HUMAN COMPUTER INTERACTION

BSE: 6th SEMESTER

3/2/25

⊙ HUMAN COMPUTER INTERACTION:

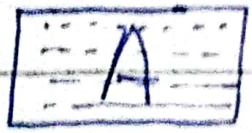
→ Discipline concerned with:
(i) Design (ii) Evaluation
(iii) Implementation
of Interactive Computing systems and the phenomenon surrounding them.

→ Its about giving convenience to users.

→ In 60's CHI (Computer Human Interaction) as computers are less at that time.

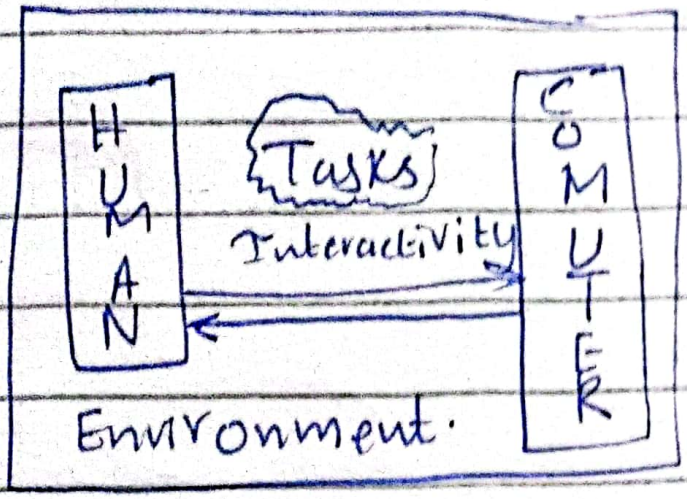
→ At start punch cards were famous and Ivan sutherland, display derices are discovered.

→ In 1990's : text + images, tables. Then graphics (Raster Graphics).



→ Interactivity started :

- (2 way) Communication



- In CHI (Computer is important entity) and in HCI (Human is important entity)

→ Why Prefer MS windows :

- Graphical Interfaces
- Command Line Interface
- Convenience (Affective Computing)
- Backword compatability.

→ 110 → Lshift (×2) → 1100
↳ R.shift (÷ 2)

RoL LoR

110 110

011 101

→ **Human:**

⊙ **Capabilities:**

→ Learn, Adapt, Eat

→ 5th Senses

→ Logic building,

→ Problem Solving, Emotion.

⊙ **Limitations:**

→ complex case (trade off of speed)

→ Repetitive tasks take much time.

→ **Computer:**

⊙ **Capabilities:**

→ Repetitive Tasks.

→ Can be performed much efficiently

⊙ **Limitations**

→ cannot think of its own [DeepSeek, ChatGpt]

→ Computer and Human Limitations

can be bridged by each other.

→ Cognitive (Retrieval of information from brain)

→ Ubiqoutous computing :

- Computing everywhere
- Punch card evolution (CLI)

- **FIGMA :**

→ Tool used for prototypes.

User Interface (UI) → Interaction → User Experience (UX)

(UI) → (UI/UX) ← (UX)

10/2/25

	Windows	Linux
-> space		✓
-> Reliance		✓
-> Preinstalled Packages		✓
-> Security		✓
-> UX	✓	

Usability:

("TinkerCad") : 3D Models

-> Learnability
-> Memorability
-> Efficiency (Time, space)
-> Error handling (User can make error) (So we can revert error)
-> Subject Pleasing (Norms, preferences, culture aspects)

Accessibility:

-> People with special need are not excluded.

Timeline:

1- Memex: hyperlinks 2-Mouse Invent

Comparison Light

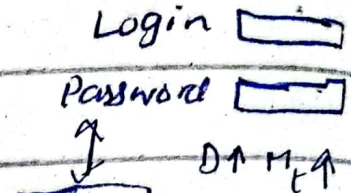
3- Screen / Display : sketch Pad

4- Xerox (WIMP) (WYSIWYG)
(Window Icons) (What you See is what you Get)
(Icons, Pointer)
(Windows Recognize the recall)

5- Apple Macintosh.

