# Human Computer Systems

Lecture 2

HCI - When things go wrong – Bad Designs!

Cognitive Psychology Intro

# HCI - When things go wrong! Bad Designs

- Three Mile Island nuclear disaster (ref: Preece)
  - experts blamed combination of operator error and bad interface design
  - interface problems -
    - light indicated valve was shut when it wasn't
    - light indicator was covered by tag to another controller
    - audible & visual controls for >1500 faults. One button silenced all alarms at same time, but was not used because operators knew they would lose information if they switched off the alarm

# HCI - When things go wrong!

- Indian Airlines Flight 605 Airbus disaster
  - 98 people killed
  - Report in Flight International magazine “undoubtedly derives from poor understanding between the machine and the pilot - pilots not adapting to automation”
- China Airlines Flight 006 plunged 32,000 ft in 2 minutes, damaging tail & landing gear
  - comment “crew’s role is reduced to one of monitoring performance of boring, reliable systems - to perform well, humans need to be ... giving commands, controlling inputs etc an feeling the result”

# HCI - When things go wrong!

# Bad Designs

- Iranian Airbus shot down by mistake
  - 290 people killed
  - US Navy investigators concluded “Aegis (sophisticated on-board computer) had provided accurate information - the crew had misinterpreted it
  - radar image of airbus was on one screen, other vital info was on another. Crew had to keep moving attention between screens

# HCI - When things go wrong!
# Bad Designs

- http://www.baddesigns.com/
- Scrapbook of examples – worth a look!

# Examples from Baddesigns

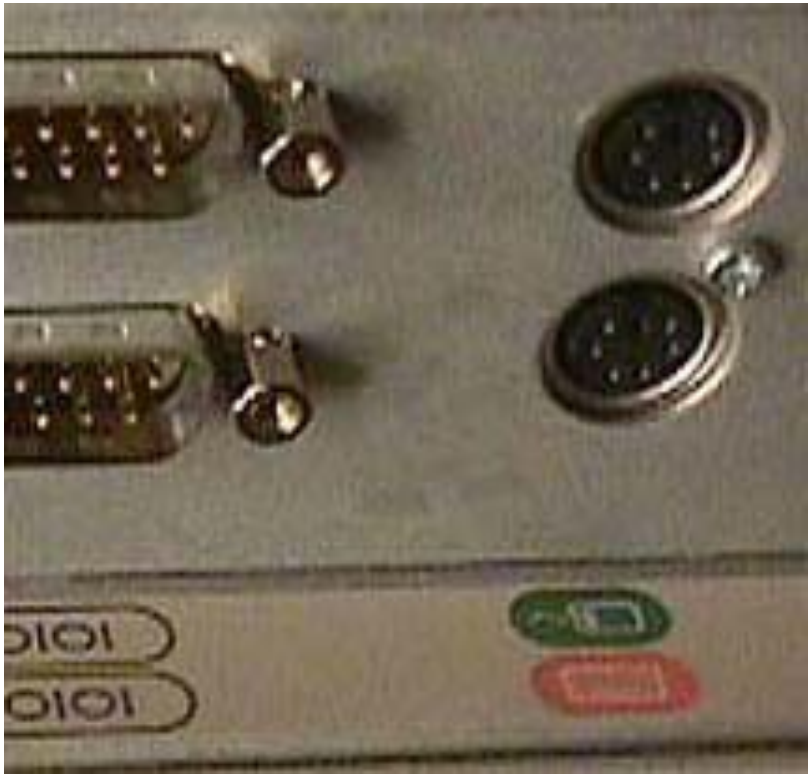
- How fast?

# Examples from Baddesigns

- How to work the lift?

# Examples from Baddesigns

- Mouse where?



# Design Principles

- Donald Norman: The Design of Everyday Things
  - Visibility
  - Feedback
  - Constraints
  - Mapping
  - Consistency
  - Affordance

# HCI Factors

- Main factors that should be taken into account in HCI design are shown below:
- Organisational
  - training, job design, politics, roles, work organisation
- Environmental
  - noise, heating, lighting, ventilation
- Health & Safety
  - stress, headaches, muscular/skeletal disorders

# HCI Factors

- Cognitive processes & capabilities of users
  - motivation, enjoyment, satisfaction, personality, experience level
- **Comfort**
  - seating, equipment, layout
- User Interface
  - input devices, output displays, dialogue structures, use of colour, icons, commands, graphics, natural language, 3-D, user support materials, multimedia

