HUMAN-COMPUTER INTERACTION THIRD EDITION

DIX FINLAY ABOWD BEALE

Lecture 17

chapter 10

# universal design

## universal design principles

- equitable use
- flexibility in use
- simple and intuitive to use
- perceptible information
- tolerance for error
- low physical effort
- size and space for approach and use

## Design to be inclusive

- And you'll get other unexpected benefits
  - Doors that slide open via sensor are good for a person with a walker… and for someone with their hands full
  - Wheelchair access toilet… is also handy when you have three toddlers in tow
  - Audible crosswalk sound… also reminds those who aren't looking



## How can we make our software this way?

- Use multiple modes
  - Colour, font, icon, unique sound; shortcut key and mouse/trackball (and touch screen if you can)
- Adhere to standards
  - 'straight' HTML is more friendly to reading software used by the blind than graphical rendering of text or text fragmented in tables
- Make it simple and 'idiot proof'
  - Reasonably big print, attractive, prevent errors, easy undo, good feedback on actions, self explanatory, avoid unnecessary functionality
  - Good for elderly, less-computer literate and children; and helpful for the busy, stressed and distracted, too!

# Multi-Sensory Systems

- More than one sensory channel in interaction
  - e.g. sounds, text, hypertext, animation, video, gestures, vision
- Used in a range of applications:
  - particularly good for users with special needs, and virtual reality
- Will cover
  - general terminology
  - speech
  - non-speech sounds
  - handwriting
- considering applications as well as principles



# Usable Senses

The 5 senses (sight, sound, touch, taste and smell) are used by us every day
- each is important on its own
- together, they provide a fuller interaction with the natural world

Computers rarely offer such a rich interaction

Can we use all the available senses?
- ideally, yes
- practically – no

We can use • sight • sound • touch (sometimes)

We cannot (yet) use • taste • smell

# Multi-modal vs. Multi-media

- Multi-modal systems
  - use more than one sense (or mode ) of interaction

    e.g. visual and aural senses: a text processor may speak the words as well as echoing them to the screen

- Multi-media systems
  - use a number of different media to communicate information

    e.g. a computer-based teaching system: may use video, animation, text and still images: different media all using the visual mode of interaction; may also use sounds, both speech and non-speech: two more media, now using a different mode





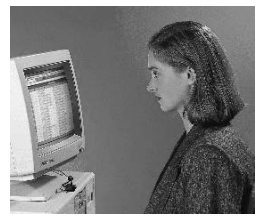
# Speech

Human beings have a great and natural mastery of speech

- makes it difficult to appreciate the complexities

but

- it's an easy medium for communication



## Structure of Speech

phonemes
- 40 of them
- basic atomic units
- sound slightly different depending on the context they are in, these larger units are …

allophones
- all the sounds in the language
- between 120 and 130 of them
- these are formed into …

morphemes
- smallest unit of language that has meaning.





## Speech (cont'd)

Other terminology:
- prosody
  - alteration in tone and quality
  - variations in emphasis, stress, pauses and pitch
  - impart more meaning to sentences.
- co-articulation
  - the effect of context on the sound
  - transforms the phonemes into allophones
- syntax – structure of sentences
- semantics – meaning of sentences

## Speech Recognition Problems

- Different people speak differently:
  - accent, intonation, stress, idiom, volume, etc.
- The syntax of semantically similar sentences may vary.
- Background noises can interfere.
- People often "ummm....." and "errr....."
- Words not enough - semantics needed as well
  - requires intelligence to understand a sentence
  - context of the utterance often has to be known
  - also information about the subject and speaker

e.g. even if "Errr.... I, um, don't like this" is recognised, it is a fairly useless piece of information on it's own





## Speech Recognition: useful?


Single user or limited vocabulary systems
e.g. computer dictation


Open use, limited vocabulary systems can work satisfactorily
e.g. some voice activated telephone systems


general user, wide vocabulary systems ...
... still a problem

- Great potential, however
  - when users hands are already occupied
    e.g. driving, manufacturing
  - for users with physical disabilities
  - lightweight, mobile devices

# Speech Synthesis

The generation of speech

Useful
- natural and familiar way of receiving information

Problems
- similar to recognition: prosody particularly

Additional problems
- intrusive - needs headphones, or creates noise in the workplace
- transient - harder to review and browse





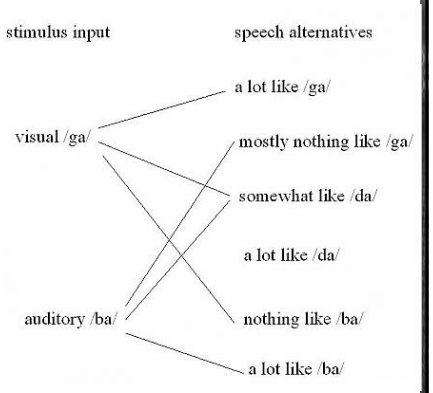
# Speech Synthesis: useful?

