



كلية علوم الحاسب و المعلومات

College of Computer and Information Sciences



Human Computer Interaction (HCI)

Course Code: **CS351**

Number of credits: 3 h

lecture : 3H & Lab: 1 h

Pre-requisite : **CS212**

Dr. Sahar Abdul Rahman

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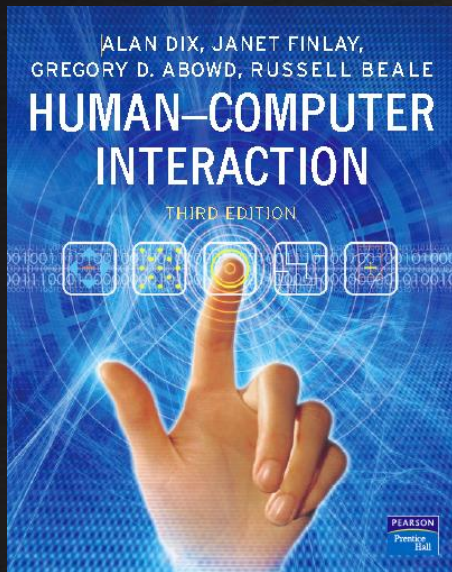
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Objectives

Students who successfully complete this course will:

- * Understand the underlying scientific theories currently applied to user interface design.
- * Be able to apply insights from these scientific theories to the design of user interfaces.
- * Be aware of the expanding range of interaction modes and styles currently available and in development and understand the issues involved in their use.



List of References

Essential Books:

"HUMAN COMPUTER INTERACTION", by
Dix, J. Finlay, G. D. Abowd and R. Beale, Third
Edition, Prentice Hall, 2004.

Recommended Books:

*"THE HUMAN-COMPUTER INTERACTION
HANDBOOK: FUNDAMENTALS, EVOLVING
TECHNOLOGIES"*, by Julie A. Jacko, Andrew
Sears , Technology & Engineering , 2003.

Grading

Assessment Methods	Week	Weighting of Assessments
1 st Midterm Exam	7	15%
2 nd Midterm Exam	11	20%
Lab works (Quiz+ assignments+ project (report+ presentation))	Every week + Quiz in week 10+ project (report+ presentation) in week 13	25%
Final Exam	After week15	40%
Total		100%

**Office
Hours
& E-mail**

Office Hours & E-mail:

According to the Instructor

Project Topic Ideas

The project topics are intended to be somewhat open-ended, giving you significant freedom to focus your problem and design user interfaces and visualizations. Although some topics are based on existing user interfaces and visualization techniques. The requirements are report and presentation by the end of week 13.

Contents

Topic	Contact Hours	No. of Weeks
-Introduction to the course content, text book(s), reference(s) and course plan.	3	1
- Chapter1: The human		
Chapter2: The computer	3	1
Chapter3: The interaction	6	2
Chapter 4: Paradigms	3	1
Chapter5: Interaction design basics	6	2
Chapter6: HCI in the software process	3	1
Chapter7: Design rules	6	2
Chapter8: Impelntation support	3	1
Chapter 9: Evaluation techniques	12	4
Total	45	15

What is HCI?

user  system

communication between the user and the system

- o “the study of the interaction between *people, computers* and *tasks*” (Johnson)
- o “a very difficult business. It combines two awkward disciplines: *psychology* and *computer science*” (Thimbleby)
- o “The ideal designer of an interactive system would have expertise in ... *psychology* ... *cognitive science* ... *ergonomics* ... *sociology* ... *computer science* ... *engineering* ... *business* ... *graphic design* ... *technical writing* ... and so it goes on” (Dix et. al)
- o Teamwork and a recognition of non-Computer Science specialisms

Why do we need to understand users?

- Interacting with technology is cognitive
- We need to take into account cognitive processes involved and cognitive limitations of users
- We can provide knowledge about what users can and cannot be expected to do
- Identify and explain the nature and causes of problems users encounter
- Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive products

Core cognitive aspects

- o Attention
- o Perception and recognition
- o Memory
- o Reading, speaking and listening
- o Problem-solving, planning, reasoning and decision-making, learning

Who are “Users”?

- o People who will use a product or web site.
- o As opposed to the “Designers”
 - o People who *create* the system or web site
- o Designers ≠ Users
- o You are the *designer*
- o Have to make an effort to ***Know The User***

What is the “User Interface”?