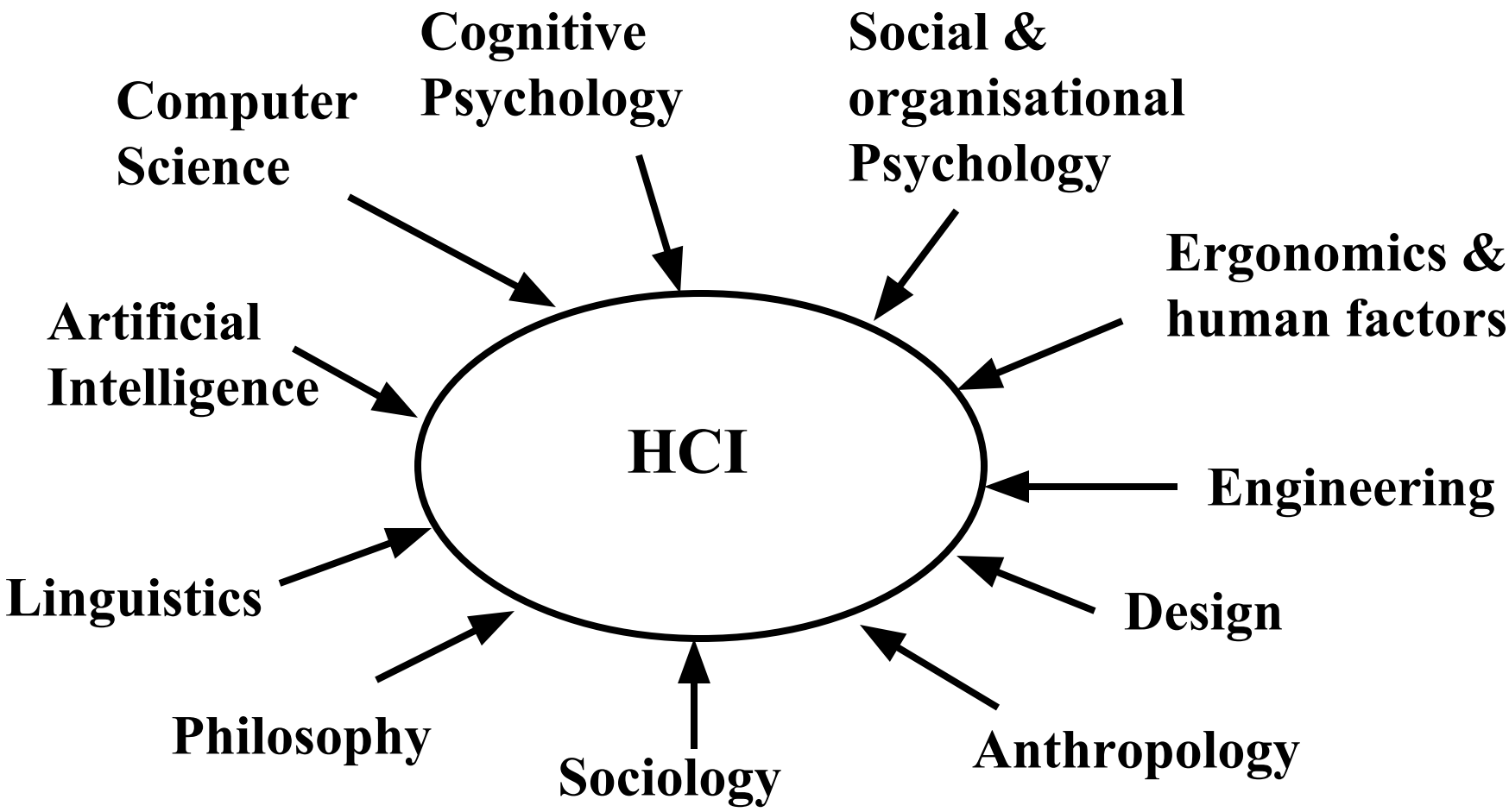
# HCI Factors

- Tasks
  - easy, complex, novel, task allocation, repetitive, monitoring, skills, components
- Constraints
  - costs, timescales, budgets, staff, equipment, building structure
- System Functionality
  - hardware, software, applications

# HCI Factors

- Productivity
  - increase output, increase quality, decrease costs, decrease labour requirements, decrease production time, increase creative and innovative ideas leading to new products

# Disciplines involved in HCI



# Computer Science

- A major contributor to HCI
- provide knowledge about capability of technology and how to harness potential
- techniques for software design, development & maintenance
- object-oriented languages, user interface management systems (UIMS), user interface design environments (UIDEs), debugging tools multimedia, virtual reality, prototyping tools etc

# Cognitive Psychology

- Understanding human behaviour & underlying mental processes
- perception, attention, memory, learning, thinking, problem solving
- aim to characterise these in terms of capabilities and limitations
- guidelines, use of models to predict human performance, methods to test systems

# Social & Organisational Psychology

- Nature & causes of human behaviour in a social context. 4 main concerns:
  - influence of one individual on another's attitudes & behaviour
  - impact of a group on it's members attitudes & behaviour
  - impact on a member on a group's activities & structure
  - relationship between the structure & activities of different groups
- structure & function of organisations in terms of:
  - authority, power, size, complexity, information flow etc

# Ergonomics (human factors)

- Design to suit the capabilities of users eg car seat, computer system
- objective - maximise operator safety, efficiency & reliability, make task easier, increase satisfaction & comfort
- major input on workstation design, readability of info on VDU, repetitive strain injury, VDU radiation etc

# Linguistics

- Scientific study of language
- early work on syntax of languages eg del fred or fred del
- understanding the structure (syntax) and meaning (semantics) is important in developing natural language interfaces, also conversational analysis
- internationalisation - eliminate cultural aspects of software (split words, dates etc from product which can then be generic)
- localisation - opposite, infuse cultural context

# Artificial Intelligence

- Design of intelligent computer systems to simulate aspects of intelligent human behaviour
- representing knowledge used in problem solving
- expert systems, systems which can justify their reasoning, intelligent user interfaces, ICAL...etc
- natural language & speech for communication
- intelligent agents to support user navigation & reduce menial tasks

# Philosophy, Sociology & Anthropology

- “Soft Sciences” - more indirect influence eg technology transfer effects
- How to make sense of what is going on when people communicate with each other and computers
- Implications of introduction of IT to society
- computer supported cooperative working (CSCW) - sharing software & hardware among a group of people working together eg groupware

# Engineering & Design

- Model building & empirical testing
- design contributes creative skills & knowledge to this process eg graphic design, 2-D, 3-D modelling, CAD, CAE