Successful in certain constrained applications when the user:
- is particularly motivated to overcome problems
- has few alternatives

Examples:
- screen readers
  - read the textual display to the user
    utilised by visually impaired people
- warning signals
  - spoken information sometimes presented to pilots whose visual and haptic skills are already fully occupied

# McGurk Effect

- Visual 'GA' + auditory 'BA' = perceived 'DA'
  - 'DA' seems to be the most feasible fusion of our auditory and visual sensory inputs
- Properly synchronised visual input of lip and tongue motion can reinforce and improve our comprehension of the audio signal
- Thus there are potential advantages is having the visual image of a 'talking head' along with computer generated speech



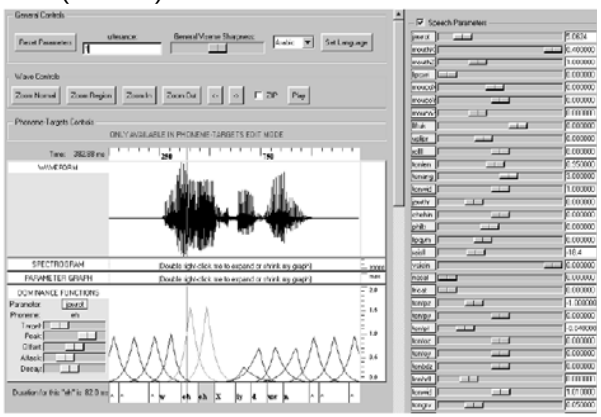



# Baldi – a talking head

- Baldi generates the visual impression of a talking head to complement text-to-speech services
- Baldi is trained to a speaker by modelling the motion (in 3D over time) of points on a speaker's mouth and face as they make the various sounds of English (or another language)
  - LED markers let key points be tracked during speech
- Baldi's 'canonical head' can then be morphed to better fit an individual pattern
- See http://mambo.ucsc.edu/pdf/cohenm_training.pdf

# Tuning the head

- A battery of parameters can be manually tuned to adjust the appearance of the head while pronouncing particular phonemes (sounds)

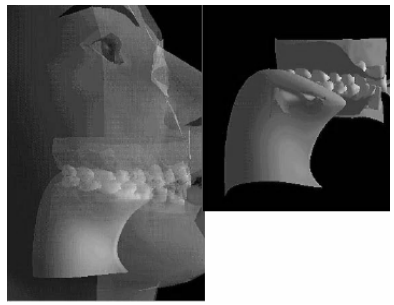







# Application - Language tutor

- Baldi is a language tutor who can make his skin transparent!
  - And illustrate tongue placement and movement
  - Advantage for Japanese learning English '*ℓ*' and 'r' sounds
  - Also very useful for teaching speech to the deaf (they can see how it's supposed to be done)



## Non-Speech Sounds

boings, bangs, squeaks, clicks etc.

- commonly used for warnings and alarms
- Evidence to show they are useful
  - fewer typing mistakes with key clicks
  - video games harder without sound
- Language/culture independent, unlike speech





## Non-Speech Sounds: useful?

- Dual mode displays:
  - information presented along two different sensory channels
  - redundant presentation of information
  - resolution of ambiguity in one mode through information in another
- Sound good for
  - transient information
  - background status information

e.g. Sound can be used as a redundant mode in the Apple Macintosh; almost any user action (file selection, window active, disk insert, search error, copy complete, etc.) can have a different sound associated with it.

