Sound as a communication medium

Auditory display, sonification, auralisation, earcons, & auditory icons

Auditory display

- Last week we touched on research that aims to communicate information using non-speech audio
- The representation of data/information in sound is called auditory display
  - Information is displayed, or communicated using the audio channel rather than the visual channel
  - The loudspeaker, therefore, is an ADU (auditory display unit, c.f. VDU)
  - See www.icad.org (PV is a member of the board)

Visualisation

- Apart from speech, we normally consider visual techniques as most appropriate for information exchange
  - Text-based email programs
  - Graphs
  - Tables of data, etc.
- What do blind people use?
  - See Will Pearson's Auditory Synthetic Vision Project
  - http://www.freelists.org/list/asvs
  - http://www.seeingwithsound.com/auddisp.htm

Sound

- Since 1982 or so researchers have begun to explore the use of sound as a communication medium
- Belief that non-speech audio useful as interaction medium
- Nascent field of auditory display spawns techniques like:
  - Sonification
  - Audification
  - Auralisation

Examples

- Auditory icons
- Earcons
- Data visualisation (sonification & audification)
- Program auralisation
- Assistive technologies
  - e.g. web browsers for the blind
  - Diagram readers (speech and musical)

Audification

- Simple techniques of scaling data into the range of audible frequencies yields very insightful results
  - Chris Hayward's "Listening to the earth sing"
    - ★ audified seismographs
    - ★ Discriminate between earthquakes and atomic tests

Sonification

- Using non-speech audio to convey information

More specifically, sonification is the transformation of data relations into perceived relations in an acoustic signal for the purposes of facilitating communication or interpretation.

NSF Sonification Report, available from
http://www.icad.org/websiteV2.0/References/nsf.html

Sonification/audification

- Audification is a scaling of data into audible frequency ranges
  - Data multiplied/scaled by a time constant to fall between 20 Hz and 20 KHz, converted to the analogue domain, and amplified
- Sonification is the use of data to control a sound generator
  - Data and sound generation technique need not have any direct relationship
  - Associations are often metaphorical

Metaphorical associations

- Louder = more
- Brighter = more
- Faster = more
- Higher pitch = more
  - Not always though
- Higher pitch = faster
- Higher pitch = up
- etc. etc.

Example (Fitch & Kramer, 1994)

- Monitoring of patient state data
  - Body temperature
  - Heart rate (BPM)
  - Blood pressure (mmHg)
  - Blood CO2 level (mmol/L)
  - Respiratory rate (BPM)
  - Atrio-ventricular dissocation (present/absent)
  - Fibrillation (present/absent)
  - Pupillary reflex (present/absent)

Operation complications

	Symptom								
Complication	Temp	HR	BP	CO2	RR	AV	Fib	Reflex	Response
Temp down	↓								Heat on
CO2 down				↓					↑Ventillation
HR up		↑							Digitalis on
O2 down		↑	↑			×			↑Oxygen
Blood loss	↓		↓				×		↑Blood
Overdose			↓		↓			×	↓Anaesthetic

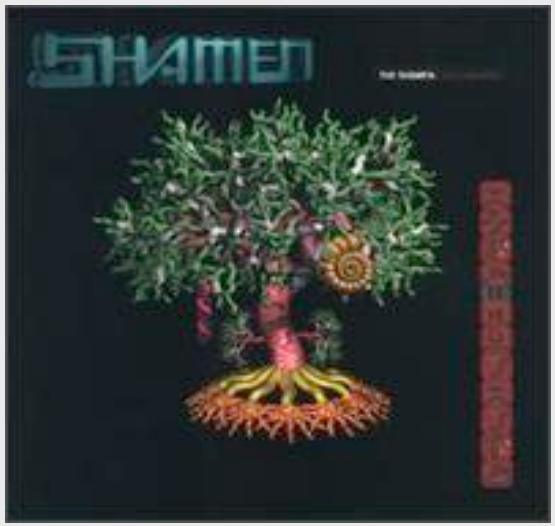
Heart = low freq thud (high & low)
breathing = modulated noise
AV diss = atrial heart tone varies
fib = both heart tones vary
Temp = freq of breathing,
CO2 = timbre of heart
BP = heart pitch

Example 2 (Sturm, 2002)

- Data from Pacific Ocean buoys mapped to sound
- Listen...

Example 3 (King & Angus, 1996)

- Mapping of DNA nucleotide sequences to musical parameters
- S2 translation by The Shamen (Colin Angus) is a piece representing the DNA of serotonin receptors in the brain
- Listen...



Auditory icons

- Representational sounds
  - For interface widgets
  - System events
  - Real world events
- Not always very representational
  - E.g. Gaver's filling bottle sound to represent state of a file copy operation
- Sort of a sound-effect approach
- Based on Schafer's idea of soundscapes & acoustic ecology

Earcons

- Short tunes constructed around a set of hierarchic rules to represent
  - Events
  - Objects
  - Choices in a telephone-based interface, etc.

Example earcon hierarchy

(Brewster, 1998)