



HUMAN-COMPUTER
INTERACTION

THIRD
EDITION

DIX
FINLAY
ABOWD
BEALE

chapter 1

the human

part 1

(modified extract for AISD 2005)



HUMAN-COMPUTER
INTERACTION

Traffic lights



<http://www.baddesigns.com/many1ts.html>



HUMAN-COMPUTER
INTERACTION

User-centred Design

- Bad design contradicts facts pertaining to human capabilities
- Usability problems
- Design process should place emphasis on the user



HUMAN-COMPUTER
INTERACTION

the human

- Information i/o ...
 - visual, auditory, haptic, movement
- Information stored in memory
 - sensory, short-term, long-term
- Information processed and applied
 - reasoning, problem solving, skill, error
- Emotion influences human capabilities
- Each person is different



HUMAN-COMPUTER
INTERACTION

Vision

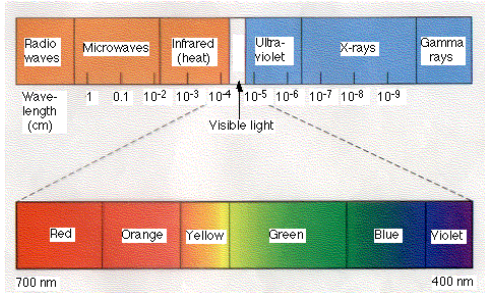
Two stages in vision

- physical reception of stimulus
- processing and interpretation of stimulus



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INTERACTION

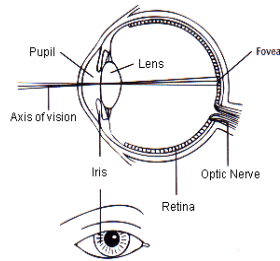
Light



<http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/R/RadiantEnergy.html>

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 (brain!) detect pattern and movement



http://www.diefertigenfinger.com/english/bl_spot.html

Eye

Rods

- Black –white vision
- Highly sensitive to light
- Edges of retina – peripheral vision

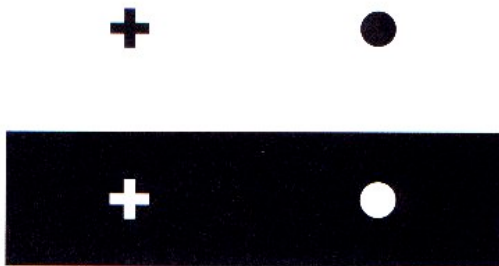
Cones

- Colour-vision
 - long-wavelength light (red)
 - middle-wavelength light (green)
 - short-wavelength light (blue)
- On the fovea 2mm diameter – clear vision

Ganglion cells

- X-cells – on fovea, early detection of patterns
- Y cells – distributed, early detection of movement

Blind Spot



Interpreting the signal

- 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 detail (limited)
 - familiar objects perceived as constant size (in spite of changes in visual angle when far away)
 - cues like overlapping help perception of size and depth

Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- Linear Perspective
- Relative size
- Occlusion
- Colour vision

Binocular clues

- Stereoscopy

Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- Linear Perspective
- Relative size
- Occlusion
- Colour vision

Binocular clues

- Stereoscopy

The apparent relative motion of stationary objects against a background when the observer moves.

Depth cues

Monocular clues

- Motion parallax
- **Aerial Perspective**
- Linear Perspective
- Relative size
- Occlusion
- Colour vision

Binocular clues

- Stereoscopy

Due to the scattering of blue light in the atmosphere, distance objects appear more blue.

Aerial Perspective



Aerial Perspective



Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- **Linear Perspective**
- Relative size
- Occlusion
- Colour vision

Binocular clues

- Stereoscopy

The property of parallel lines converging at infinity.

Linear Perspective



Linear Perspective



Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- Linear Perspective
- **Relative size**
- Occlusion
- Colour vision

Binocular clues

- Stereoscopy

The apparent retinal image size allow us to judge distance based on our past and present experience and familiarity with similar objects

Relative size



Relative size



Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- Linear Perspective
- Relative size
- **Occlusion**
- Colour vision

Binocular clues

- Stereoscopy

The overlapped object is considered further away

Occlusion



Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- Linear Perspective
- Relative size
- Occlusion
- **Colour vision**

Binocular clues

- Stereoscopy

Correct interpretation of colour, and especially lighting cues, allows us to determine the shape of objects

Lights and shades



Depth cues

Monocular clues

- Motion parallax
- Aerial Perspective
- Linear Perspective
- Relative size
- Occlusion
- Colour vision

Binocular clues

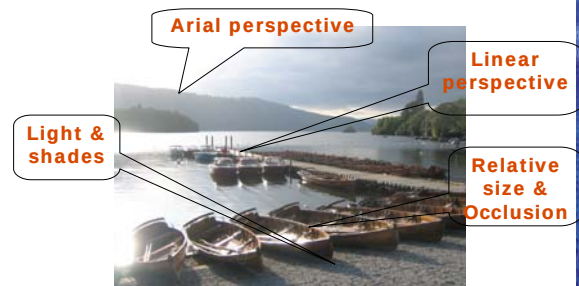
- Stereoscopy

Three-dimensional vision produced by the fusion of two slightly different views of a scene on each retina

What depth cues we have here?



