

Lecture 10

Models 2 – MHP and KLM

with reference to sections 7.1 and 7.2 of
The Resonant Interface
HCI Foundations for Interaction Design
First Edition
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Chapter 7 Interaction Design Models

- **Model Human Processor (MHP)**
- **Keyboard Level Model (KLM)**
- GOMS
- Modeling Structure
- Modeling Dynamics
- Physical Models

Predictive/Descriptive Models

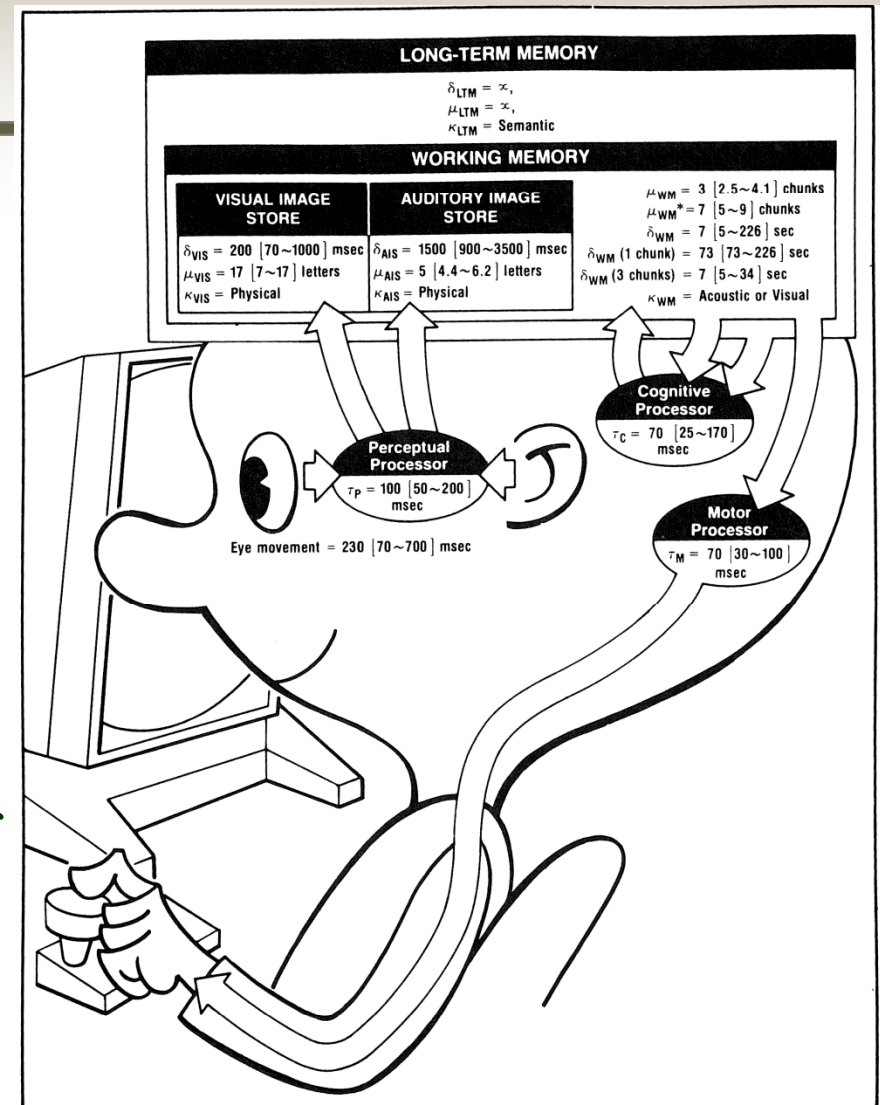
- **Predictive models** such as the Model Human Processor (MHP) and the Keyboard Level Model (KLM), are derived from experiments and give approximations of user actions before real users are brought into the testing environment.
- **Descriptive models**, such as state networks and the Three-State Model, provide a framework for thinking about user interaction
 - They can help us to understand how people interact with dynamic systems.

