color

- Eye percieves colour because of cones. They are sensitive to light of different wavelength.
- 8% male & 1% female suffer from color blindness, unable to discriminate b/w green & red.

Capabilities & limitation of visual processing

Visual processing involves the transformation & interpretation of complete image, from the light that is thrown onto retina.

Scanned with CamScanner

As we know that our expectations affect the perception according to the law of size constancy.
Most of the time our expectations which may be false creates ambiguity.

Reading: Perception & processing of text is important to interface design. In reading, first visual pattern of the words are percieved then decoded with reference to an internal representation of language. The final stages of language processing includes syntactic, semantic and operational analysis on phrases or sentences.
During reading, eye makes jerky movements called saccades followed by fination.
Eye moves backward as well as forward to the text, is called regression. If the text is complex, there is more regression.
- Reading from computer screen is slow than of book, due to longer line length, fewer words to a page, orientation etc. It could be reduced by careful design of textual interface.
- A negative contrast (dark characters on light screen) is highly prefered and more accurate in performance as it provide higher luminance.

Scanned with CamScanner

1.2.2 Hearing

The auditory system conveys alot of info about our environment like from how much distance a sound is coming from, what is type of sound etc.

- As vision begins with light similarly hearing begins with vibration in air or sound waves.
- Sound changes due to vibration or pressure in air. Pitch is the frequency of sound.
- The auditory system peyorms some filtering of sounds recieved & allowing us to consider on important information. However if sounds are too loud & frequencies of both sounds are same so its become difficult to distinguish.
- Sound can be used to tell about system state to convey information like warnings.

- Sounds in interface design: Speech sound can be used in applications for visually impaired people and also in app where user's attention has to be divided like in flight control etc. Non speech sound includes attention, status information, confirmation & navigation (indicate where the user in system)

Scanned with CamScanner

touch == haptic perception.

1.2.3 Touch:

Touch is an important means of feedback. like by pressing key we get feedback from computer system. Haptic perception is also important for those persons who are impaired.

- The greater the distance, the lower the sensitivity.

1.2.4 Movement:

A simple action such as hiting a button involves number of processing stages. Brain processes the information and take moves accordingly. These moves varies with person fitness & age. Reaction time also depends on the sensory channel through which the stimulus is recieved.

- There is another factor that speed of reaction results in reduced accuracy, but this depends on task & user. lets take example of video games where less skills users fails because games requires faster response.
- Speed and accuracy of movement are imp in the design of interactive systems.

Scanned with CamScanner

The time taken to hit a target is a func. of the size of the target and the distance that has to be moved.

This is formalized as Fitt's law.

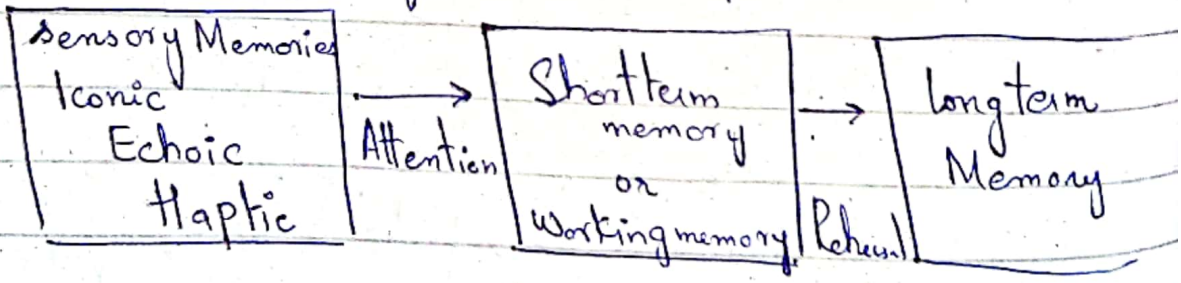
Movement time = $a + b \log_2 (\text{distance}/\text{size} + 1)$

Ideally target should be large and distance should be small.

For example in listing something, the most frequently used options is placed closest to the users start point.

1.3 Human Memory

As the list of objects increases there is more chance of missing objects. Memory contains our knowledge of actions & procedures.



- Memory is associated with each level of processing. The above diagram is the type of memories or we can say different functionalities of same system.