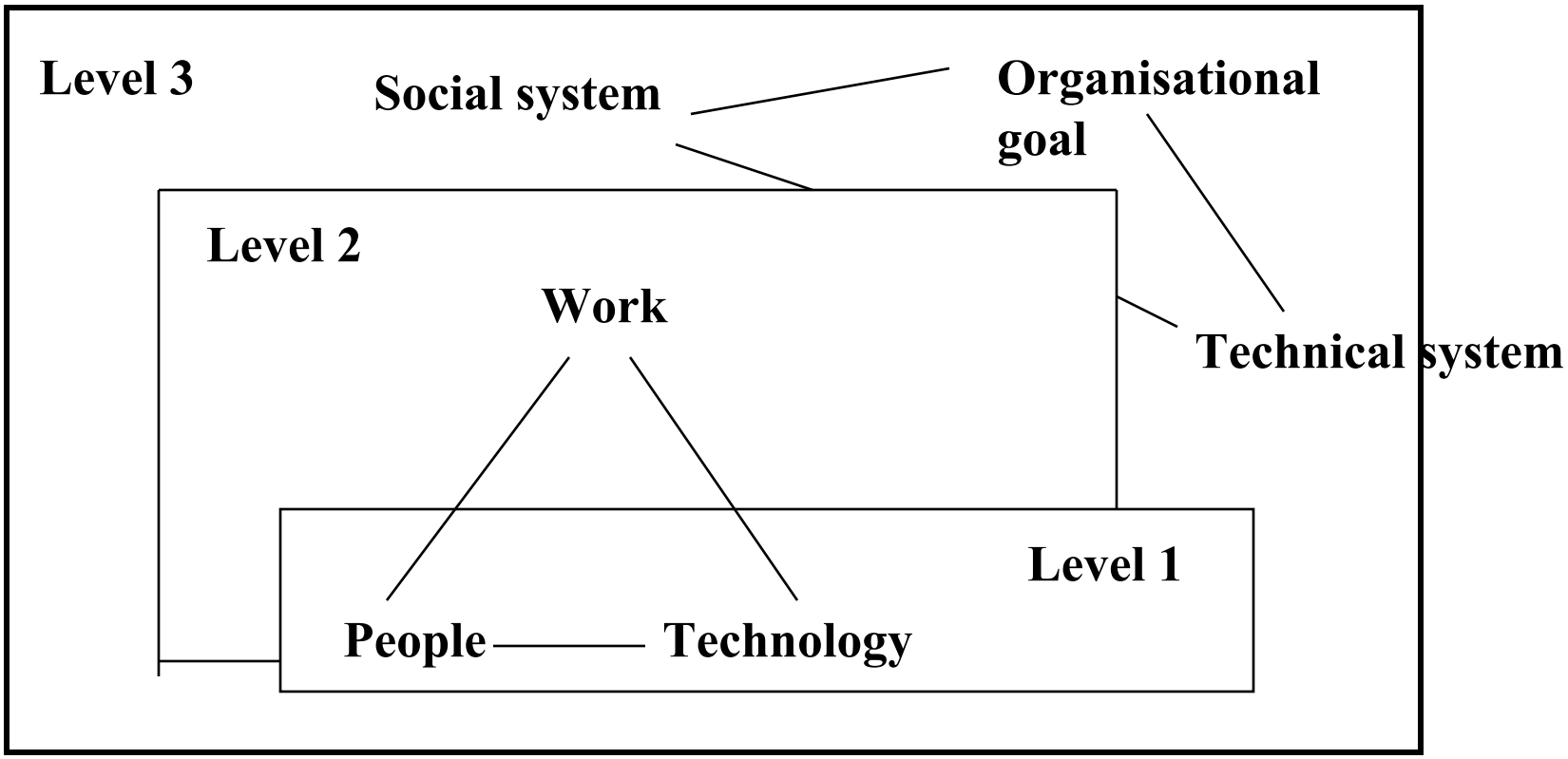
# HCI Model

- Role of HCI in system design is to enhance the quality of the interaction between humans and computer systems
- apply knowledge about human goals, capabilities and limitations with knowledge about computer capabilities and limitations
- relate this knowledge to understanding the social, organisational and physical aspects of the work environment of the user

# HCI Model...

- Make the transition between what can be done (functionality) to ... How it can be done to match the users' needs (usability) in the work environment. How?
  - Select most appropriate input device (keyboard, mouse, pen etc)
  - select output devices (video, speech, text, graphics etc)
  - select best style of interaction (eg forms, natural language, GUI, virtual reality etc)

# HCI Model...


Level 3
Social system
Organisational goal
Level 2
Work
Technical system
Level 1
People
Technology