- o Everything the user encounters
 - o Functionality
 - o Content
 - o Labels
 - o Presentation
 - o Layout
 - o Navigation
 - o Speed of response
 - o Documentation & Help
- o There are three ‘use’ words that must all be true for a product to be successful; it must be:
 - o **useful** – accomplish what is required: play music, cook dinner, format a document;
 - o **usable** – do it easily and naturally, without danger of error, etc.;
 - o **used** – make people want to use it, be attractive, engaging, fun, etc.

The Human INPUT-OUTPUT CHANNELS

- Consider human as **Information Processor**
- Receiving inputs from the world, storing and using information
- Information receive through the senses,(particularly, in case of computer use)
 - **Sight**
 - **hearing**
 - **Touch**
- information is stored in memory:
 - either temporarily in sensory or
 - permanently in Long Term Memory

The human

- Humans are limited in their capacity to process information
- Humans are not without their limitations
- An understanding of the capabilities and limitations of the human as information processor can help us to design interactive system
- Each person is different
- Five major senses: sight, hearing, touch, taste & smell

Vision

Two stages in vision

- physical reception of stimulus
- processing and interpretation of stimulus

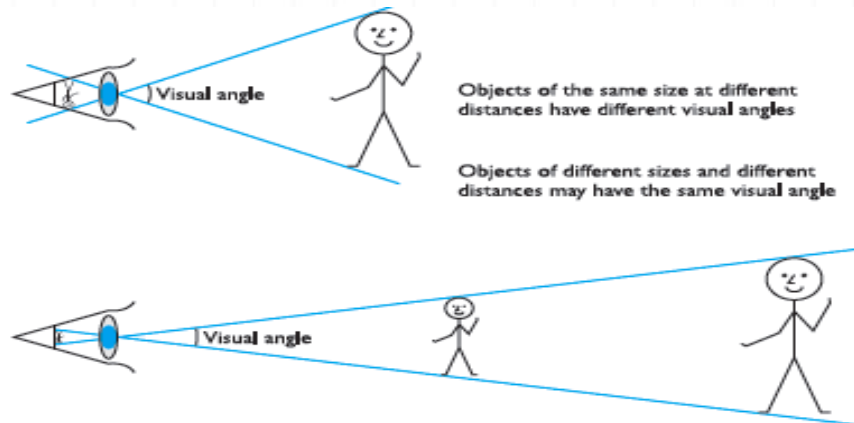
The Eye - physical reception

- mechanism for receiving light and transforming it into electrical energy.
- light reflects from objects.
- images are focused upside-down on retina.
- retina contains rods for low light vision and cones for colour vision.
- ganglion cells detect pattern and movement.

Vision

Size and depth

- visual angle indicates how much of view object occupies (relates to size and distance from eye)
- visual acuity is ability to perceive fine detail (limited)
- familiar objects perceived as constant size (in spite of changes in visual angle when far away)
- cues like overlapping, the size and height of the object in our field of view, A third cue is familiarity help perception of depth.



Vision

Perceiving Brightness

- Brightness is in fact a subjective reaction to levels of light. It is affected by *luminance*.
- *luminance* which is the amount of light emitted by an object. The luminance of an object is dependent on the amount of light falling on the object's surface and its reflective properties.
- Luminance is a physical characteristic and can be measured using a *photometer*.
- *Contrast* is related to luminance: it is a function of the luminance of an object and the luminance of its background.

Vision

Perceiving Color

- Color is usually regarded as being made up of three components: *hue*, *intensity* and *saturation*.
- Hue is determined by the spectral wavelength of the light. Blues have short wavelengths, greens medium and reds long. Approximately 150 different hues can be discriminated by the average person.
- Intensity is the brightness of the color.
- Saturation is the amount of whiteness in the color.

Vision

The capabilities and limitations of visual Processing

- our expectations affect the way an image is perceived. For example, if we know that an object is a particular size, we will perceive it as that size no matter how far it is from us.
- Visual processing compensates for the movement of the image on the retina which occurs as we move around and as the object which we see moves. Although the retinal image is moving, the image that we perceive is stable.
- Similarly, color and brightness of objects are perceived as constant, in spite of changes in luminance.
- This ability to interpret and exploit our expectations can be used to resolve ambiguity.

ABC

13

An ambiguous shape?