Scanned with CamScanner

1.3.1 Sensory Memory

It act as a buffers for stimuli recieved through senses. Sensory memory exists for each sense.

iconic memory → visual stimuli

echoic → aural stimuli

haptic → touch

These memories are continously overwritten by new information coming.

Eg for visual stimuli is light affect of firework after it has been removed or moving finger close to eyes also leave affect.

Eg for echoic memory, we asked question to repeat only to know what was asked after all.

Information is passed from sensory memory to short term memory by giving attention.

Attention is the focus on one thing out of many stimuli or thoughts. This is due to the limited capacity of our sensory & mental process. If we will not select a single thing, it will be overloaded. Attention depends on our interest or need.

Information recieved by sensory are likely to overwritten, lost or move into permenant memory.

Scanned with CamScanner

1.3.2 Short term memory:

It is used to store information which is required fleetingly. For example the multiplication of 35×6, we need to go through different steps so remembering the first step's result is also necessary here, this requires short term memory. If the short term memory is use rapidly so the information is stored otherwise it will decay.

- There are two basis of measuring memory capacity.
  1) Length of sequence which can be remembered in order.
  2) Items recall to be freely in any order

7±2 rule states that we can remember 7±2 chunks of information.

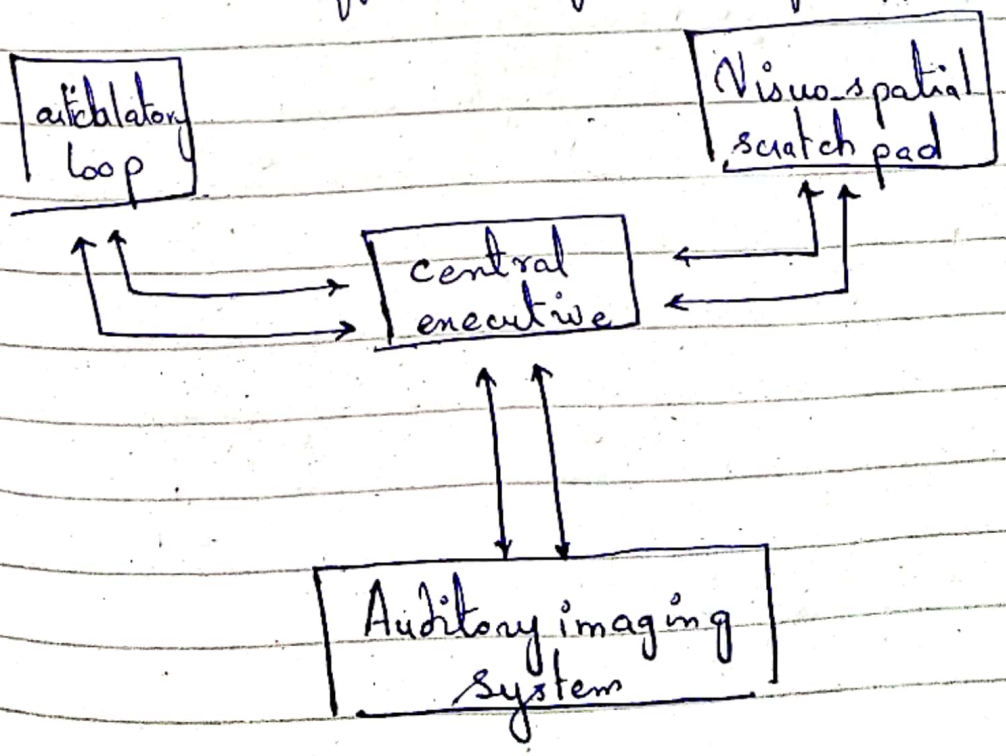
Chunking increases the short term memory capacity. There is a limited capacity in short term memory so by creating chunks it optimize the use of memory.

- The successful formation of a chunk is known as closure. This process is generalized by completing or closing task held in short term memory. At this point mind have

Scanned with CamScanner

tendency to flush short term memory. Eg of ATM.
- The sequence of chunks also matters.
HEC ATR ANU PTH ETR EET
It is difficult to remember but if we move first and last alphabet, the seq is easy to recall.

Recency Effect shows that recall of last words presented is better than recall of those in middle.
But we are asked to (count backward) the recency effect is eliminated. This suggests that short term memory recall is damaged by interference of other information.
So the item is placed in long term memory where it is unaffected by recency affect.

