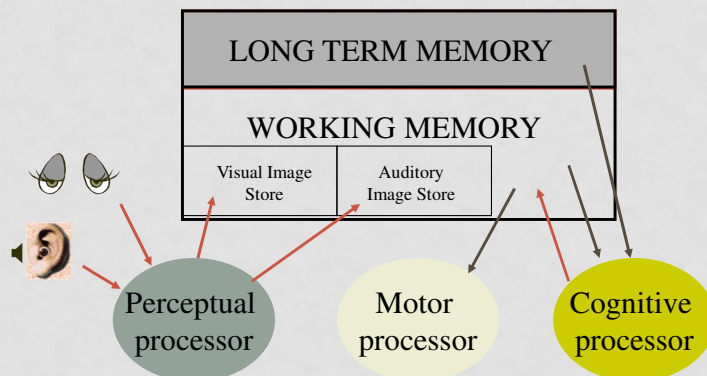# HUMAN COMPUTER INTERACTIONS

1

"Through a combination of instinct and experience, we expect objects to behave in a certain way based on their appearance and we have very strong expectations if we've used an identical object before."

-R. HOWARD & ASSOCIATES, UI HALL OF SHAME

2

MODEL HUMAN PROCESSOR

Developed by Card, Moran, Newell, 1983

LONG TERM MEMORY

WORKING MEMORY

Visual Image Store | Auditory Image Store

Perceptual processor

Motor processor

Cognitive processor

3

WHAT WE KNOW ABOUT BASIC HUMAN CHARACTERISTICS

- Humans like to problem solve
- Humans do not like insolvable problems
- Humans are always learning
- Learning is hard
- Humans use prior learning to support new learning

4

HUMAN CHARACTERISTICS

- Users don't like to read manuals but work by copying and asking

- Users are always building and adapting models of their world

5

HUMAN COGNITIVE ABILITIES

Cognitive psychology
- provides knowledge about what users can and cannot be expected to do
- identifies & explains the nature & causes of the problems users encounter
- supply modeling tools & methods to help build interfaces that are easier to use

6

WHAT IS COGNITION?

Cognition refers to the processes by which we become acquainted with things or, in other words, how we gain knowledge.

Four stages

Stimuli ->

    1. Encoding ->

        2. Comparison ->

            3. Response selection ->

4. Response Execution -> Response

7

HUMAN INFORMATION PROCESSING

Short-term memory or "working memory"
- Information actively processed and then may be transferred to long-term memory
- Main characteristics are that its capacity to hold information is limited in amount and time.
- At most, the number of items or 'chunks' we can remember at any one time is about 7 (2)
- The "rule of seven" identified by Miller in 1956

8

Example:

You have 3 seconds to memorize the following number - NO WRITING!

6048649753

How many memorized the number correctly?

What do you do to memorize the number?

9

"Chunking"?

"Pattern recognition"?

• Phone numbers

604 - Vancouver area code

864 - even numbers descending

9753 - odd numbers descending

10

Say the **colours** of the following words not the words themselves.

Red	Pink
Blue	Purple
White	Yellow
Orange	Grey
Green	Mauve
Black	Brown

This is the Stroop Effect.   Frustrating, right?

11

Distributed cognition

- New approach which has broadened the theoretical basis to take into account how users carry out their work activities when using computer systems in work settings

- E.g. air traffic control, ship navigation, programming development teams

12

COGNITIVE ENGINEERING PRINCIPLES

Based on the Model Human Processor
- **Recognize - Act Cycle of the Cognitive Processor**

- **Encoding Specificity Principle**

- **Discrimination Principle**

- **Variable Cognitive Processor Rate**

13

RECOGNIZE – ACT CYCLE OF THE COGNITIVE PROCESSOR

On each cycle of the cognitive processor, the contents of working memory are linked to long term memory

Actions associated with these contents modify the contents of working memory

- **Examples**
- Reading a string of characters
- Hearing a spoken phrase
- Picking up a book

14

ENCODING SPECIFICITY PRINCIPLE

- Memory best when the cues present at retrieval match those encoded (present) at study
  - Studying in the same room and seat as the exam itself
  - Emotional, mood dependent

15

ENCODING SPECIFICITY PRINCIPLE

- When you were a child, have you ever rushed into a room to tell your friend something but then forgot what it was you wanted to tell?