Model Human Processor (MHP)

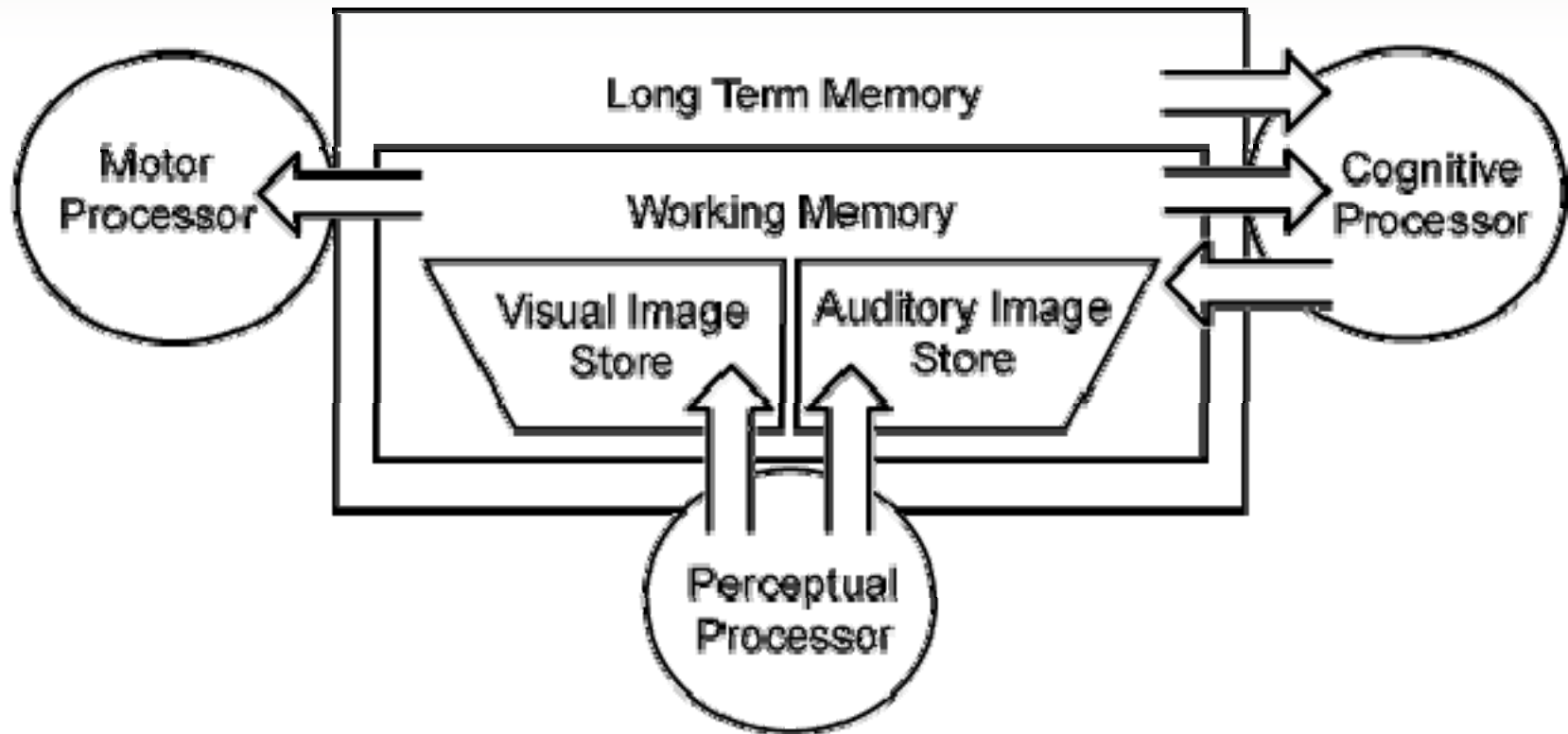
MAXIM

The Model Human Processor can make general predictions about human performance

- The MHP is an integrated predictive model and is described by a set of memories and processors that function according to a set of principles (principles of operation)
- The MHP can reproduce Hick's law and Fitts' Law.



Model Human Processor (MHP)



Model Human Processor (MHP)