121314

Optical Illusions

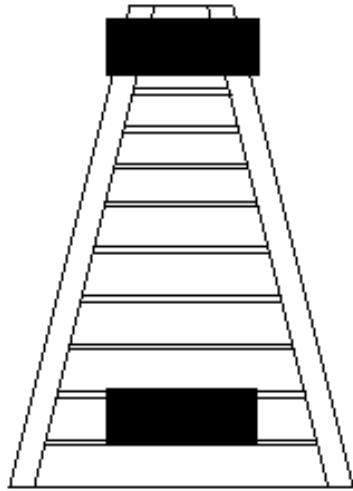


Figure 1: The Ponzo illusion

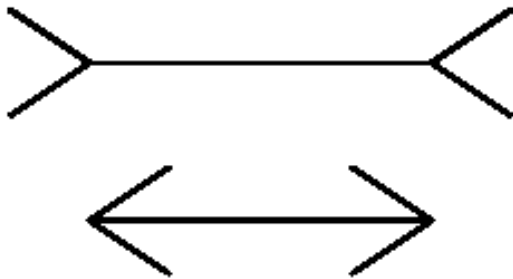


Figure 2: The Muller Lyer illusion

Proof-Reading illusion

The quick brown
fox jumps over the
the lazy dog.

a concave edge, the
bottom like a convex
edge.

Reading

- o There are three stages:
 - o visual pattern perceived
 - o decoded using internal representation of language
 - o interpreted using knowledge of syntax, semantics, pragmatics
- o The **speed** at which text can be read is a **measure of its legibility**
 - o Experiments shown that standard font size of 9 to 12 points is legible
- o **Word shape** is important to recognition
- o Negative contrast improves reading from computer screen
- o Reading from a computer screen is slower than a book

Hearing

- Provides information about environment:
distances, directions, objects etc.
- Physical apparatus:
 - outer ear – protects inner and amplifies sound
 - middle ear – transmits sound waves as vibrations to inner ear
 - inner ear – chemical transmitters are released and cause impulses in auditory nerve
- Sound
 - pitch – sound frequency
 - loudness – sound amplitude
 - timbre – sound type or quality
- Humans can hear frequencies from 20Hz to 15kHz
 - less accurate distinguishing high frequencies than low.

Touch (haptic Perception)

- Provides important feedback about environment.
- May be key sense for someone who is visually impaired.
- Stimulus received via receptors in the skin:
 - thermoreceptors – heat and cold
 - nociceptors – pain
 - mechanoreceptors – pressure
(some instant, some continuous)
- Some areas more sensitive than others e.g. fingers.
- Kinethesis - awareness of body position
 - affects comfort and performance.

Movement

- how the way we move affects our interaction with computers
- Time taken to respond to stimulus:
reaction time + movement time
- Movement time is dependent largely on the *physical characteristics* of the subjects: their age and fitness,
- The time taken to hit a target is a function of the size of the target and the distance that has to be moved. This is formalized in *Fitts' law*
- Reaction time - dependent on stimulus type:
 - visual ~ 200ms
 - auditory ~ 150 ms
- The speed of reaction results in reduced accuracy. This is dependent on the task and the user (unskilled or skilled).

Memory

o There are three types of memory function:

o Sensory memories



Attention

o Short-term memory or working memory



Rehearsal

o Long-term memory

sensory memory

- o Buffers for stimuli received through senses
 - o iconic memory: visual stimuli
 - o echoic memory: aural stimuli
 - o haptic memory: touch stimuli
- o Continuously overwritten

Short-term memory (STM)

- STM acts as a scratch-pad for temporary recall of information
- It is used to store information which is only required quickly
- STM has a limited capacity
- Examples:

212348278493202

0121 414 2626

HEC ATR ANU PTH ETR EET

Long-term memory (LTM)

- Two types of LTM structure

- episodic – memory of events and experiences in a serial form

- semantic – is a structured record of facts, concepts, skills that we have acquired