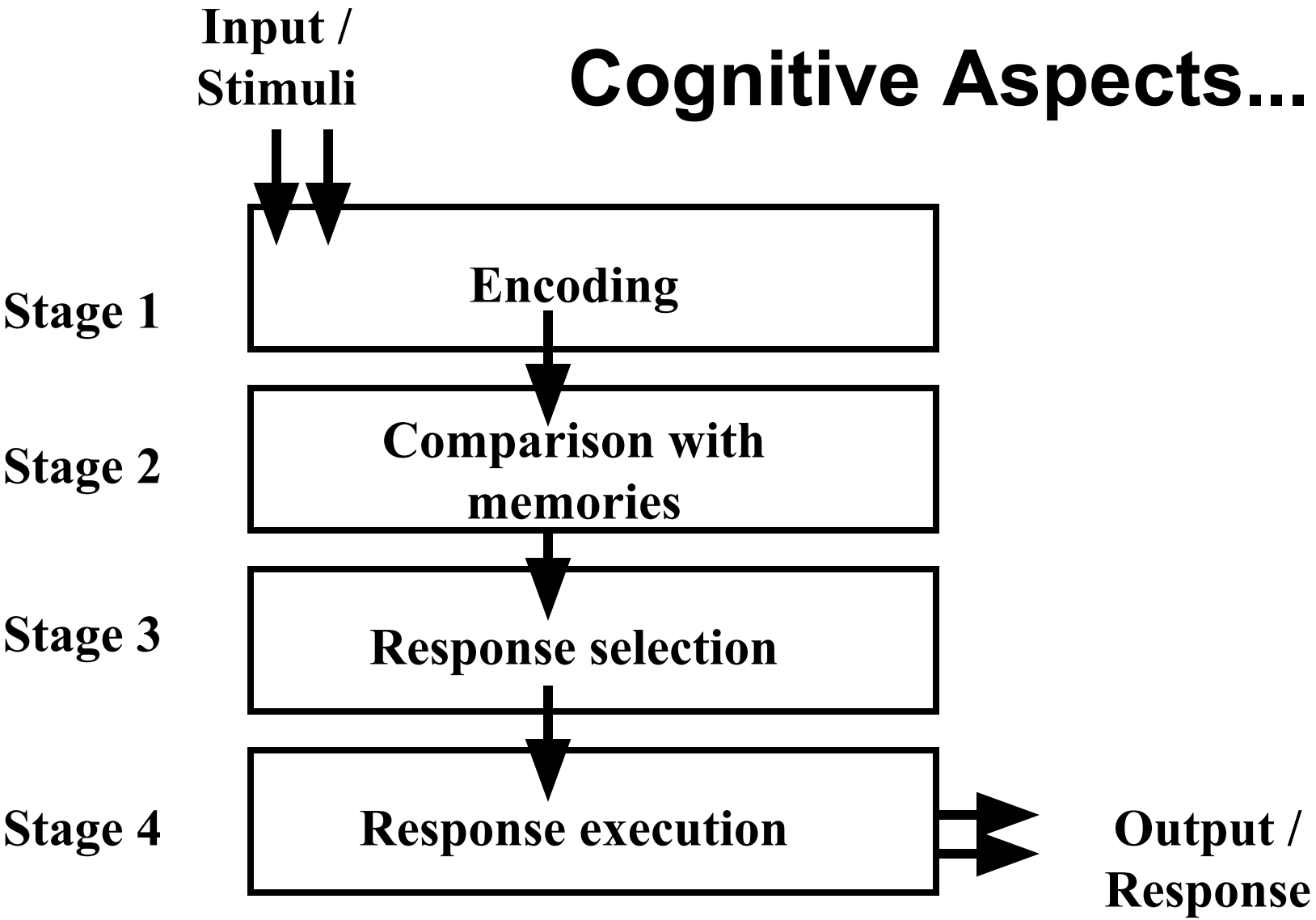
# Cognitive Aspects

- Cognitive models of users
- Distributed cognition -
  - central concern is to re-embody cognitive processes in a real-world context
  - instead of conceptualising an individual's cognitive tasks when interacting with an individual computer, characterise cognitive activities of a group of people working together in a given setting

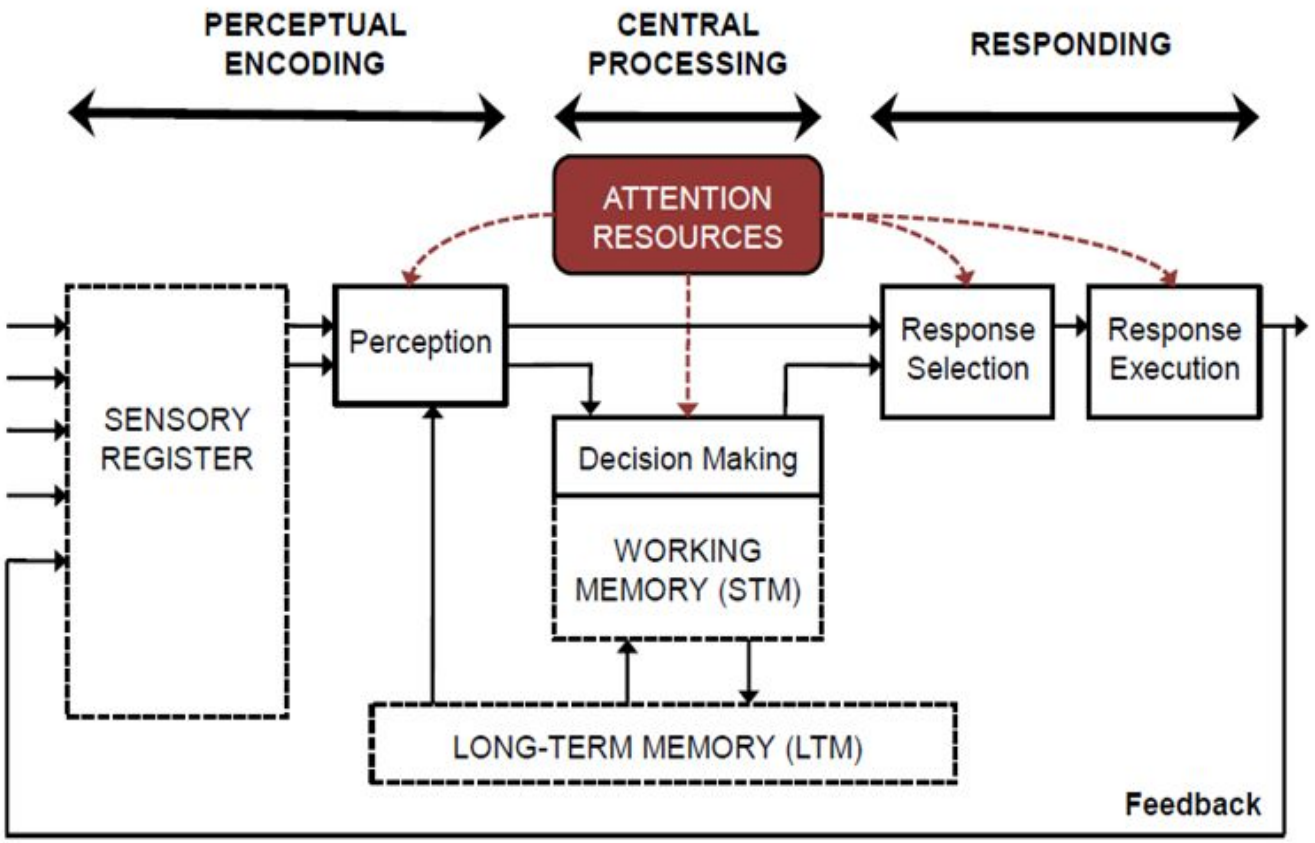
# Cognitive Aspects...