What depth cues we have here?



What depth cues we have here?



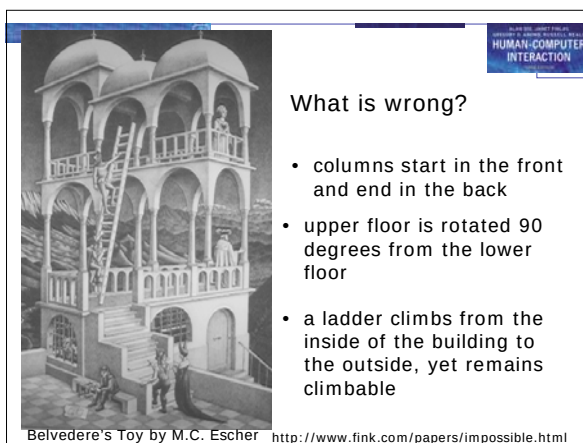
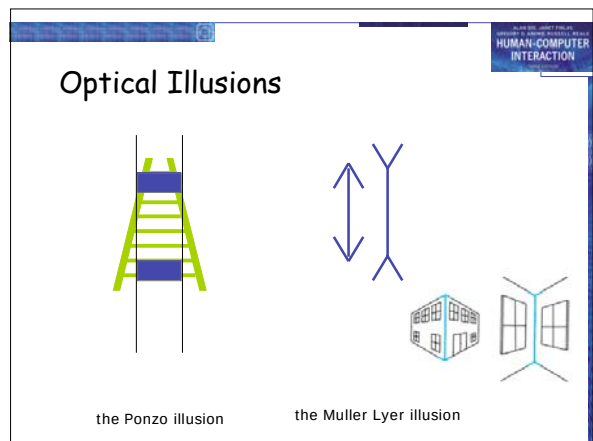
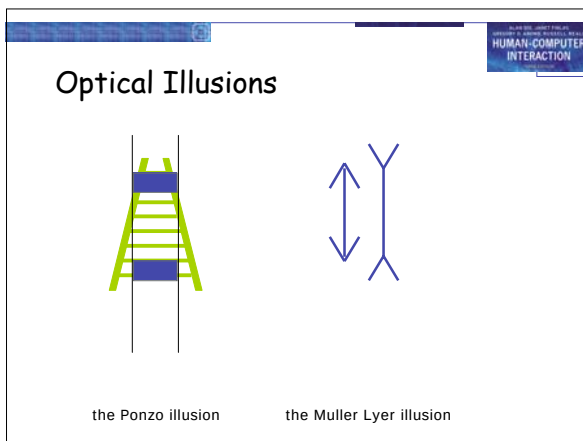
Interpreting the signal (cont)

- Brightness
 - subjective reaction to levels of light
 - affected by luminance of object
 - measured by just noticeable difference
 - visual acuity increases with luminance as does flicker
- Colour
 - made up of hue, intensity, saturation
 - cones sensitive to colour wavelengths
 - blue acuity is lowest
 - 8% males and 1% females colour blind



Interpreting the signal (cont)

- The visual system compensates for:
 - movement
 - changes in luminance.
- Context is used to resolve ambiguity
- Optical illusions sometimes occur due to over compensation



Reading

- Several stages:
 - visual pattern perceived
 - decoded using internal representation of language
 - interpreted using knowledge of syntax, semantics, pragmatics
- Reading involves saccades and fixations
- Perception occurs during fixations
- Word shape is important to recognition
- Negative contrast improves reading from computer screen

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 – amplitude
 - timbre – type or quality

Hearing (cont)

- Humans can hear frequencies from 20Hz to 15kHz
 - less accurate distinguishing high frequencies than low.
- Auditory system filters sounds
 - can attend to sounds over background noise.
 - for example, the cocktail party phenomenon.

Touch

- 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

- Time taken to respond to stimulus: reaction time + movement time
- Movement time dependent on age, fitness etc.
- Reaction time - dependent on stimulus type:
 - visual ~ 200ms
 - auditory ~ 150 ms
 - pain ~ 700ms
- Increasing reaction time decreases accuracy in the unskilled operator but not in the skilled operator.

Movement (cont)

- Fitts' Law describes the time taken to hit a screen target:

$$Mt = a + b \log_2(D/S + 1)$$

where: a and b are empirically determined constants
Mt is movement time
D is Distance
S is Size of target

⇒ targets as large as possible
distances as small as possible

Individual differences

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

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

Psychology and the Design of Interactive System

HUMAN-COMPUTER
INTERACTION

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