- Repository for all our knowledge

- slow access

- slow decay, if any

- huge or unlimited capacity

LTM - Semantic Network

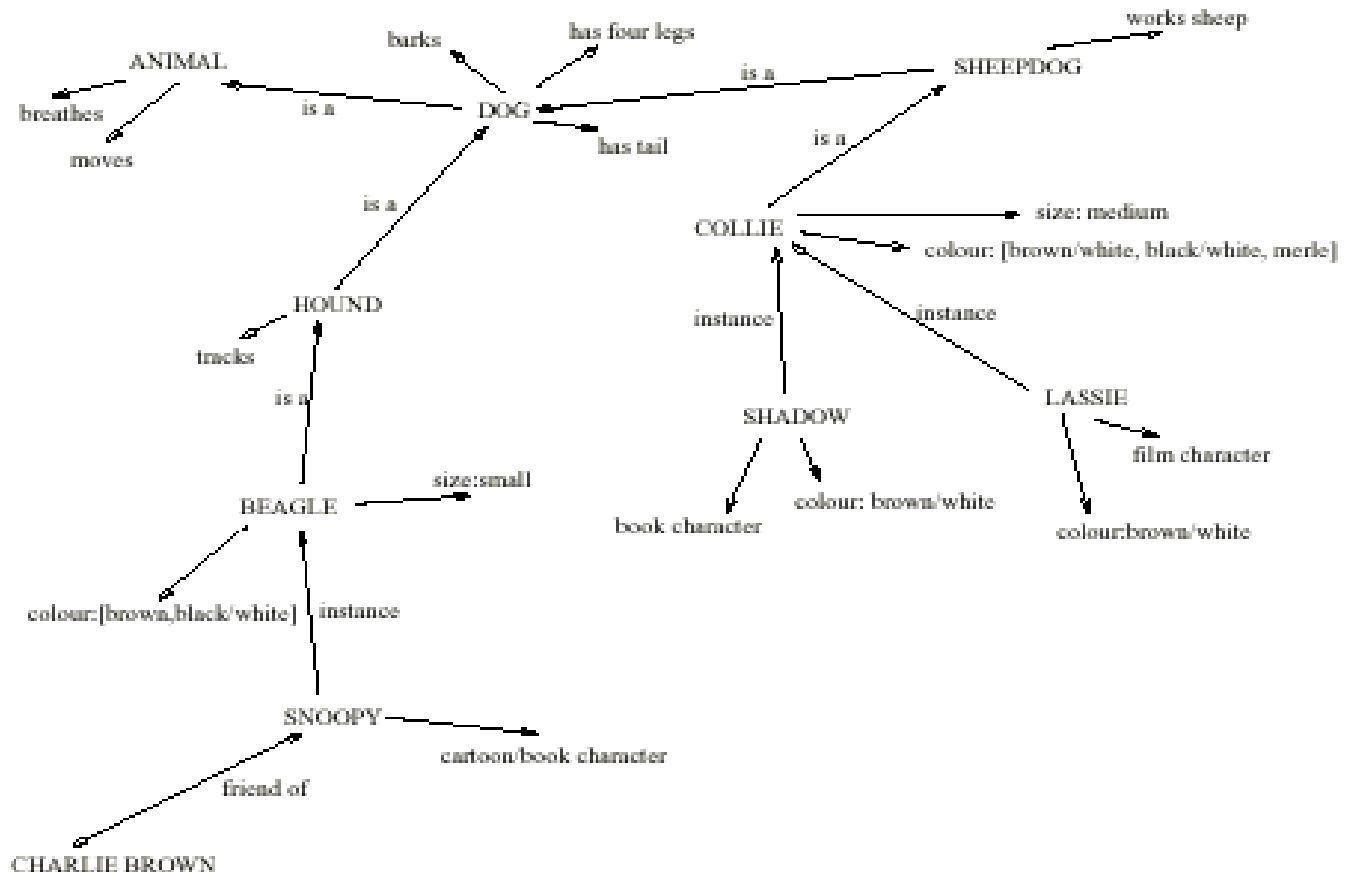
Semantic networks are:

- o Knowledge Representation Schemes

- o Items are associated to each other in classes, and may inherit attributes from parent classes.
- o The network defines a set of binary relations on a set of nodes.
- o involving nodes and links (arcs or arrows) between nodes.
- o The nodes represent objects or concepts
- o The links (arcs or arrows) represent relations between nodes.
- o The links are directed and labeled; thus, a semantic network is a directed graph.
- o The nodes are usually represented by circles or boxes .