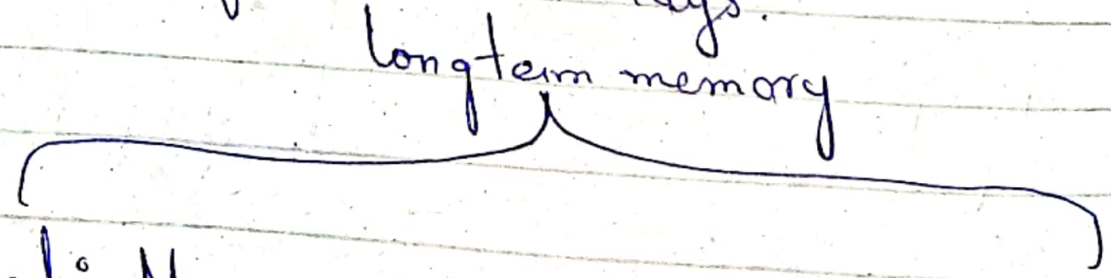


Scanned with CamScanner

7±2 rules conclude that in design there should not be more than 7 items in a list, but it has not do with short term memory as cues are available there. On the other hand, 7±2 rule would apply in command line interface. Commands contain parameter, file path names so we need manual here if the number of parameters in command is more than 7.

1.3.3 longtermMemory:

Longterm memory is our main resource. It is a huge capacity but its' access time is quite slow. Forgetting occurs more in longterm memory. longterm memory recall after minutes is same as recall after hours or days.



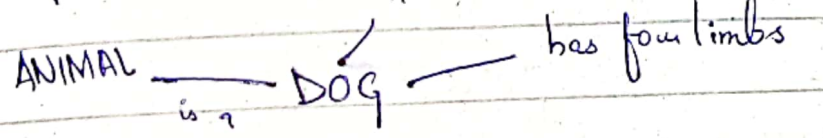
Episodic Memory
- represents our memory of events and experiences in a serial form. By this we can reconstruct the actual events.

Semantic Memory
- represents record of facts concepts and skills that we acquired.

Scanned with CamScanner

Semantic Network as a model of memory is demonstrated by Collins & Quillian.

Semantic memory is derived from episodic memory such that we can learn new facts and concepts from our experiences.
Semantic memory is in structured, it is accessed by representation of relationships between pieces of information. Semantic memory is in form of network. Associate with the help of classes and inherit attributes from parent class.



In this we have to seach further through the memory hierarchy to find the answer.
There are other types of information as well like frame based representation of knowledge.
In frame, memory is presented in datastructure and is instantiated when the slots are filled with appropriate value.

- Condition action rule are stored in long term memory.
- Script consist of entry condition, results, props, roles, scenes & tracks.

Scanned with CamScanner

Long term processes:

There are 3 long term memory processing activity:

1) Storage & remembering of information
2) Forgetting
3) Information retrieval.

- Information from short term memory goes into long term memory by rehearsal. Repeated exposure to a stimulus transfer it

Ebbinghaus performed an experiment in which he conclude that the amount learned depend on the amount of time spent learning. This is known as total time hypothesis
However Baddley & other suggests that learning time is more effective if it is distributed over time This is known as distribution of practice effect.

- Repitition is not enough to learn info, for information to learn it must be meaningful It is proved by that it is difficult to remember a set of words representing concepts than a set of words representing objects.

Scanned with CamScanner

- If information is meaningful & familiar it can be related to existing structures & more easily incorporated into memory.

Eg: People choose common words or names from dictionary as password. Security here is in conflict with memorability. So the solution is that the person should keep password which is meaningful to him but not to other.

There are two theories of forgetting.

- decay & interference.

↓

* information in long term memory may eventually be forgotten.
* information decayed logarithmically, rapidly then slowly
* The older memory are more durable then recent one.

→

* New information causes the loss of old information (retroactive interference)
eg: phone number.
It is because new association masks the old.
* Old information causes the loss of new information (proactive inhibition)
eg: driving to house.

- Emotions causes to remember in long term. We remember positive information more.