① Fitts Law:

$M_t \propto Distance$
(Movement Time) $\propto \frac{1}{size}$



: Where efficiency is required
movement time (M_t) will be less

② Ergonomics:

→ convenience
→ Adjustments, facilitation for better interaction. (Screen Angle)
→ CHI → HCI → User centered
(ACM) (SIGCHI) (Special Interest Group)
→ Recognition
(comparision of equal models)
(Cognitive models) (Familiarity)

- Inductive Reasoning, Deductive Reasoning, Abductive Reasoning.
- Brain Computer Interface (EEG) (Mind Signals simulates something).
- IoT: Internet of Things (smart homes)
- **Augmented Reality:**
  - → Virtual Reality
  - → Any Feature Added virtually. (senses, feeling etc... making).

till slide 11

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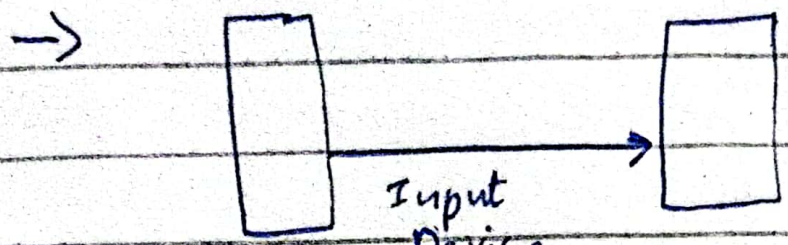
HISTORICAL PERSPECTIVE - STATE OF ART:

- → Mouse → pointing device
- → ChatGpt (LLA model)
- → Intelligence in speech (Content Recognition etc.....)
- → State of art (New Trends) (AI-Driven Interaction Model) (Abound & Beale Model)
- → Human ⇄ Computers



1- Articulation phase (How easily we can provide info)

(Articulation phase) Performance

① Articulation Phase:

How easily we can provide info.

② Performance:

On receiving input by external stimulus, how effectively system can process it.

③ Presentation Phase

④ Observation:

05 Senses:

→ Human Information Processing:

(i) Sensory Processors

(ii) Perceptual Processors

(iii) Cognitive Processors

(iv) Motor Processors

: Steroscopic View
: For VR, we use glasses, which shows same image on different angle (3D)
: In Real environment, some projection occurs (Augmented Reality)

we can interact with Augmented reality which is mixed reality

: Ganglion cells (Pattern or movement detection) (Object has a context)

⊙ Sensory Processors:

↳ Vision
↳ Saccades fixations
↳ Regression

→ Color perception : [Rods] → cells dim Light (Tufo perception)
→ Text Perception
→ Image

Cones → Color Perception (Color blindness) : In low light, only object boundaries will be found

⊙ Acuity: Ability to perceive finer details (blue, cyan has low acuity)

⊙ Luminance / Brightness ∝ Acuity
(Of its own object) (Provided by objects)

: At a certain; flicker due to increased luminance.

→ Ganglion cells:
↳ Pattern or movement detection
→ Object has a context
→ Distance (Depth Perception)

⊙ Perceptual processor

A-2 → Hearing:

⊙ 20 Hz - 20,000 Hz
⊙ Loudness, Amplitude Frequency, Tuning
⊙ Speech Sounds vs other speech signals

⊙ Cocktail Party effect:

A.3 → Touch (Heptic)

→ Receptors:

(i) Mechanorecepter

(ii) Thermorecepter

(iii) Nuciceptor

A.4 → Smell (olfactory)

⊙ Burning Smell

A.5 → Taste

⊙ Cognitive Processors: (Comparison)

⊙ Long-term Memory

⊙ Short-term Memory

: STM (Limited capacity)
(7±2 Chunks of Data)

: LTM (Models used to populate LTM)

: CUES (Hints)
(Complete Visible - Close
Hidden - Far)

Rehersals (More will be speed of perceptual)

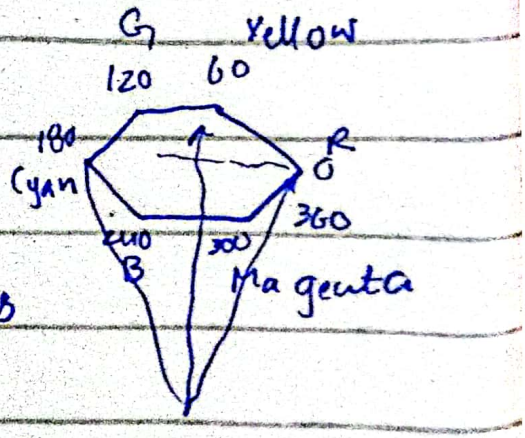
An imp for Exam ⊙ Colors:

→ HIS (Saturation)
(Hue) (Intensity)

→ Human, Perception, Colors

→ HLS:

Pure color lie on boundary of hexcone



→ Intensity : Light is Intensity

→ saturation : Impurity in pure color

L=0.5	L=0.5	L=0	L=0.5
H=0	H=0	H=0	H=120
S=0	S=1	S=0	S=1
(pink)	(Red)	(Black)	(Green)

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⊙ Human Computer

Interaction

Human Info Processor

↳ Sensory Processor → attention → Perceptual Processor → attention → Cognitive Processor

Memory: STM, LTM (Infinite capacity) ⟷ Comparison

→ **STM**

⊙ Rapid Access
⊙ Limited capacity
⊙ Volatile (erase very quickly)
⊙ Chunking is used to memorize

LTM

⊙ Slow access
⊙ Infinite capacity
⊙ Non-Volatile
⊙ Models

⊙ Models in LTM:

(Episodic memory) → Script based (Functionality)

Semantic memory → Semantic Network → Site Maps (You may build comparism)
→ Relationship representation

→ Frame based representation (Individual Entity detail)

→ Script: Login to CMS

⊙ Entry conditions: CMS frame page is launched

⊙ Success Guarantee: Welcome message on top of screen

⊙ Props (Apparatus): Computer System, Internet, Browser

⊙ Script: → Enter login name in login box
→ Enter password in password box
→ select siginin option

⊙ Tracks Box: System displays stored password with in already selected

⊙ Roles: Users (Faculty, Admin, Students)

⊙ Pre condition → Script → Post Condition

→ Miller's principle:

+92 111 123 456

111-KFC-KFC : (Chunking)

: Tinkercat (3D-models)

: Empirical values (by Experiment)

→ Cognitive processor ⟷ Comparisons
Problem Solving Reasoning ↵

⊙ Script - Based (Episodic Memory)
(Required Production Rules)

⊙ Forgetting (old information is interfering with new information and vice versa).

→ Thinking:

⊙ Reasoning:

⊙ Inductive, Deductive, Abductive

⊙ 

Vertices	Region
2	2^2
3	2^3
4	2^4
5	$2^5 - 1 = 31$ (Exception)

⊙ 7 E 4 K

$p \to q \neq q \to p$

$\equiv \sim q \to \sim p$ (contrapositive)

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⊙ **Entropy:**

→ Hangman (Pattern Recognition)

: Shannon Experiment

: Book URL

yorku.ca/mack/HCIBook (1st edition)

- - - - -

(Repetition, familiarity (a, e, i, o, u))

Huffman encoding)

→ Huffman coding is used to recognize pattern which contains repetition, familiarity.

(*) Speech Sounds (Any Natural Language) Vs. Non-Speech Sounds (Sirens, Beep) (Not a word associated but have meaning)

→ Speech (content) Vs. Voice (Who + speech)

(*) Ambigious word don't give us more information and hare low entropy (Apple, Sun etc.....)

(*) Lossless Compression Algo:

→ Exact old object can be recovered again, it is loseless.

→ Losi - Old version not obtained

(*) Dribbble (Designer social media)

(*) **Emotion:**

→ Affective Computing

→ Interpretation of physiological expression.

→ Cognitive and physical senses both included in it.

→ Urdu Poems, story
Origamii

Command Line,
Menu
Touch interface
Natural language
(Text speech)

→ Fonts: Serif, Sans serif, Times New Roman
(Paper reading)
Verdonna
(Screen Reading)

→ Computer

⊙ computer limitations:

→ Electricity (powers)
→ Memory crash
→ security Breach
→ storage
→ Expensive
→ Maintenance

: output
vision
Screen Paper
Monitor CRT LCD LED 3D
(Holographic)

⊙ Paper Output:

→ Dot Matrix (Text, Daisy, low cost)
→ Ink-Jet (Liquid Ink)
→ Laser Jet (Heating Process)
→ Plotters
→ 3D Printers

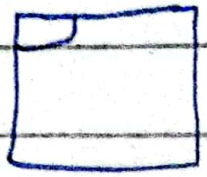
⊙ Hearing (Speakers), Touch (Vibration), Smell (Entertainment)

⊙ Color Models:

→ HLS, HSV [Human Perception]
(1) (0.5)

→ Hardcopy : CMY (Cyan Magenta Yellow) Color Models

→ Soft-copy, RGB, Monochrome
(255)



additive Color Model → RGB(A) → alpha Transparency

→ Flicker due to refresh rate (60Hz)

→ Paper : white (all colors intensities are maximized)