- Cognition
  - processes by which we become acquainted with things, ie gain knowledge
    - understanding, remembering, reasoning, being aware, acquiring new skills, creating new ideas
- Main objective in HCI has been :
  - to understand & represent how humans interact with computers in terms of how knowledge is transmitted between the two
- explain how humans achieve goals

# Cognitive Aspects...



# More advanced model…

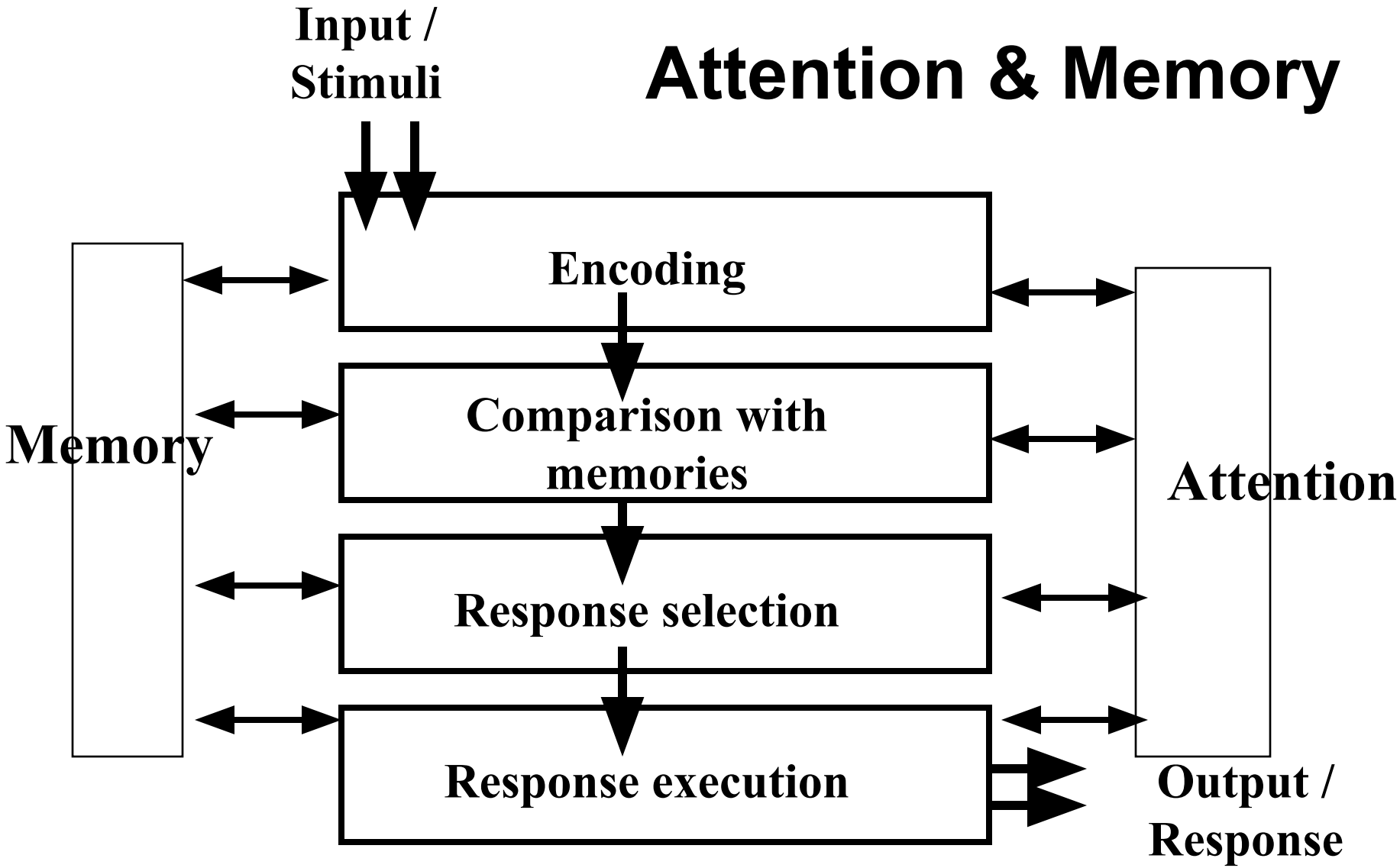



Wickens (1984)