- Perceptual system

- Sensors

- eyes
- ears

- Buffers

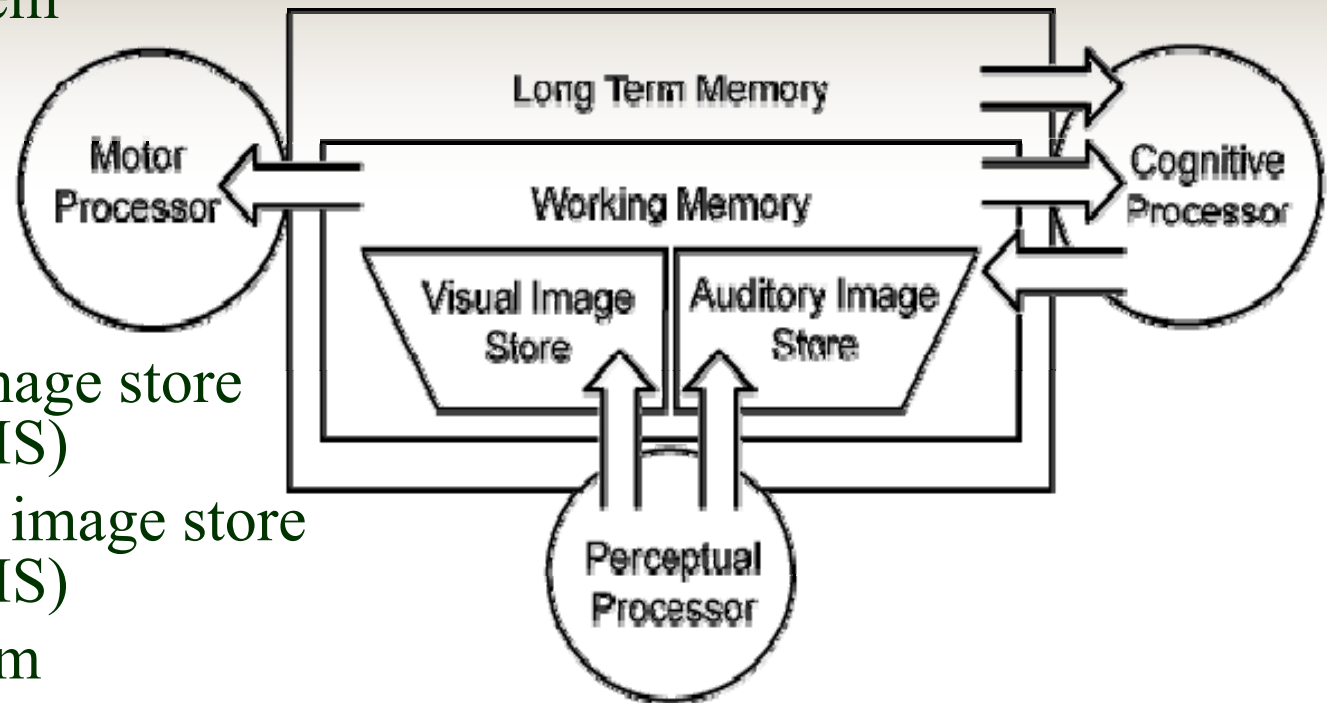
- Visual image store (VIS)
- Auditory image store (AIS)

- Cognitive system

- Working memory (WM)—*Short-term memory*
- Long-term memory (LTM)

- Motor system

- arm-hand-finger system
- head-eye system



MHP – *Working Memory (WM)*

- WM consists of a subset of “activated” elements from LTM (long-term memory)
- The SISs (Sensory Image Stores – visual and audio) encode only the nonsymbolic physical parameters of stimuli.
- Shortly after the onset of a stimulus, a symbolic representation is registered in the WM

MHP – *Working Memory*

- The activated elements from LTM are called “chunks”
 - Chunks can be composed of smaller units like the letters in a word
 - A chunk might also consist of several words, as in a well-known phrase

MHP – *Working Memory*

UNGP~~M~~HZDN
GNUM~~H~~PNZD
GNU MHP NZD

MHP – *Working Memory*

- Thus, how well you can remember something in WM will depend on how you think about it
 - Can you combine details into larger chunks?
 - E.g., noting “double-3” “triple-7” in a phone number will make it easier to keep in memory while you dial

MHP – *Long-Term Memory*

- The cognitive processor can add items to WM but not to LTM
- The WM must interact with LTM over a significant length of time before an item can be stored in LTM
- This increases the number of cues that can be used to retrieve the item later
- Items with numerous associations have a greater probability of being retrieved

MHP – *Processor Timing*

- You can run a ‘program’ on the MHP and estimate its time
 - People vary, so MHP allows ‘Slowman’, ‘Fastman’ and (typical) ‘Middleman’ values for MHP steps

MHP – *Processor Timing*

- **Perceptual**—The perceptual system captures physical sensations by way of the visual and auditory receptor channels
- Perceptual decay is shorter for the visual channel than for the auditory channel ($\delta_{\text{VIS}} < \delta_{\text{AIS}}$)
- Perceptual processor cycle time is variable according to the nature of the stimuli
($\tau_p = 100 [50 \sim 200]\text{ms}$)

MHP – *Processor Timing*

- **Cognitive**—The cognitive system bridges the perceptual and motor systems
- It can function as a simple conduit or it can involve complex processes, such as learning, fact retrieval, and problem solving
- Cognitive coding in the WM is predominantly visual and auditory