Scanned with CamScanner

- Information is not lost completely from long term memory. First reason is proactive inhibition. Second is "tip of tongue" means information is present but access in unsatisfactory. Thirdly that information is recalled when prompting. Those reason shows that information is not completely lost from memory.

Here comes the concept of information retrieval

recall
- information is reproduced from memory.
- It is more cognitive activity.
- Recalling is easy when knowledge is meaningful.

recognition
- presentation of information provides that it has been seen before.
- here information is provided as cue, It is less cognitive activity.

- The use of vivid imagincy is a common cue to help people to remember information. People usually visually scene & it makes for them easy to remember.

Scanned with CamScanner

1.4 Thinking: Reasoning & Problem solving

Here we see how information is processed & manipulated. It is complex area & it seperates human from other information processing systems. Animals & AI have different system.

- Thinking requires knowledge, sometimes from different domains too.

eg: Subtracting requires Math knowledge however reading newspaper requires knowledge from different domains.

1.4.1 Reasoning: Reasoning is the process of using our knowledge to draw conclusions and infer something new about the domain of interest.

Deductive:
- derives logically necessary conclusion.
- It conflicts with our knowledge of what true in world.
- Here truth & validity clash.

eg: Some people are babies
Some babies cry.

Abductive:
- Abduction reasons from a fact to the action or state that caused it.

eg: Sam doing fast...
- Usa infer that this event is caused by this action although its not.

Inductive:
- It is the reasoning we generalize from cases we have seen.
- Here we have to gather evidence to support inductive inference.

eg: elephant, was a his card

1.4.2 Problem Solving:

Problem solving is the process of finding a solution to an unfamiliar task, using the knowledge we have.

Gestalt Theory states that problem solving is a matter of reproducing known responses or trial and error. Problem solving can be productive & reproductive. Reproductive draws on previous experiments while productive involves insights & restructuring of problem.

Problem space theory Newell & Simon proposed that problem solving centers on problem space.

Problem space == problem states

Problem solving == generating these states using legal state transition operators.

- Problem compromise of initial & goal state, people use operator to move from one & another.
- Some problems are huge so heuristics are used as operators to reach goal. One of the heuristic is **means-ends analysis**, in this the initial state is compared with goal state & operator are chosen to reduce the difference b/w them.
  eg. moving desk
- It operates within the constraints of human processing system. It allows to solve problem easily since we structure problem space appropriately and choose operators efficiently.

Scanned with CamScanner

- Its use in solving puzzle.
(comparing things for the purpose of clarification)

Analogy in Problem solving:

This refers to the mapping of the problem to the other problem of similar domain. Similarities are noted & operators are transfer to the new one from known domain.

- Here subjects are not similar but we have to make analogy with the help of stories.
It is similar to the view of Gestalt that old knowledge can be used to solve a new problem.

1.4.3 Skill Acquisition:

Skilled programmers do things more effectively as they are experienced and use their recall of that particular plan & reuse it. Skilled person use generalization from these rules to produce general purpose rules.

1.4.4 Errors & Mental Models:

Human has high capability of manipulating & interpreting. Human causes errors too, some are very serious. Catastrophic effects (causing sudden yet damage) can be seen using human error, plane crash or nuclear plant leak.

Scanned with CamScanner

- There are several reasons of errors.
. For example if a skilled person is moved from it specific activity in which he is expert, there are great chances of making errors by him. We are familiar with things to do if any unfamiliar things happen than we are supposed to make errors.
. Other errors are also caused due to incorrect ordering of problem or situation.
. People make wrong theories to understand the behaviours of system. They are called "mental models". People don't have complete information about it, they are unstable & subject to change, internally inconsistent, based on incorrect interpretation of evidence
eg: lift button.

There are certain conventions for a specific things that we used to interpret the world and ideally designs should support these. These enable us to form a correct mental model.

Scanned with CamScanner

1.5 Emotion:

Our emotional response to situation, depends on how we perform, for example positive emotions enable us to perform creatively while negative emotions pushes us into narrow.
A easy problem become difficult when we are frustated or afraid.

James lange theory the emotion was the interpretation of a physiological response. we respond physiologically to a stimulus and interpret that as emotion.
But experiments suggest that emotional response is more than a recognition of physiological changes.

Schachter & Singer proposed that the emotion results from a person evaluating physical responses in the light of whole situation.

