

chapter 10

universal design

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HUMAN-COMPUTER INTERACTION

universal design principles

- NCSW

- 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

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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

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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

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

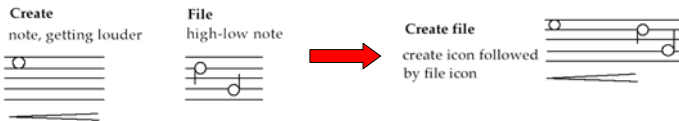
- Use natural sounds to represent different types of object or action
- Natural sounds have associated semantics which can be mapped onto similar meanings in the interaction
 - e.g. throwing something away
~ the sound of smashing glass
- Problem: not all things have associated meanings
- Additional information 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

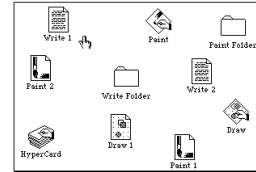
Earcons

- 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' - Graffiti 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)