- If you went back to the room where you decided you wanted to tell that person something, did you recall what it was?

16

ENCODING SPECIFICITY PRINCIPLE (ESP)

Specific encoding operations performed on what is perceived, determine what is stored, and thus, what is later retrieved

– "We only hear what we want to hear."

– Reason why it is so hard for novices to learn computer systems - they don't know what to focus their attention on.

– They try to encode everything which is too much effort

EXAMPLE OF ESP

- Half of the class turn around!
- The other half:
  Try to remember the second word of the following pairs:

ESP EXAMPLE

star – whisker	atlas – pepper	spool – coaster
sleep – orange	laced – sticker	parts – belt
tide – newspaper	reward – canvas	rail – perjury
live – cackle	timer – invoice	tinker – yarn
deer – hollow	avid - soprano	retool – arrest
lamina - tiger	fires – courier	smart – carriage
regal – bottle	tang – insect	net – finger
brag – apparel	yam – permit	warts – bend

ESP EXAMPLE

avid –	sleep –	spool –
atlas –	regal –	net –
brag –	retool –	live –
deer –	tinker –	timer –
tide –	star -	reward –
fires -	lamina –	tang –
laced –	smart –	warts –
rail –	parts –	yam –

DISCRIMINATION PRINCIPLE

The difficulty of memory retrieval is determined by the candidates that exist in long term memory, relative to the retrieval cues - if there are few candidates, it is hard to perform the discrimination. If there are many, discrimination is relatively easy

- **Examples**
  - Finding car in parking lot
  - Remembering what someone looks like

EXAMPLE OF DISCRIMINATION PRINCIPLE

Finding Car in Parking Lot
- Information is available in parking lot that discriminates one spot from another
- We do not encode the available information because our long-term memory has not stored these fine discriminations
- Thus, when we return from shopping or class to look for our car, many possible site match our internal coding or where the car might be.

VARIABLE COGNITIVE PROCESSOR RATE

- **The cognitive processor rate is shorter when increased task demands introduce more effort**
- However, demands can increase to a point where the rate is not fast enough to handle the task we often give up.

VARIABLE COGNITIVE PROCESSOR RATE

- **Avoid computer demands which add increased demands on user while they are performing other tasks**
- **Examples**
  - **Having to calculate relative cell addressing in a spreadsheet while building a financial model**
  - **Having to remember compilation results in an interactive compiler while performing code repair**

FORGETTING

- Most "forgetting" isn't really forgetting but encoding errors
- Assuming information was indeed encoded, how quickly do we forget?
  - What are the dependent factors?

WHY DO WE FORGET?

- Retrieval failure
- Decay
- Interference
  - Proactive Interference
    - Something we learned earlier disrupts something we will learn later
  - Retroactive Interference
    - Something we learn later disrupts something we already learned earlier

HUMAN FACTOR SUMMARY

- **The main objective in HCI has been to understand and represent how humans interact with computers in terms of how knowledge is transmitted between the two.**
- **An understanding of the "human factor" is essential to the design and development of computer systems**

DIFFERENCES IN POPULATION

Different populations learn certain behaviours and expect things to work in different ways

Examples:

- Light switches
  - America: down is off
  - Britain down is on
- Faucets
  - America: counter-clockwise on
  - Britain: counter-clockwise generally off

PERCEPTION

- Designing a good interface requires knowledge about how people see

- Understand how the eye and the mind work together

- There are different schools of thought on this

- Examine the school of *constructivism*

29

CONSTRUCTIVISM

- Our brains do not create a pixel-by-pixel recording of a scene like a digital camera

- Instead we construct intervening models that abstract and summarize what comes out of the optic nerve

- These models influence what we perceive

30

CONSTRUCTIVISM

- When we see something, we don't remember all the information in the scene, only the pieces that have meaning for us

- Do you remember how many lines make up the IBM logo?

- People "filter out" the irrelevant parts and save the important ones

31

Do you see the face of a man hidden in this image?

32

Once you have recognized it, your mind recreates a summary of the picture and you will see the face easily when you encounter the image again

CONSTRUCTIVISM CONTEXT

- Constructivism theory states that *context* plays a major role in what people see in an image.