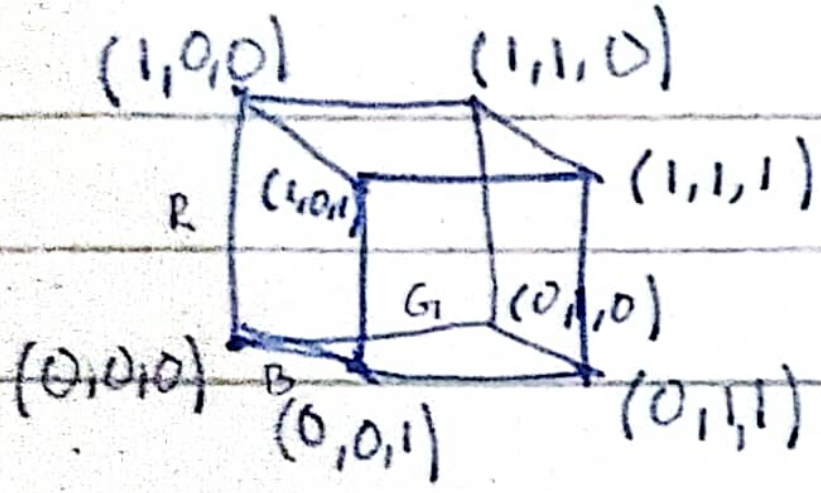
→ Subtractive Color Model

$$\begin{bmatrix} W \\ W \\ W \end{bmatrix} = \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} C \\ M \\ Y \end{bmatrix}$$

$$\begin{bmatrix} R+G+B \\ R+G+B \\ R+G+B \end{bmatrix} = \begin{bmatrix} R \\ G \\ B \end{bmatrix} + \begin{bmatrix} B+G \\ R+B \\ G+R \end{bmatrix}$$

→ CMY(K) (Black Ink separately provided to make it cost efficient)

**: Additive & Subtractive Color Model (Important for Exam)



: Vertices of R, G, B

+ HCi book ro
e 3

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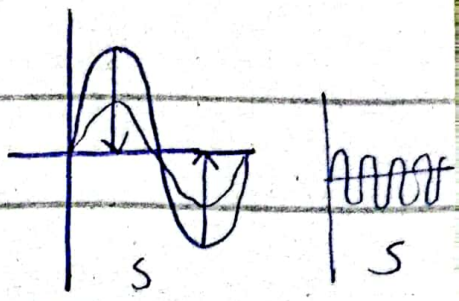
⊙ **Hearing:**

→ Loudness, Pitch

→ Customize Loudness and pitch according to environment.



→ Envelope (Gradual Start)
(Can be set by default)

→ Vibrator gives info by sense of touch.

→ Affectiveness (+ve emotions Vs -ve emotions)

⊙ **Cognitive Processor:**

→ Decision making

→ [Comparison : Input stimulus == Stored info

Solution → Reasoning: Inductive, Deductive, Abductive.

NO Solution → Problem Solving → Analogy

→ Language : IPA (International Phoenetic Alphabets)
(Sh, ش : ʃ)

→ Computer.

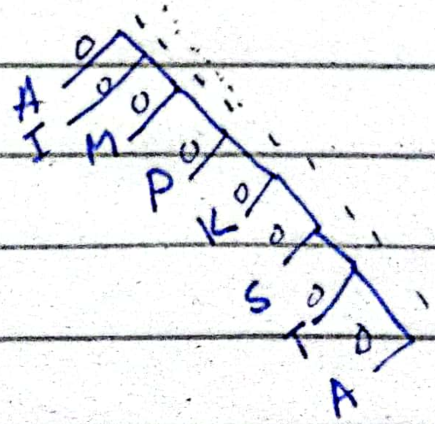
- IPA
- Unicode (instead ANSI)

→ Redundancy vs language : Compression Algo

Losless Compression Technique {
- Run Length Encoding : 0000111111000 ...
- Huffman Encoding : PAKISTANI

P-1 , A-2, K-1, I-2 , S-1, T-1 , N-1

P-110
K-1110

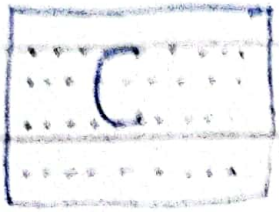


→ Images : Lossy compression : JPEG
GIF : lossless → Lookup table (CLUT)
SVG (Vector Graphic)

: BMP (without compression)

→ Vector Vs Raster Graphic

(Projection on Mathematical definitions)



→ Graphics pipeline

- Wireframe Model
- Visible surface determination
- Backface Cutting
- Lighting & shading
- Texture Mapping } Rendering
- Rasterization

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→ Data → # of errors

→ Experiment Design :

- Hypothesis : H_0, H_1
  - (H_0 (which can be true or false) (Null Possible rejection))
  - (H_1 (Alternate Hypothesis) (Possible acceptance))

E.g: Choose of Interaction style effects No. of errors.