MHP – Processor Timing

- Cognitive coding in LTM is involved with associations and is considered to be predominantly semantic
- Cognitive decay time of WM requires a large range...
 $\delta_{WM} = 7 [5 \sim 226]s$
- Cognitive decay is highly sensitive to the number of chunks involved in the recalled item
 - $\delta_{WM}(1 \text{ chunk}) = 73 [73 \sim 226]s$
 - $\delta_{WM}(3 \text{ chunks}) = 7 [5 \sim 34]s$

MHP – *Processor Timing*

- Cognitive decay of LTM is considered infinite
- Cognitive processor cycle time is variable according to the nature of the stimuli

$$\tau_C = 70 [25 \sim 170]ms$$

- **Motor**—The motor system converts thought into action
- Motor processor cycle time is calculated in units of discrete micromovements

$$\tau_M = 70 [30 \sim 100]ms$$

MHP – *Processor Timing*

- Total time is the sum of time for the subsystem actions

$$\text{Total time} = \tau_P + \tau_C + \tau_M$$

Keyboard Level Model (KLM)

- The KLM is a practical design tool that can capture and calculate the physical actions a user will have to carry out to complete specific tasks

MAXIM

The KLM can be used to determine the most efficient method and its suitability for specific contexts.

Keyboard Level Model (KLM)

- **Given:**
 - A task (possibly involving several subtasks)
 - The command language of a system
 - The motor skill parameter of the user
 - The response time parameters
- **Predict:** The time an expert user will take to execute the task using the system
 - Provided that he or she uses the method without error

Keyboard Level Model (KLM)

- The KLM is comprised of:
 - Operators
 - Encoding methods
 - Heuristics for the placement of mental (**M**) operators

KLM - Operators

- Operators
 - **K** Press a key or button
 - Varies with task and typing skill, typically 0.28s
 - **P** Point with mouse
 - Can apply Fitts' Law – on average, 1.10s
 - **B** Mouse button
 - Down or up – 0.10s Click – 0.20s
 - **H** Home hands to keyboard or peripheral device
 - 0.4s
 - **D** Draw line segments
 - $0.9 \times \# \text{ of segments} + 0.16$ total length in cm
 - **M** Mental preparation
 - 1.35s
 - **R** System response
 - Depends on the system

KLM – *Encoding Methods*

- Encoding methods define how the operators involved in a task are to be written

MK[i] K[p] K[c] K[o] K[n] K[f] K[i] K[g] K[RETURN]

It would be encoded in the short-hand version as

M 8K [ipconfig RETURN]

This results in a timing of $1.35s + 8 \times 0.20s = 2.95$ seconds for an average skilled typist.

Rules for Placing Mental (M) Operators

Use Rule 0 to place candidate M's and then cycle through Rules 1 to 4 for each M to see whether it should be deleted

- **Rule 0** Insert M's in front of all K's and B's that are not part of text or numeric argument strings proper (e.g., text or numbers). Place M's in front of all P's that select commands (not arguments).
- **Rule 1** If an operator following an M is fully anticipated in an operator just previous to M, then delete the M.
 - E.g., point with mouse then click PMB -> PB
- **Rule 2** If a string of MK's belongs to a cognitive unit (e.g., the name of a command) then delete all M's but the first.
- **Rule 3** If a K is a redundant terminator (e.g., the terminator of a command immediately following the terminator of its argument) then delete the M in front of it.
 - E.g., terminate argument and then command MKMK -> MKK
- **Rule 4** If a K terminates a constant string (e.g., a command name) then delete the M in front of it; but if the K terminates a variable string (e.g., an argument string) then keep the M in front of it.

KLM exercise answer

Drag to trash

P[to file]	1.1
B[LEFT down]	0.1
M	1.35
P[to trash]	1.1
B[LEFT up]	0.1
====	
	3.75 s

Delete key

P[to file]	1.1
B[click]	0.2
H[to keyboard]	0.4
M	1.35
K[Delete key]	0.28
M	1.35
H[to mouse]*	0.4
M	1.35
P[to Yes button]	1.1
B[click]	0.2
====	
	7.73 s

* using the mouse for the Yes (confirm)

Assume that the user's hand starts on the mouse. Also assume that the trash icon is visible at the time the user wishes to delete the file.

What the KLM Does Not Do

- The KLM was not designed to consider the following:
 - Errors
 - Learning
 - Functionality
 - Recall
 - Concentration
 - Fatigue
 - Acceptability