Human Computer Interaction

UNIT-6
Lecture 2:
Cognitive Architecture

Mr. Nachiket Sainis

B K Birla Institute of Engineering & Technology, Pilani

Lecture 2:
Model Human Processor - I

MHP

- **Contains three interacting systems:**

1. Perceptual system

2. Cognitive system

3. Motor systems

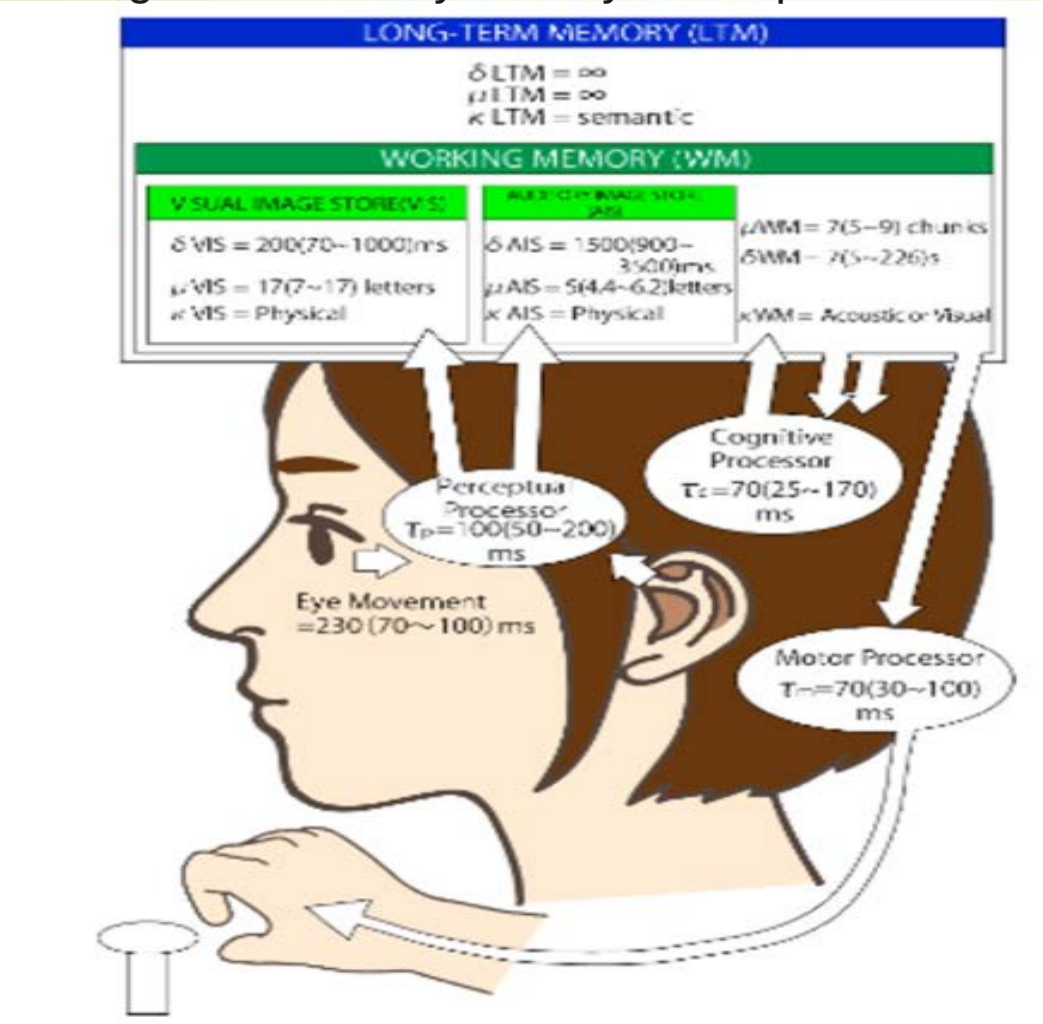
  - For some tasks, systems operate in serial (pressing a key in response to a stimulus)

  - For other tasks, systems operate in parallel (driving, talking to passenger, listening to radio)

MHP

- The Model Human Processor, developed by Card, Moran and Newell, is a design tool that is used for creating an effective user interface.
- It draws an analogy between the processing and storage facilities in a computer system with the perceptual, cognitive, memory and motor activities of a computer user.
- The Model Human Processor describes how a user interacts with a computer system
- Each system has its own memory and processor with characteristics
  - Memory: storage capacity and decay time
  - Processor: cycle time (includes access time)

The Model Human Processor is a model of a series of information flows in a human from the viewpoint of information processing (Fig). In the model, sensory information is input to perceptual processor, and then processed in cognitive processor, and finally an action is output through the motor system by motor processor.