- However on exact, emotions involves both physical & cognitive events.

1.6 Individual differences:

Every person in this world is diffrent. These differences should be taken into acc while design decision.
eg. visually impaired.

Scanned with CamScanner

1.7 Psychology & the design of interactive systems.

- Recognition is easier than recall as it allow users to select command from a set rather than input directly.
- Gardiner & Christie illustrates that how guidlines can be deived from psychological theory.
- physiological theories can be led for the development of analytic & predictive models of user behaviour.
- Techniques for evaluation.

Chapter 3: Interaction:

3.2.1 Models of Interaction:

The purpose of interactive systems is to aid user in accomplishing goals from some application domain. In graphic design domains, some important aspects are geometric shapes, drawing surface and utensils.

- Tasks are operation
- Goal is desired output
- Intention is specific action required to meet goal.
- Task analysis involves the identification of user space.

Scanned with CamScanner

- There are system and user. System's lang can be ~~refer~~ as core language, User's language can be refer as task language.
- Core lang. describes computational attribute of the system, task lang. describes the psycological attributes relevant to user state.

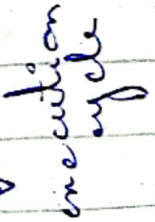
3.2.2 The execution evaluation cycle:

Norman's model of interaction is most influential in HCI. Here user formulate a plan of action which is then executed at the compute interface. When these actions are performed, user observes results and perform further actions.

- Interactive cycle is divided into two parts.
  1) execution
  2) evaluation.

They are further divided into 7 stages.

1) Establishing the goal
2) Forming the intention
3) Specifying the action sequence
4) Executing the action
5) Perceiving the system state
6) Interpreting the system state.
7) Evaluating system state w.r.t goals and intentions.



Scanned with CamScanner

In this each stage is activity of user.

1) User notion of what need to be done.
2) It is liable so need to be translated into more specific intention.
3) User percieves new state of the system and interprets in terms of his expectations.

- If you are unable to achieve the goals so you have to change your intention.
- He also explains why some interface cause problems to user. He describes these gulf of execution and gulfs of evaluation.

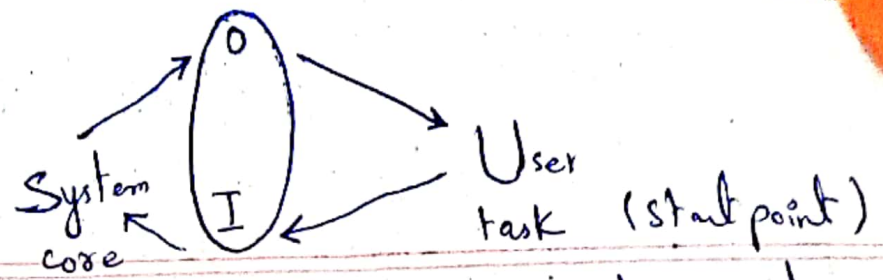
↓ difference between the user's formulation of actions to reach the goal & actions allowed by system.
- slips & mistakes.

↓ difference between physical presentation of the system state and the expectation of user.

3.2.3 The interaction framework:

It breaks the system into 4 main components that is necessary for an interactive system.

Scanned with CamScanner



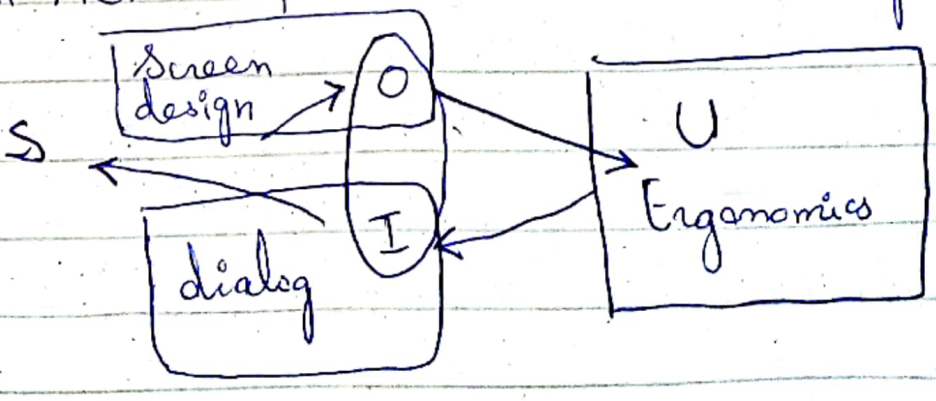
like language for user and system there are languages for input & output.
- Output and Input form the interface

- User gives input which is translated to the core by system and operation is performed, execution cycle ends here and evaluation phase begins and then give to output.
- There are 4 main translations (act of expressing an idea) involved in interaction: articulation, performance, presentation & observation.