CONSTRUCTIVISM

- Interpreting a shape on the basis of its context

CONSTRUCTIVISM PARTITIONING

- We decompose or partition images into entities recognized as *figure* (foreground) and *ground* (background)

- But what constitutes either can be ambiguous

GESTALT PSYCHOLOGY

- This leads into a branch of psychology called *Gestalt psychology*

- "Gestalt" is German for shape

- Main idea is that we see things not in isolation but as parts of some larger whole

- We organize into meaningful wholes using five principles: proximity, similarity, symmetry, continuity, and closure

PROXIMITY

- Proximity describes the process of using distance or location to create groups

- We tend to perceive any closely clustered objects as a group
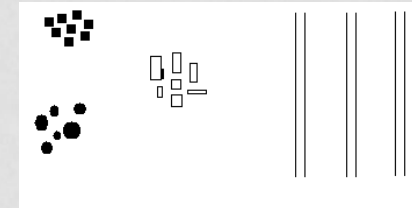
SIMILARITY

- Similarity is a grouping by like kind or type

- It is possible to use similarity in any combination of size, shape, texture, boldness, or orientation to create groups
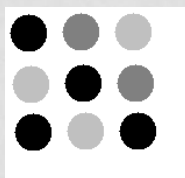
SYMMETRY

- The whole of the figure is perceived rather than the parts that make up the figure

CONTINUITY

- The term for groupings created by the flow of lines or by alignment

A

D

C

B

•We see two smooth lines
A to B and C to D – not
A to D and C to B
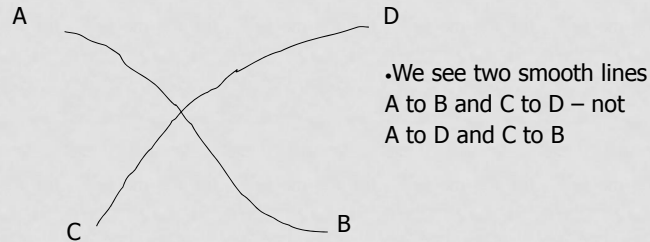
CONTINUITY

- Our eyes follow the lines formed by the circles
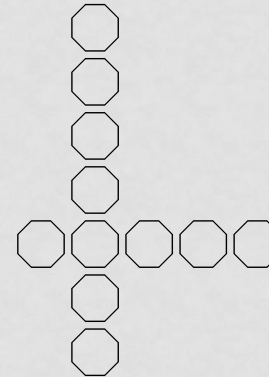
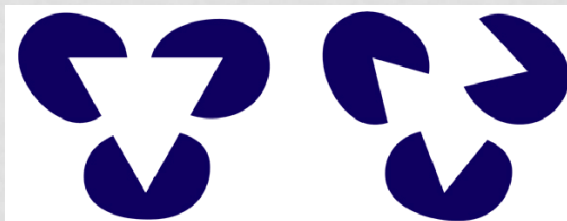•Mmmm
•Mmmm
•Mmmm
•Mmmm
•Mmmm
•Mmmm
•Mmmm
•Mmmm
•mmm

- Alignment is a type of continuity – use indentation to show hierarchy

CLOSURE

- Process by which we perceive shapes that, in a certain sense, aren't really there
- We mentally complete the shape in our heads
- Our minds want to impose order and meaning on an incomplete set of data

GESTALT AND WEB PAGE DESIGN

- Gestalts' visual principles are useful in structuring Web pages – article
- Links are grouped together by proximity
  - People think of those links as being related
  "The whole is other than the sum of the parts."
  — Kurt Koffka

Breaking News
Camcorders
Contacts
Digital Cameras
DVD Players
Press Releases
Reviews
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Breaking News
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time-sensitive information

merchandise

services

MEASURING LIMITS OF PHYSICAL MANIPULATION

- Fitt's Law
  - Predicts the time required to move the cursor to a target area as a function of the distance to the target and the size of the target
    - Smaller buttons are harder to click on
    - Make important buttons larger
    - Context menus and popup menus are opened faster because the cursor does not have to move
- Hick's Law
  - Decision time needed to process N menu options

FITT'S LAW - ERGONOMICS

- Fitts' law is used to model the act of *pointing*, both in the real world, for example, with a hand or finger and on computers, for example, with a mouse.