# Cognitive Example

- ATM Machine:
  - users generally come to the task with a substantial amount of knowledge
  - assumed to be able to read and to understand the mapping between instructions printed on the display and the actions they are to take

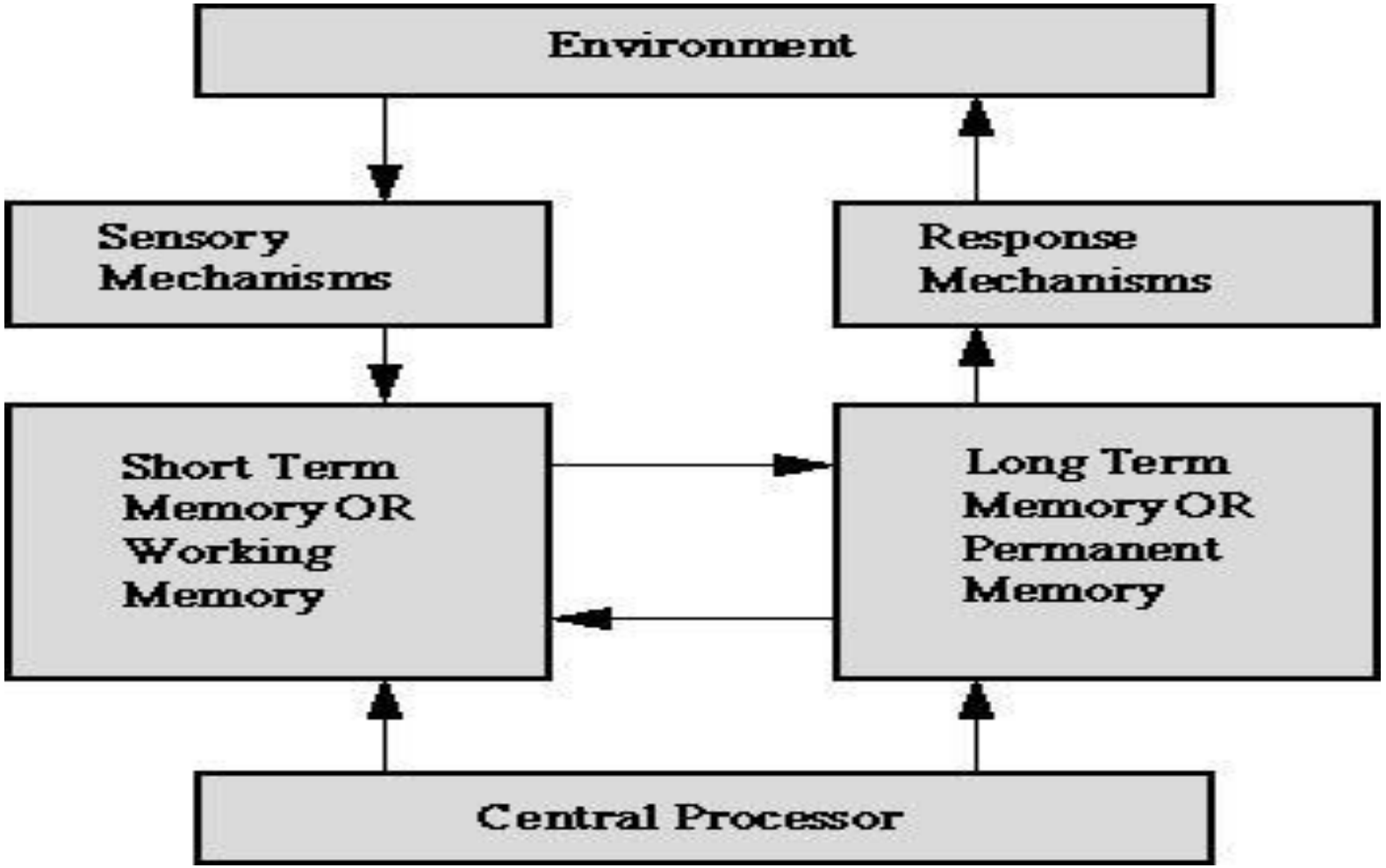
# Attention & Memory



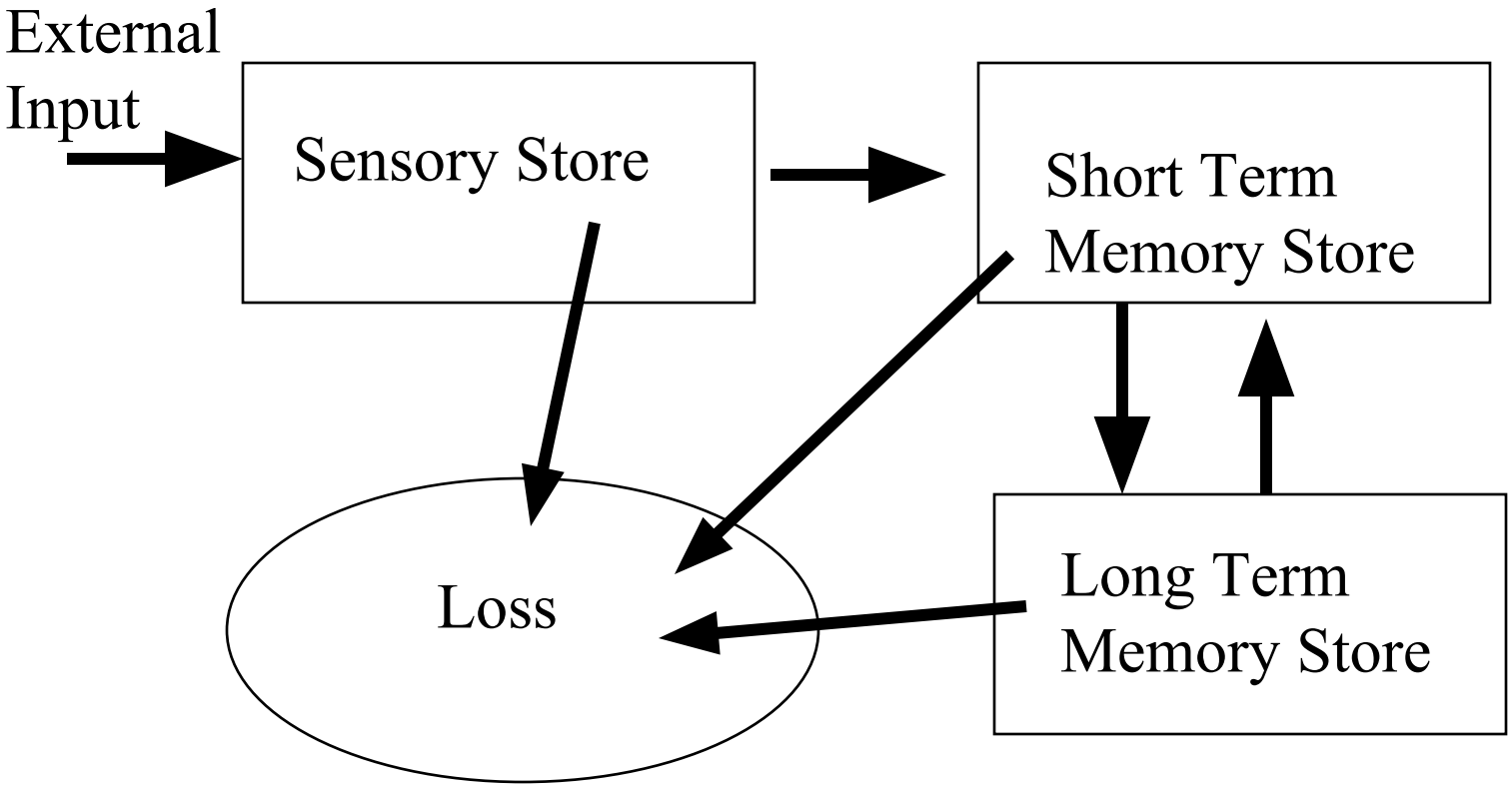
# Attention & Memory

- Cognition has been extended to include:
  - how information is perceived
  - how that information is attended to
  - how that information is processed and stored in memory

# HIP Model


Environment
Sensory Mechanisms
Response Mechanisms
Short Term Memory OR Working Memory
Long Term Memory OR Permanent Memory
Central Processor