(Does or Doesnot).

⊙ Variables:

→ Independent: Interaction style

→ Dependent: No. of errors

④ Test to be conducted:

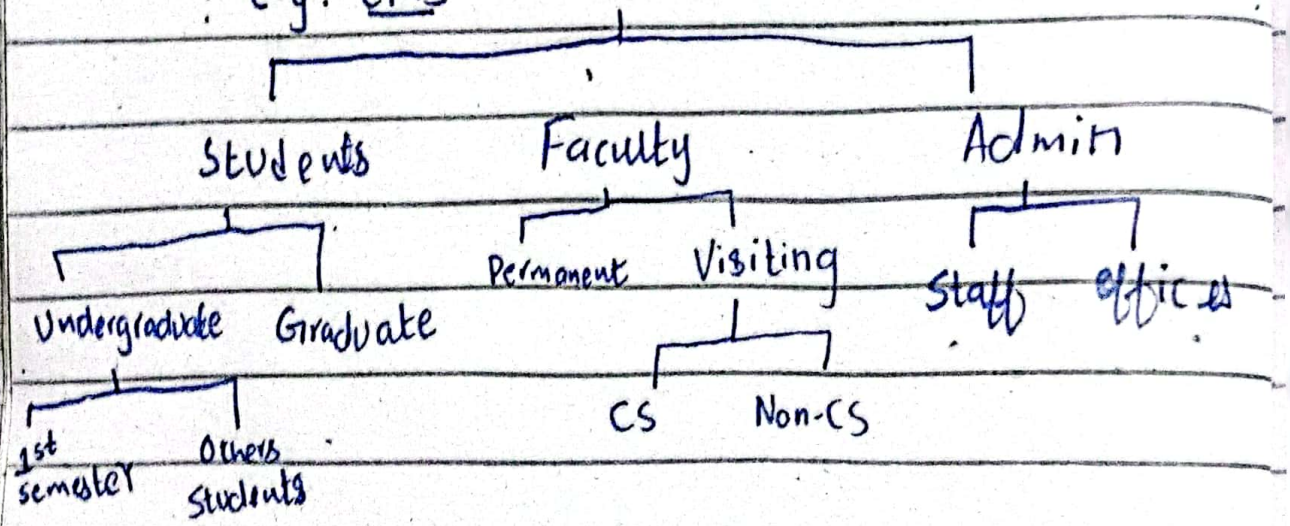
Correlation coefficient [data Numeric]

χ^2 (Chi Square)

④ Participants:

→ Stakeholders group Representative

: e.g: CMS



④ Method:

→ Load CMS interface

→ Provide login and password

→ Check Course

→ Check attendance

→ Choose date

: Ch#9

→ Choose Absent Students
→ Click Submit.
→ Count no. of errors at each step.
→ Systems displays updated attendance concatenated with other attendance of this course student wise.

* **Test Results:**

: for each group = $\frac{\text{No. of errors}}{\text{No. of experiment}}$

→ **Analysis:**
Test Result indication

* **Conclusion:**
Collection of analysis data.

→ **Information:**
# of error / Groups

: for each
Interaction Style : Knowledge Insights.

(Ch#3)

⊙ Donald Norman Model:

→ 7 step Process to execute a task:

① Formulation of Interaction
Execution
② Task
③ Action
④ Execute Action

Evaluation
- 5: Perceive State of System
- 6: Interpretation of system state
- 7: Decision

→ 3 & 4 Mismatched User formulation of Interaction (Interface provided to execute action)

is Gulf of Execution

→ Gulf of Evaluation:
Mismatched User Exception with output provided by the system.