- Faster to click on a larger target than a small one.
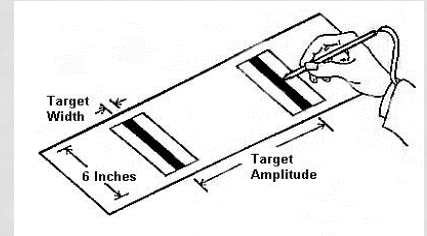
HICK'S LAW

- The decision time to select n options rises with the log of n
- The more options you have to choose from, the longer it takes to pick one
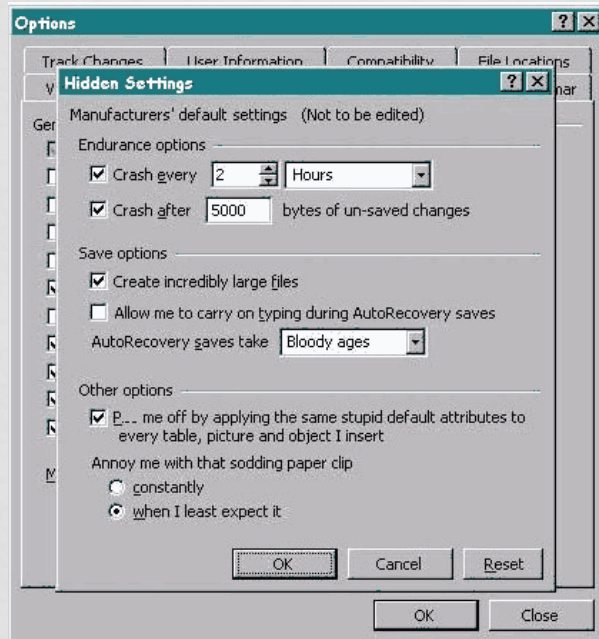- May seem obvious but it is frequently overlooked in web site menu designs

INTERFACE DESIGN EXAMPLES

- Some from Interface Hall of Shame
- http://homepage.mac.com/bradster/iarchitect/controls.htm
- GUI bloopers
- Learning by observing the mistakes of other designers

49

A TV remote that has volume control buttons labelled with a "V".

http://www.baddesigns.com/remote.html

50

UI HALL OF SHAME

- Quicktime controls have low contrast, needlessly disadvantaging those with less than perfect visual acuity.

51

Confusion over Palm Beach County ballot

Although the Democrats are listed second in the column on the left, they are the third hole on the ballot.

Punching the second hole casts a vote for the Reform Party.

Sun-Sentinel graphic/Daniel Niblock

52

UI EMPLOYMENT

- Increasing need for HCI specialists
- Corporate interest in HCI growing
- Standards for UI are expanding
- Software to gauge compliance with usability guidelines and U.S. Section 508

  www.nngroup.com/reports/accessibility/software/

- UX for web-design is also a highly-employable field today.

EVALUATE A UI DESIGN

- What can we do to ensure the quality of the UI design?
- What methods and tools are available?

HEURISTIC EVALUATION

- Expert team of evaluators follows a set of guidelines to evaluate interface
- Each drawing of a screen is observed to see if it matches the following set of criteria
  - dialogue simple and natural
  - memory load minimized
  - consistency preserved
  - short cuts provided
  - error messages clear
  - etc.
- Method is under fire because of its vague wording and lack of useful results

USER WALKTHROUGHS

- Users are given set of hand drawn displays and shown the accomplishment of different tasks with the interface
- Users ask questions and are videotaped
- Questions are asked of the user such as:
  - What do you think this does?
  - What would you select to do this task?
  - What do you think just happened?
  - Often, the most valuable information is obtained in this fashion
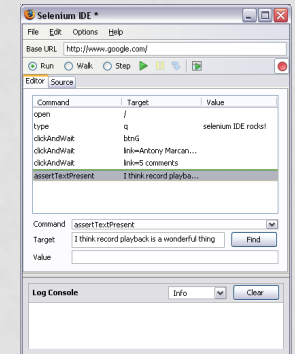
BACK OF THE ENVELOPE MODELING

- Mathematical models of human performance are approximated
  - Often, the amount of time it takes to do a task, parallels how hard the task is to learn and how error prone it is
  - The models are based on assumptions about human motor performance, visual scanning times & approximate thinking times
  - The models are most inaccurate when predicting thinking time and are invalid when the task is a difficult problem solving task

TESTING THE UI

- Open source tools can be used to perform tests on the working user interface
- Selenium is an open-source Firefox add-on for testing UI of web apps.