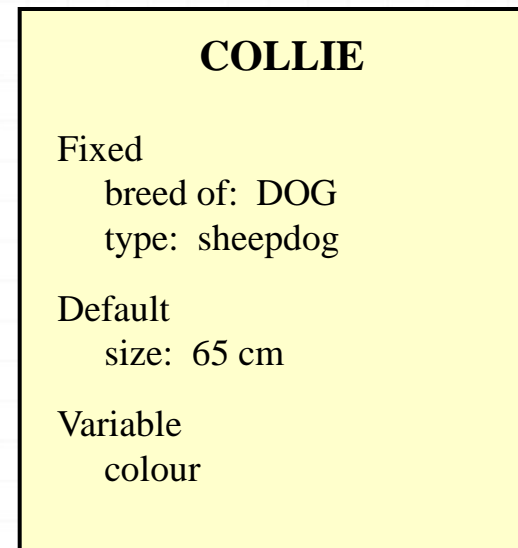
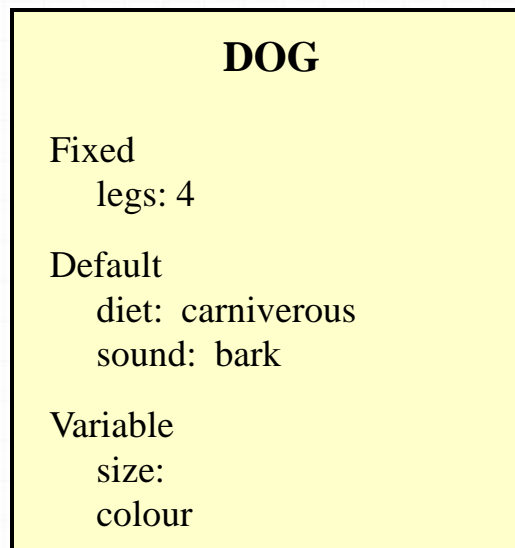
Long-term memory -

Long-term memory (cont.)



Models of LTM - Frames

- Structured representations such as *frames* and *scripts* organize information into data structures.
- *Slots* in these structures allow attribute values to be added. Frame slots may contain default, fixed or variable information.
- A frame is instantiated when the slots are filled with appropriate values.
- Frames and scripts can be linked together in networks to represent hierarchical structured knowledge.



Models of LTM: Script

- Scripts attempt to model the representation of stereotypical knowledge about situations.
 - Entry conditions:
 - Conditions that must be satisfied for the script to be activated.
 - Result Conditions:
 - that will be true after the script is terminated.
 - Props:
 - Objects involved in the events described in the script.
 - Roles:
 - Actions performed by particular participants.
 - Scenes:
 - The sequences of events that occur.
 - Tracks:
 - A variation on the general pattern representing an alternative scenario.

Models of LTM: Script

John took his dog to the surgery. After seeing the vet, he left.

Script for a visit to the vet

Entry conditions:	<i>dog ill vet open owner has money</i>	Roles:	<i>vet examines diagnoses treats owner brings dog in pays takes dog out</i>
Result:	<i>dog better owner poorer vet richer</i>	Scenes:	<i>arriving at reception waiting in room examination paying</i>
Props:	<i>examination table medicine instruments</i>	Tracks:	<i>dog needs medicine dog needs operation</i>

Models of LTM - Production rules

- Representation of procedural knowledge:
 - our knowledge of how to do something
- Condition/action rules
 - if condition is matched
 - then use rule to determine action.

IF dog is wagging tail
THEN pat dog

IF dog is growling
THEN run away

LTM - Processes

- There are **three main activities** related to long-term memory:
 - Storage or remembering of information
 - Forgetting
 - Information retrieval

LTM - Storage of information

- **Rehearsal**
 - information moves from STM to LTM
- The amount learned was directly proportional to the amount of time spent learning. This is known as the ***total time hypothesis***.
- if information is **meaningful and familiar**, it can be related to existing structures and more easily incorporated into memory.
- If information is not meaningful it is more difficult to remember.

List A: Faith Age Cold Tenet Quiet Logic Idea Value Past Large

Now try list B.

List B: Boat Tree Cat Child Rug Plate Church Gun Flame Head

LTM - Forgetting

There are two main theories of forgetting:

- o Decay

- o information is lost gradually but very slowly

- o Interference

- o new information replaces old: *retroactive interference*

- o old may interfere with new: *proactive inhibition*

so may not forget at all, memory is selective ...

... affected by emotion

LTM - Retrieval

There are two main types of information retrieval:

o Recall

- o information reproduced from memory can be assisted by the provision of retrieval cues, e.g. categories, imagery. For example make up a story from the following list:

child red plane dog friend blood cold tree big angry

o Recognition

- o information gives knowledge that it has been seen before
- o **less complex** than recall – since the information is provided as cue

THINKING: REASONING AND PROBLEM SOLVING

- Thinking can require *different amounts of knowledge*. Some thinking activities are very directed and the knowledge required is constrained. Others require vast amounts of knowledge from different domains.
- *For example*, performing a subtraction calculation requires a relatively small amount of knowledge, from a constrained domain, whereas understanding newspaper headlines demands knowledge of politics, social structures, public figures and world events.
- There are two categories of thinking: *reasoning and problem solving*.