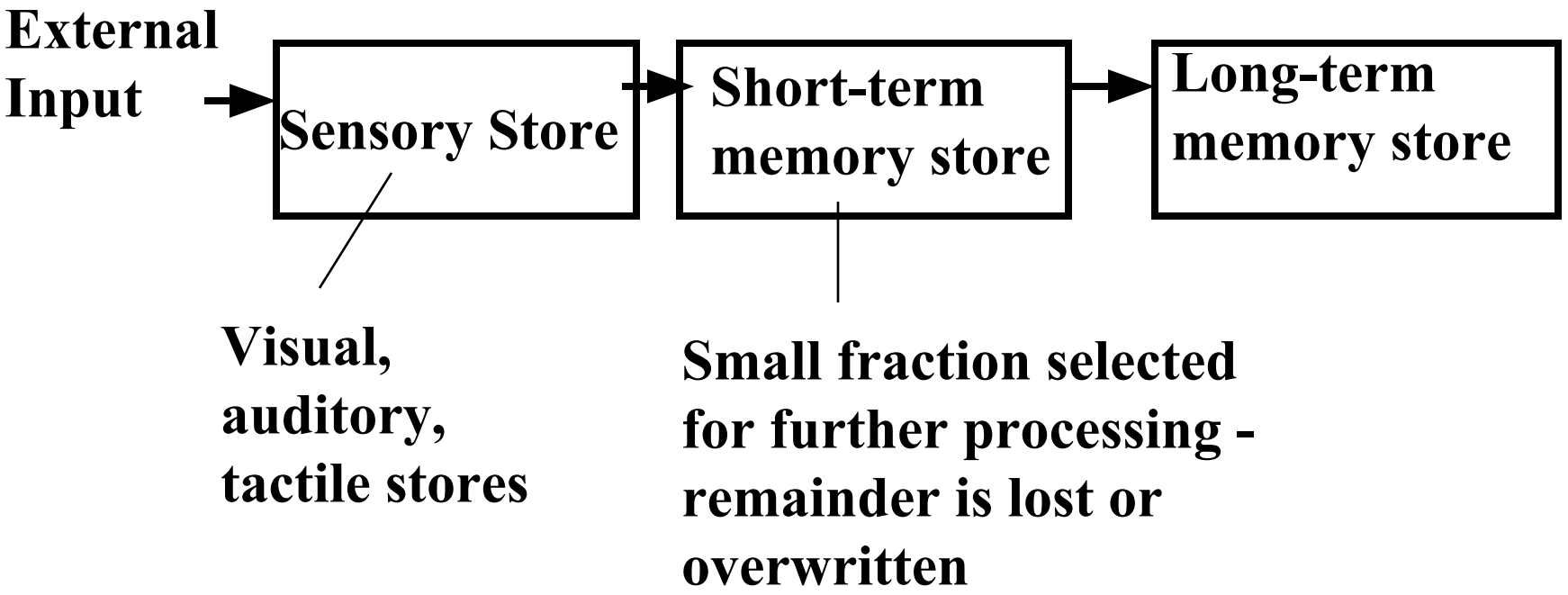
# HIP Model


External
Input
Sensory Store
Short Term
Memory Store
Loss
Long Term
Memory Store

# Multi-Store Model of Memory

- Sensory Store
  - hold information for a very brief period of time (e few tenths of a second)
- Short-Term Memory Store
  - short period of time (few seconds)
- Permanent Long-term Memory Store
  - hold info, indefinitely

# Multi-Store Model of Memory



# HIP Model

- Sensory System
  - time-limited with a limited capacity
  - performs 2 classes of operations:
    - momentarily holding (buffering)
    - feature extraction - beginning to organise input e.g. in terms of perception things like enhancing contours, centering the figure and isolating from background
- Each sense has own separate store for preliminary analysis and buffering
- only in memory system that info can be integrated and compared

# Short Term or Working Memory

- Linked to long term memory
- Where cognitive processing of sensory input occurs
- Bower (1975) identifies:
  - info is temporary & subject to inference from new information
  - limited capacity ( 7 + or - 2 chunks - number of chunks we can remember at a time) - chunking can increase capacity - interference reduces capacity
  - fast access to items in short term memory

# Short Term or Working Memory

- If a goal requires more info than short term memory can handle the system will fail - central processor would have to break down goal into a number of manageable sub-goals to reduce cognitive load on short term memory
- probably several STMs

# Permanent/ Long Term Memory

- Largest structure in the model- stores all knowledge. Information includes:
  - Visual images, sound sequences, motor programs
  - abstract concepts & relationships
  - propositions, values & attitudes
  - programs for processing information

# Permanent/ Long Term Memory

- Research has attempted to classify info
- Semantic memory
  - facts about world in general
  - abstract concepts
- Episodic Memory
  - memory about particular episodes or events
- Searching long term memory is based on
  - feature analysis of sensory input
  - contextual information

# Permanent/ Long Term Memory

- Much of info stored is in a visual representation of abstract concepts -
  - we remember what cars look like, forgetting most of the specific cars that we have seen
- Long term memory has 2 main mechanisms:
  - Storage of information
  - Retrieval of information

# Storage of Information

- How info is stored, coded, classified and organised
- even if info is adequately stored  and coded it can become inaccessible or lost entirely - could be as a result of new information affecting old information
  - inteference
  - merging of information

# Retrieval of Information

- How long term memory is searched & info is located
- types of retrieval
  - effortless (automatic)
  - effortful
- retrieval effected by:
  - time/ decay
  - incomplete / ambiguous info
  - context

# Information Processing & HCI

- Model Human Processor
  - one of the earliest models
  - 3 interactive systems : perceptual, motor & cognitive
  - each has its own memory & processor
  - viewed as series of processing stages

# Information Processing & HCI

- recent attention on:
  - how knowledge is represented
  - how mental models develop & are used in HCI
  - how users learn to interact and become experienced in systems
- recent research into:
  - interface metaphors (GUIs that are electronic counterparts to physical objects in real world)
  - conceptual models (ways in which systems are understood by different users) to help design interfaces

# Recent Developments in Cognitive Psychology

- Since 1980's has been a move away from models of information processing and reduced importance of model human processor
- Move to computational and connectionist approaches

# Computational Approaches

- Emphasis on modelling human performance in terms of what is involved when information is processed rather than when & how much
- concerned with goals, planning and action involved in task performance
- includes modelling: how info. is organised & classified, retrieved, what decisions are made etc in terms of how to deal with new info.

# Connectionist Approach

- Neural networks or parallel distributed processing (PDP)
- simulate behaviour through programming models
- adopts the “brain” metaphor- cognition is represented at the level of neural network consisting of interconnected nodes
- all cognitive processes viewed as activations of the nodes in the network and the connections between them, rather than  the processing & manipulation of information

# Distributed Cognition

- Primarily concerned with describing cognition as it is distributed across individuals and in the setting in which it takes place
- the collection of people, computers systems and other technology and their relations to each other in the environmental setting in which they are situated - referred to as "functional systems" eg ship navigation, air traffic control etc

# Distributed Cognition

- Main goal is to analyse how different components are coordinated
  - how is information propagated through the system in terms of technological, cognitive, social and organisational aspects
  - focus on way information moves and transforms  eg air traffic controller verbally passes information (eg giving clearance to fly at particular altitude) to another (pilot) - on receiving this the person responds, which may have consequences for someone else etc...)

# Distributed Cognition

- Situation Awareness
  - silent communication that is shared among a group eg watching and overhearing
- A main concern of distributed cognition is to map out how the various states are coordinated across time, location and objects
- can be breakdowns eg pilot misunderstands gesture of captain - knock-on effect etc.. - must analyse & explain, and suggest solutions