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⊙ Computers & Interaction Styles:
↓
Capabilities and limitations

→ Ubiquitous Computing.
(Computing is everywhere)

→ Limitations:

① Computing bound application
E.g: RSA edges
(2 large prime prq)
..... = mod (p)q

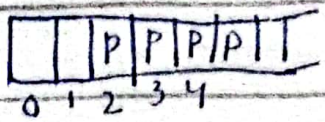
② Power bound application

: finding Prime No.:

```
r = (n../.2 -> n-1)
if (r=0) break;
r = (2 -> n-1)
  , (2 -> n/2)
  : (2 -> √n)
```

: Sieve of Germain

: Character of Array



(check for all numbers)
(log n)

: Reduce No. of application features

: Dark theme mode

: Screen Type (LCD, LED, CRT, Projector)

: 3D TV (Stereoscopic View)

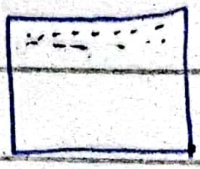
③ Graphics bound (I/O devices advancement, Moore's law is not mapped)

④ Network bound

: Moore's law (Every 6th month new invention)

CPU → Generate

RGB → 24 bit



↓

→ 2^{24} Colors

→ 2^4 2^{20}

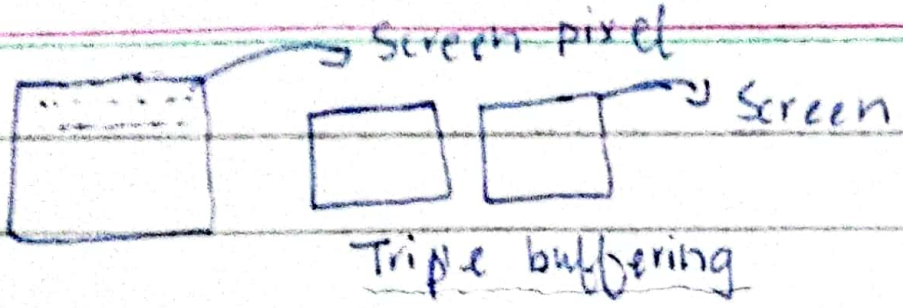
16 M

RGBA (a: alpha)

$2^{32} = 2^2 2^{30}$

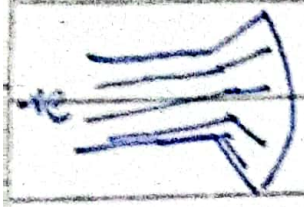
= 4 G colors

: System is now working in triple buffering



Triple buffering

Refresh rate : 60 Hz, 90 Hz (TV)



Inter laced (portion of image previous in unorder form)

Non-Inter laced (Portion of image appear in order form)

File formats:

→ BAMP ✗ → GIF ✓

→ JPEG ✓ → PNG ✓ → SVG ✓✓

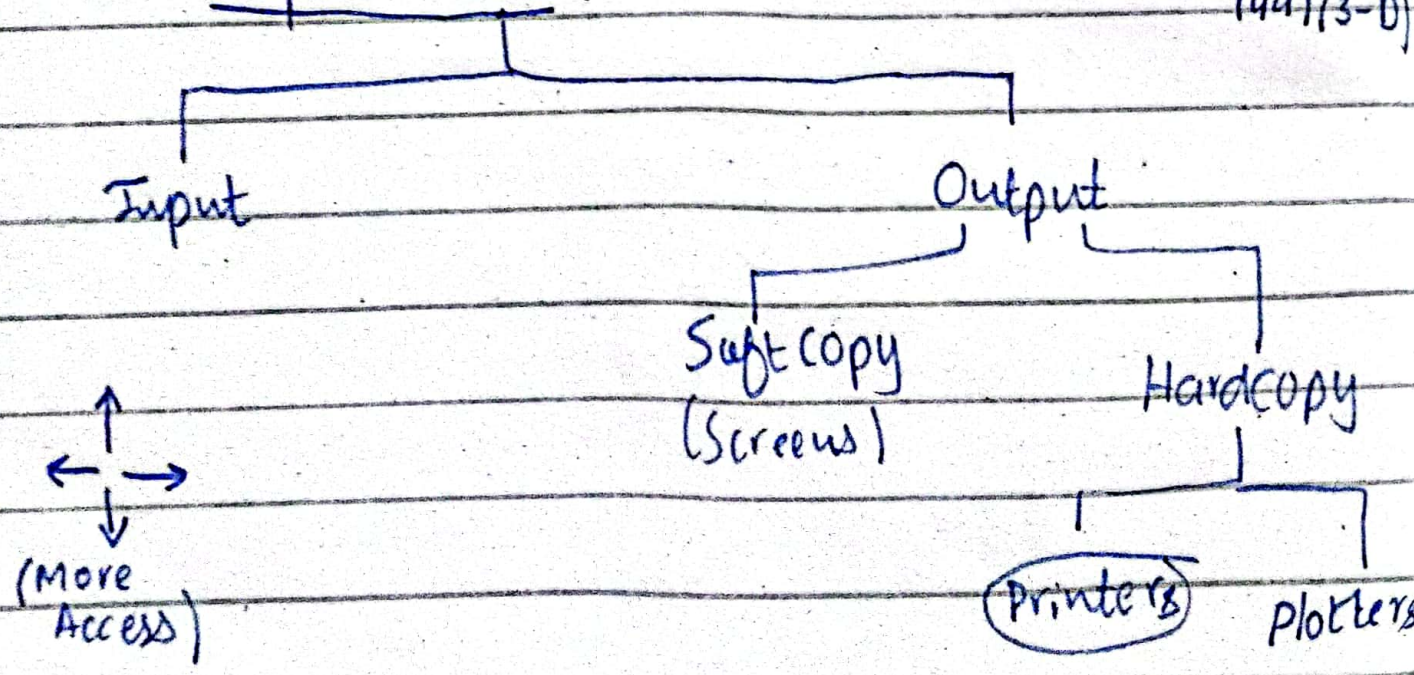
Network:

(Limitation)

→ Network Bandwidth

Capabilities:

: Slide (49) (3-0)



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Ch#3

⊙ Devices + Interaction Models & Styles:

- Limitations
  - 1- Computation
  - 2- power
  - 3- storage
  - 4- Graphics
  - 5- Network
  - → Minimize the impact + h/w increase + s/w solution
- Capabilities
  - Input
    - → Vision
      - Pointing (Mouse, Joystick)
      - Text-Entry (KB)
      - Image (Scanner, OCR)
    - → Hearing (Mic)
    - → Touch (Touchscreen)
  - Output
    - → Types of Screen
    - → Printers
  - Memory
  - processing

⊙ Interaction Model:

① Donald Norman Model:

(7 steps)

- → Gulf of Execution
  - 1- Establishes goal
  - 2- Formulation of Interaction
  - 3- specification
  - 4- Execute action
- → Gulf of Evaluation
  - 5- Perceive sys states
  - 6- Interpret
  - 7- Evaluate

: Exec : Input
: Eval : Output

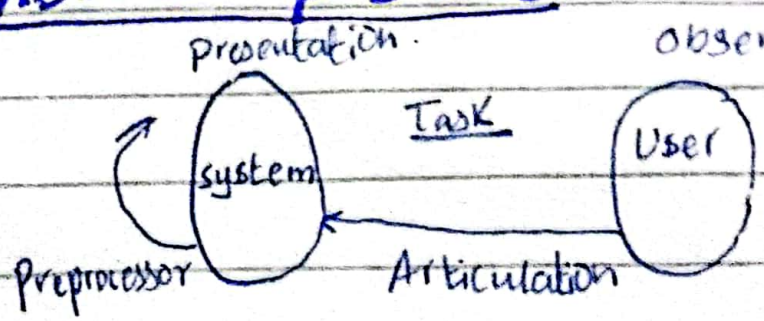
→ Tutorial :

* sending an email to students with predefined draft
* Students email action
* Draft of email
* Computing System
  → Type URL, mail (pucit-edu.pk)
  → Enter login, password
  → compose click
  → To: address,
  → Subject, Type
  → Message → attachment
  → Click "send button on bottom Right of screen.
  → Message has been sent displayed on bottom left.

5 * Displays on the screen (Output state
6 * Interpret
7 * Evaluate
(Gulf of Execute)

① Gulf of Execution (Mismatch b/w User expectations & Mechanism of input provided by System)

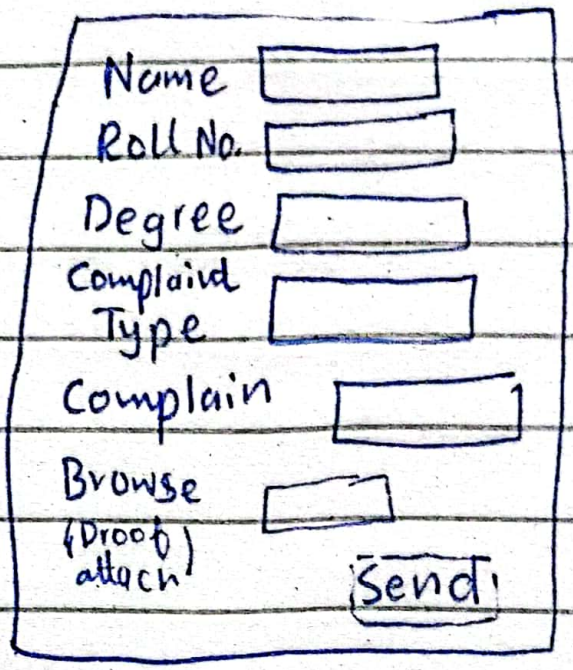
② Abourd & Beale:



: Donald Norman model (only focuses on observation)

→ Prototype:

Login



* (H.W) : State of art interaction styles (Sensors, Brains, Gestures)

→ WIMP → Pointers

Windows Icons Menus

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⊛ Quiz (Interaction Models & CLO's) Course Learning Objective

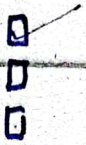
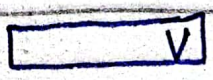
⊙ Case Study (Senior Citizen uses app, so interaction style matters).