THINKING: REASONING

o Deductive Reasoning

o Deduction:

- o derive logically necessary conclusion from given premises.

e.g. *If it is Friday then she will go to work*

It is Friday

Therefore she will go to work.

o Logical conclusion not necessarily true:

e.g. *If it is raining then the ground is dry*

It is raining

Therefore the ground is dry

o When truth and logical validity clash ...

e.g. *Some people are babies*

Some babies cry

Inference - Some people cry

Correct? All babies are people

THINKING: REASONING

o Inductive Reasoning

o Induction:

- o generalize from cases seen to cases unseen

e.g. all elephants we have seen have trunks
therefore all elephants have trunks.

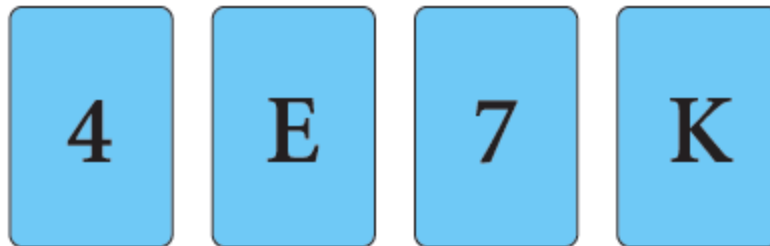
o Unreliable:

- o can only prove false not true

... but useful!

o Humans not good at using negative evidence

e.g. Wason's cards.



THINKING: REASONING

o Abductive Reasoning

o reasoning from event to cause

e.g. Sam drives fast when drunk.

If I see Sam driving fast, assume drunk.

o Unreliable:

o can lead to false explanations

THINKING: PROBLEM SOLVING

- o Process of finding solution to unfamiliar task using knowledge.
- o Several theories.
 - o **Gestalt**
 - o problem solving is both **productive and reproductive**.
 - o **Reproductive** problem solving draws on previous experience as the behaviorists claimed.
 - o **Productive** problem solving involves insight and restructuring of the problem.
 - o **Problem space theory**
 - o The problem has an initial state and a goal state and people use the operators to move from the former to the latter.
 - o *Example*
 - o **Analogy**
 - o analogical mapping:
 - o novel problems in new domain?
 - o use knowledge of similar problem from similar domain
 - o analogical mapping difficult if domains are semantically different

THINKING: PROBLEM SOLVING

Identify the goals and operators involved in the problem 'delete the second paragraph of the document' on a word processor. Now use a word processor to delete a paragraph and note your actions, goals and subgoals. How well did they match your earlier description?

Operator	Precondition	Result
delete_paragraph	Cursor at start of paragraph	Paragraph deleted
move_to_paragraph	Cursor anywhere in document	Cursor moves to start of next paragraph (except where there is no next paragraph when no effect)
move_to_start	Cursor anywhere in document	Cursor at start of document

Skill acquisition

- o skilled activity characterized by chunking
 - o lot of information is chunked to optimize STM
- o conceptual rather than superficial grouping of problems
- o information is structured more effectively

Errors and mental models

Types of error

o slips

- o right intention, but failed to do it right
- o causes: poor physical skill, inattention etc.
- o change to aspect of skilled behavior can cause slip

o mistakes

- o wrong intention
- o cause: incorrect understanding
- o humans create mental models to explain behavior.
- o if wrong (different from actual system) errors can occur

Emotion

Emotion clearly involves both cognitive and physical responses to stimuli

The biological response to physical stimuli is called affect

Affect influences how we respond to situations

positive : creative problem solving

negative : narrow thinking

“Negative affect can make it harder to do even easy tasks; positive affect can make it easier to do difficult tasks”

Implications for interface design

stress will increase the difficulty of problem solving

relaxed users will be more forgiving of shortcomings in design

aesthetically pleasing and rewarding interfaces will increase positive affect

Individual differences

- o long term
 - sex, physical and intellectual abilities
- o short term
 - effect of stress or fatigue
- o changing
 - age

- o Ask yourself:
will design decision exclude section of user population?

Psychology and the Design of Interactive System

- o Some direct applications
- o e.g. blue acuity is poor
 - blue should not be used for important detail
- o However, correct application generally requires understanding of context in psychology, and an understanding of particular experimental conditions
- o A lot of knowledge has been distilled in
 - o guidelines (chap 7)
 - o cognitive models (chap 12)
 - o experimental and analytic evaluation techniques (chap 9)