- The tasks are responses of User and they need to be translated to stimuli for input.

3.3 Frameworks & HCI:

Frameworks that relates to HCI are used from ACM SIGCHI Curriculum Development Group.



Scanned with CamScanner

(What are the physical factors that affect the interaction)
(how interaction is affected physically)

3.4 Ergonomics: (physical characteristics of interaction)

- how controls are designed.
- the env in which interaction takes place.
- Layout and physical qualities of screen

Ergonomics also depends on human psycology & system constraints.

3.4.1 Arrangements of controls & displays

- Controls and display are placed logically to help user in access. It is important for safety critical application.
- like in air traffic control, sometimes users are underpressure, so inappropriate placement may led to frustation.
- That are functionally related must be placed together.
- Must be placed in sequence like after this task, that task is perform.
- should be placed with frequency like which are used frequently must plac at top
- User should reach all display without excess move

3.4.2 Physical environment of Interaction

How ergonomics depends on physical env. Where, By whom the system will be used Depends on the domain of the system it will use. User's position is the main concern here.

3.4.3 Health issues:

System should keep in view the safety & health of user. Safety risk can cause (aircraft crashing, nuclear plant leak). These factors directly affect the quality of interaction and the user's performance.

- physical position
- lighting
- temperature
- Noise
- Time

3.4.4 The use of color

Color should be used according to situation like red for warnings. We should also keep in view the cultural associations of color.

- Ergonomics in HCI helps in design systems and suggesting detailed and specific guidlines and standards.

Scanned with CamScanner

3.5 Interaction styles:

Interaction is the dialogue b/w user and computer. Common interface style includes

3.5.1 Command line interface:

- First interactive dialog style.
- It uses function keys, single characters, abbreviations or whole-word commands.
- Command line is flexible as we can have number of options for commands, but it is drawback on other hand as we have to remember commands, there are no cues.
- They are better for expert users.

3.5.2 Menu

It relys on recognition rather than recall. Here cues are available. Menus are hierarchically ordered. The grouping and naming of menu options are logical. It is a restricted form of full WIMP system.

3.5.3 Natural language

The most attractive way of communicating with computers is natural language. But here the problem occurs with structure & syntax. The ambiguity with words is the real problem here.

Scanned with CamScanner

For a known & constraint domain, the system is provided with limitations and sufficient information. It can be frustated for users sometimes because he has to understand each and every phrase computer understands.

3.5.4 Question/answer and query dialog

It is a mechanism for providing input to an application in specific domain. Yes/no responses, multiple choice is use here. Easy to learn & use but limited in functionality & power.

Query languages need some kind of attributes to search specific thing from database. It becomes complex when more attribute is required. Web search engine is its specialized example.

3.5.5 Forms fill & spreadsheets

It is used for data entry & data retrieval applications. The chances of error from user side in filling form must be deal here. However, it allows flexible entry.

Spreadsheets are flexible interface as user can manipulate values easily. The user can enter, alter values and formulae in any order.

Scanned with CamScanner

3.5.6 WIMP Interface

It is an environment for interactive computing. WIMP stands for windows, icons, menus and pointers and its default interface style for majority of systems.

Eg of WIMP interfaces → Microsoft Windows, MacOS, UNIX

3.5.7 Point & click interfaces.

In most multimedia systems & in web browsers all actions are take only on single click of mouse. Point & click not only tied to click also includes touchscreen. It is popularized by all web pages as they incorporate all types of point and click navigation.

3.5.8 Three-dimensional interfaces:

The obvious example of 3D is VR. The WIMP elements are given shades, colors etc in such a way that it gives 3D effects. The 3D effect is mainly used in interfaces when we want to highlight something. 3D effect lost its use when use with everything in interface.

Scanned with CamScanner