## Auditory Icons

- Use natural sounds to represent different types of object or action
- Natural sounds have associated semantics which can be mapped onto similar meanings in the interaction
  e.g. throwing something away
  ~ the sound of smashing glass
- Problem: not all things have associated meanings
- Additional information can also be presented:
  - muffled sounds if object is obscured or action is in the background
  - use of stereo allows positional information to be added



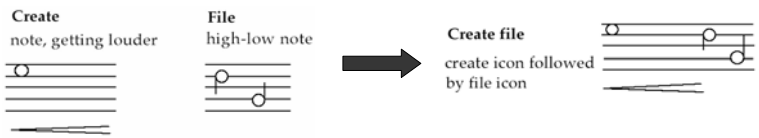


## SonicFinder for the Macintosh

- items and actions on the desktop have associated sounds
- folders have a papery noise
- moving files – dragging sound
- copying – a problem …
  sound of a liquid being poured into a receptacle
  rising pitch indicates the progress of the copy
- big files have louder sound than smaller ones

# Earcons

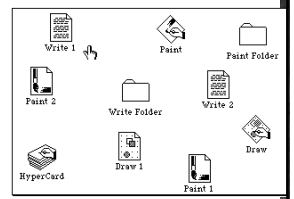
- Synthetic sounds used to convey information
- Structured combinations of notes (motives ) represent actions and objects
- Motives combined to provide rich information
  - compound earcons
  - multiple motives combined to make one more complicated earcon






# Earcons (ctd)

- family earcons
  similar types of earcons represent similar classes of action or similar objects: the family of “errors” would contain syntax and operating system errors

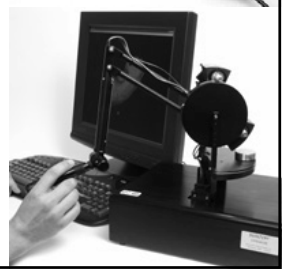



Earcons easily grouped and refined due to compositional and hierarchical nature

Harder to associate with the interface task since there is no natural mapping

# touch

- haptic interaction
  - cutaneous perception
    - tactile sensation; vibrations on the skin
  - kinesthetics
    - movement and position; force feedback
- information on shape, texture, resistance, temperature, comparative spatial factors
- example technologies
  - electronic braille displays
  - force feedback devices e.g. Phantom
    - resistance, texture





# Handwriting recognition

Handwriting is another communication mechanism which we are used to in day-to-day life

- Technology
  - Handwriting consists of complex strokes and spaces
  - Captured by digitising tablet
    - strokes transformed to sequence of dots
  - large tablets available
    - suitable for digitising maps and technical drawings
  - smaller devices, some incorporating thin screens to display the information
    - PDAs such as Palm Pilot
    - tablet PCs

# Handwriting recognition (ctd)

- Problems
  - personal differences in letter formation
  - co-articulation effects
- Breakthroughs:
  - stroke not just bitmap
  - special 'alphabet' – Graffeti on PalmOS
- Current state:
  - usable – even without training
  - but many prefer keyboards!






# gesture

- applications
  - gestural input - e.g. "put that there"
  - sign language
- technology
  - data glove
  - position sensing devices e.g MIT Media Room
- benefits
  - natural form of interaction - pointing
  - enhance communication between signing and non-signing users
- problems
  - user dependent, variable and issues of coarticulation

## Users with disabilities

- visual impairment
  - screen readers, SonicFinder
- hearing impairment
  - text communication, gesture, captions
- physical impairment
  - speech I/O, eyegaze, gesture, predictive systems (e.g. Reactive keyboard)
- speech impairment
  - speech synthesis, text communication
- dyslexia
  - speech input, output
- autism
  - communication, education





## … plus …

- age groups
  - older people e.g. disability aids, memory aids, communication tools to prevent social isolation
  - children e.g. appropriate input/output devices, involvement in design process
- cultural differences
  - influence of nationality, generation, gender, race, sexuality, class, religion, political persuasion etc. on interpretation of interface features
  - e.g. interpretation and acceptability of language, cultural symbols, gesture and colour

## Concepts and colors

8% of men and 1% of women are color blind

| Green | % | Red | % | Yellow | % | Black | % | White | % |
|---|---|---|---|---|---|---|---|---|---|
| Safe | 62.2 | Hot | 31.1 | Caution | 44.8 | Off | 53.5 | Cold | 71.5 |
| Go | 44.7 | Danger | 64.7 | | | | | | |
| On | 22.3 | Stop | 48.5 | | | | | | |

% of Hong Kong Chinese who associate particular concepts and colors (Courtney 86)

| Green | % | Red | % | Yellow | % | Blue | % |
|---|---|---|---|---|---|---|---|
| Safe | 61.4 | Hot | 94.5 | Caution | 81.1 | Cold | 96.1 |
| Go | 99.2 | Danger | 89.8 | | | Off | 31.5 |
| | | Stop | 100 | | | | |

% of Americans who associate particular concepts and colors (Bergum&Bergum 81)





## Conclusion

- Try for universal, inclusive design as much as possible
  - You'll get unexpected benefits
- Consider speech technologies and use of sound
- Remember that we don't always perceive or think the same