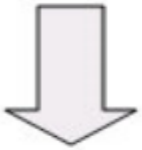
A visual or audible stimulus is captured.

The physical attributes of the stimulus are decoded.

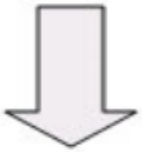
Response.

Example

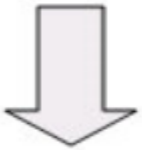
A pop up message appears on the screen (perception).



The user works out the response that is needed (cognitive processing).

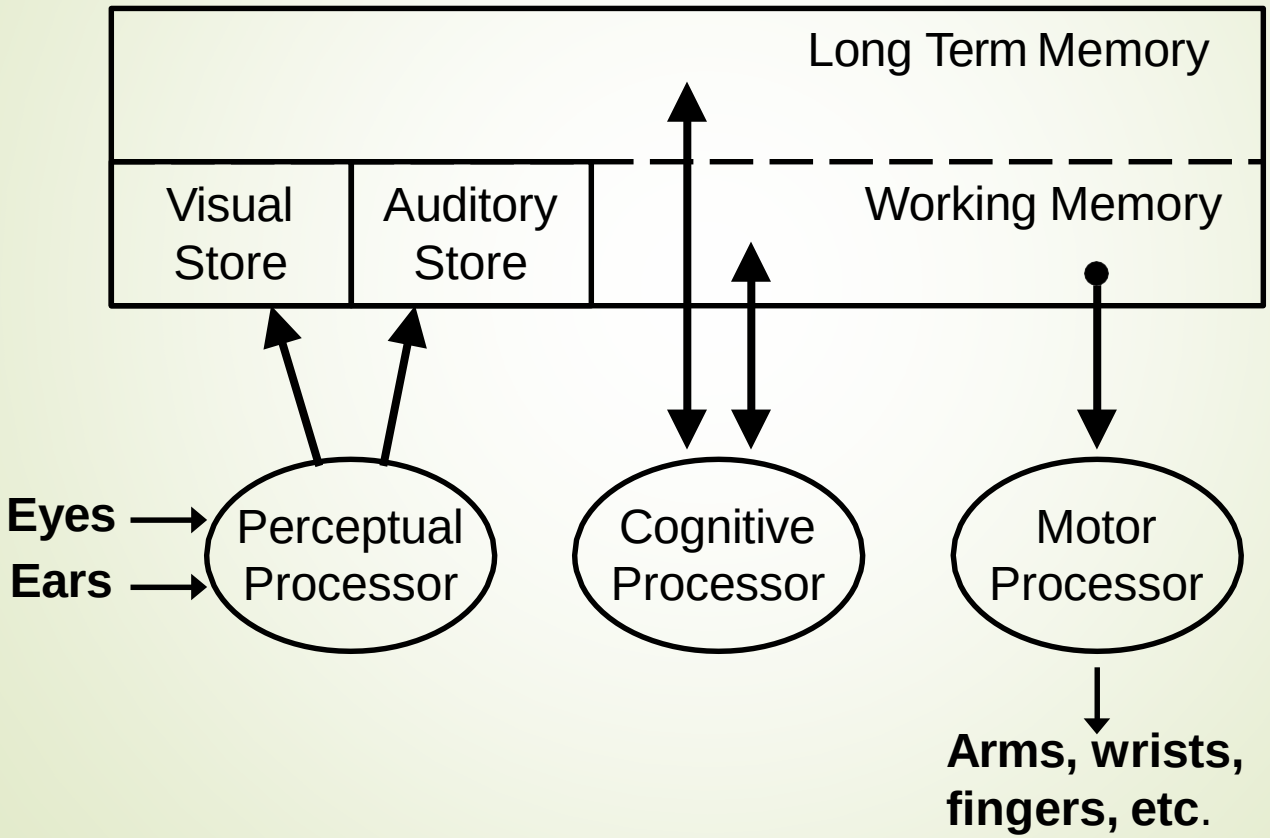


A motor response is initiated (response).