* If we wanted to make app or facility for targeted people we use approximations.

* Conceptual (self-Writing) Exam (Only HCI (theory) can be asked)

Design of Everyday things:-

→ Affordances: The thing should be like when we see we understand it use.

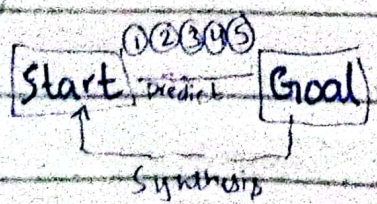
- Radio Buttons:  only one option
- CheckBox  (Multi-Select)
- Dropdown  Single
- Color choices (Blue for hyperlinks)

→ In conceptual models, story-boarding provides rough sketch of it

→ Ch#7 Usability Principles

↳ Learnability

↳ Predictability : Given by user what can be how this task can be done



FIGMA
(View it in holidays)

↳ Synthesiseability : Assessing past actions which led to this state

→ Conceptual Model: [Bread comb pattern]

↳ Generalization ↳ Familiarity

→ Make things visible

→ The Principal of Mapping

Natural Mapping

Physical Analogies — cultural

⊙ Interaction :

→ Command Line Interface

→ Menu Driven (Diversified users get options and not inject any thing)

→ Direct Manipulation (Description, Example, Use case)

→ Natural language

→ Gesture Based interfaces

→ Voice Based

→ Pen Based (Precise selection) (stylus)

→ Multi-Touch Interfaces

→ Augmented Reality Based

→ VR Interfaces

→ Brain-computers Interface.

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→ Interaction Styles

⊙ Types of application [CAD, MSWord

⇒ Users Diversified

→ support of I/O devices

⊙ **Direct Manipulation Interface:**

→ Visibility of objects of interest
(Operation allowed or not)

Name : [ ]

× Age : [ ] ✓ Age : [ ]

→ Incremental actions (Batch files)

→ Reversibility (Undo)

→ Replacement of complex commands with icons

→ Systematic conversion of actions

⊙ create "filename", "filetext"

⊙ Ms-Word:

→ Natural language based Input

→ Menu Driven

→ Direct Manipulation

⊙ Interaction:

→ Command Line Interface (Mnemonics can be made)

→ Menus (Name Meaningful)

33
55

: ABC DEF

2 3

: *22*

: Windows, Icons [Standardized e.g: floppy to save]

: Learnability Principle

Predictability | Synthesisability | Consistency | Generalization | Familiarity

: Menus (Right Click, fall down (Mouse Pointer), drop-down (Click) Defragmentation

Toolbars etc....)

: Pointer : (selection, System Status (I, 8, ↗)

→ Query Interfaces

→ Point and click interfaces.

⊛ Ch#4 : Paradigms

Batch Processing

↓

Ubiquitous Computing

[Groupware

:CSCW

(Computer Supported Cooperative Work)]

(Same time to join group app)

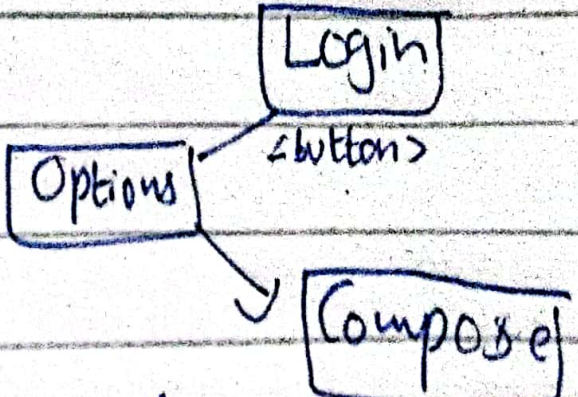
⊛ Interaction Design Basics:

1- Widget Design:

Tools (Calender, Clock etc.)

2- Screen

3- Narigation Design → Site Hierarchy / Site Map



4- Environment Applications