The mouse is moved and a button is clicked.

MHP – Schematic Diagram



MHP

- The sub systems in MHP are guided by the *principles of operation*
  - 10 such principles in total
- Two of these principles are very important
  - The rationality principle
  - The problem space principle (PSP)

The Rationality Principle

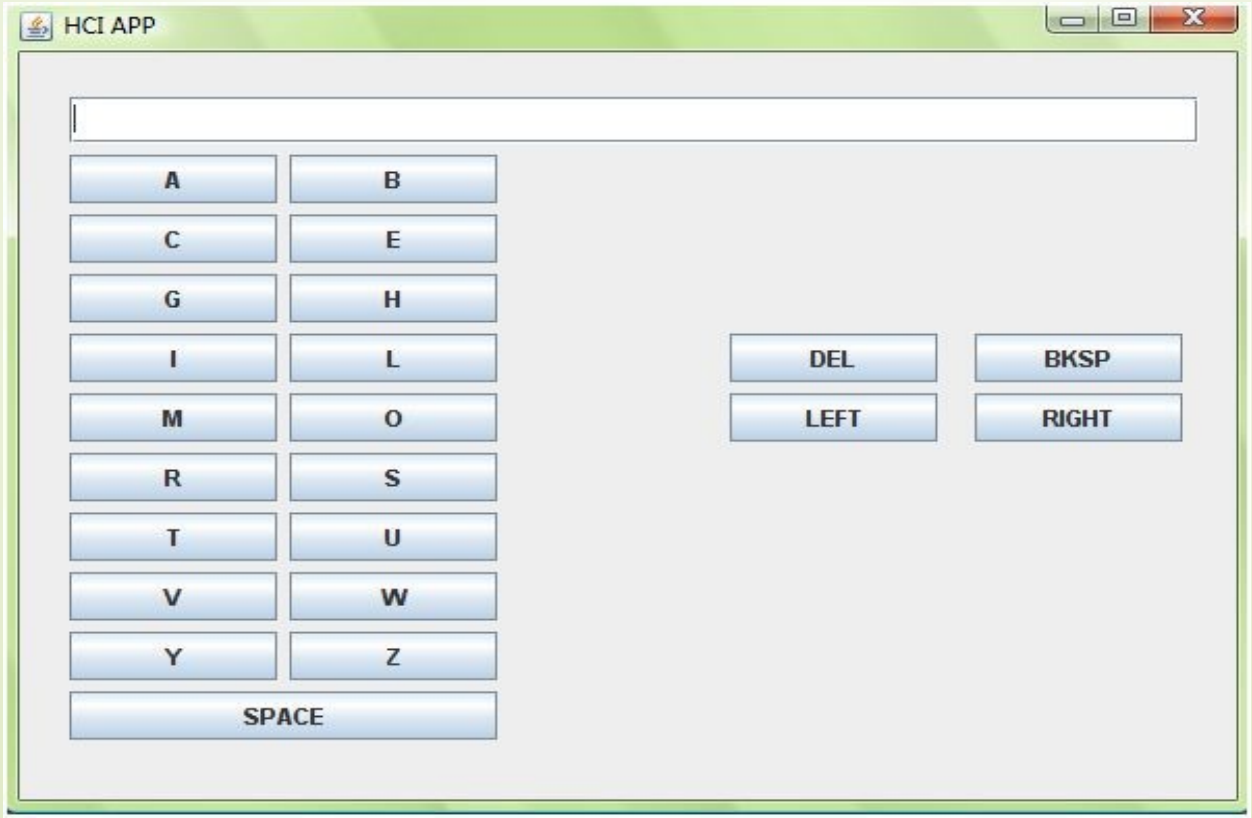
- This is one of the guiding principles of MHP
- The principle is based on the assumption that we behave rationally, rather than driven by emotion
- It states that the human behavior is determined by a set of factors that include goals, task, inputs and knowledge

The Problem Space Principle

- This is the other guiding principle of MHP
- It states that any goal directed activity can be described in terms of
  - A set of states of knowledge
  - Operators for changing one state into another
  - Constraints on applying operators
  - Control knowledge for deciding which operator to apply next

A Little on PSP

Let’s understand PSP with an example. Suppose a user John wants to write a correct sentence with only available letters on the following interface



A Little on PSP

- **Human cognitive behaviors assumed to have some common properties**
  - **Behaves in a goal-oriented manner**

    -John ultimately wants to write a grammatically and semantically correct sentence
  - **Operates in a rich, complex, detailed environment**

    -There are many other things that John has to keep in his mind.– key positions, keystrokes

A Little on PSP

- **Uses a large amount of knowledge**

  - Grammar rules, spellings

- **Behaves flexibly as a function of the environment**

  - may complete any sentence left behind

- **Uses symbols and abstractions**

  -John will start thinking from a greater level of abstraction

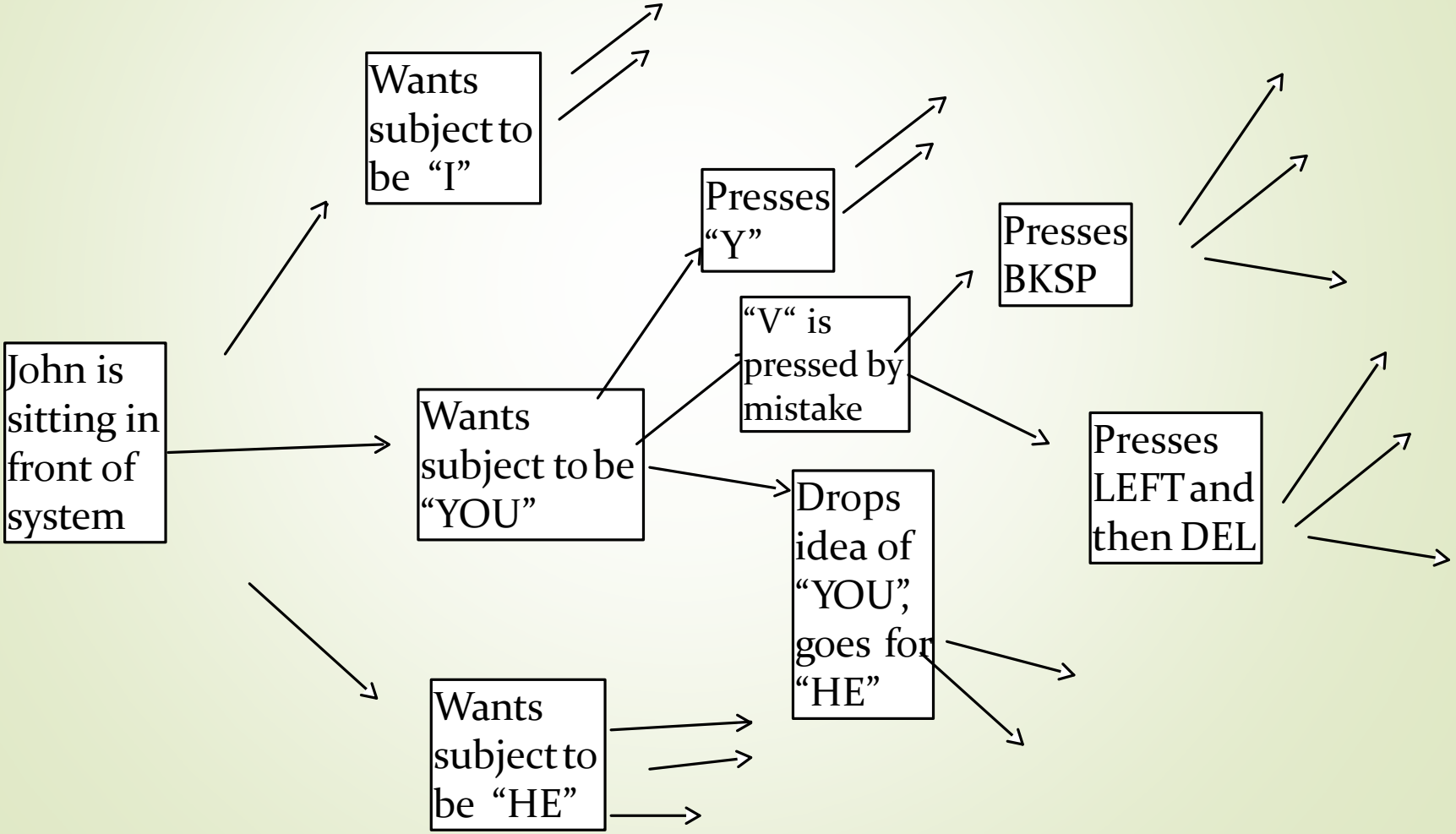
- **Learns from the environment and experience**

  -As John starts typing, he learns more about available keys

A Little on PSP

- John's behavior can be described as movement through problem space
- In problem space, there are various states and by taking an appropriate action (goal directed), John reaches a new state and this process repeats until goal is achieved
- This movement in the problem space is illustrated in the next slide

A Little on PSP

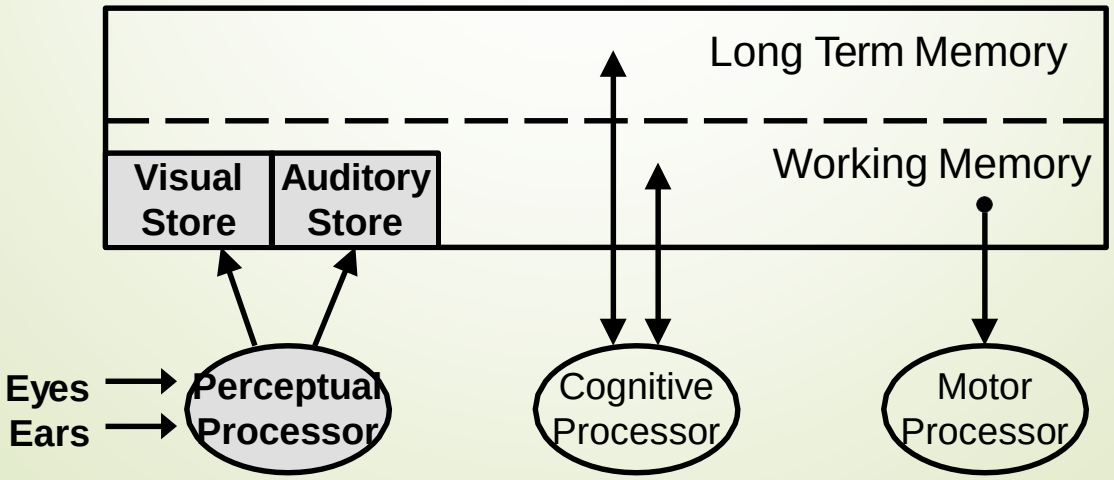


A Little on PSP

- Previous figure was only a portion of the whole problem space for John
  - Problem space is almost a finite automata with states, and actions taken by John to change states are called *operators*

MHP Subsystems: Perceptual System

- Responsible for transforming external environment into a form that cognitive system can process
- Composed of ***perceptual memory*** and ***processor***



Perceptual Memory

- Shortly after the onset of stimulus, representation of stimulus appears in perceptual memory
  - Representation is physical (non-symbolic). For example, “7” is just the pattern, not the recognized digit
- As contents of perceptual memory are symbolically coded, they are passed to the working/short term memory

Perceptual Memory

- The contents of the perceptual memory gets decayed over time
- Typical decay times
  - 200ms for visual store
  - 1500ms for auditory store

Perceptual Processor

- The perceptual processor encodes information in the perceptual memory for about 100ms and then retrieves next stimulus
  - Cycle time = ~100ms
- Processor cannot code all information before the next stimulus arrives
  - Type and order of coding are governed by the Gestalt principles (perceive shape from atomic parts) and Attention (directs processing or filters information)