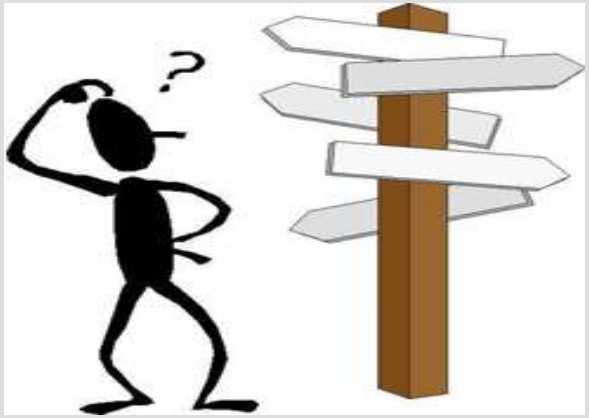
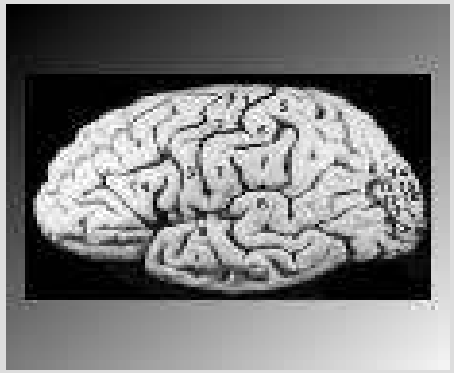
Understanding Users





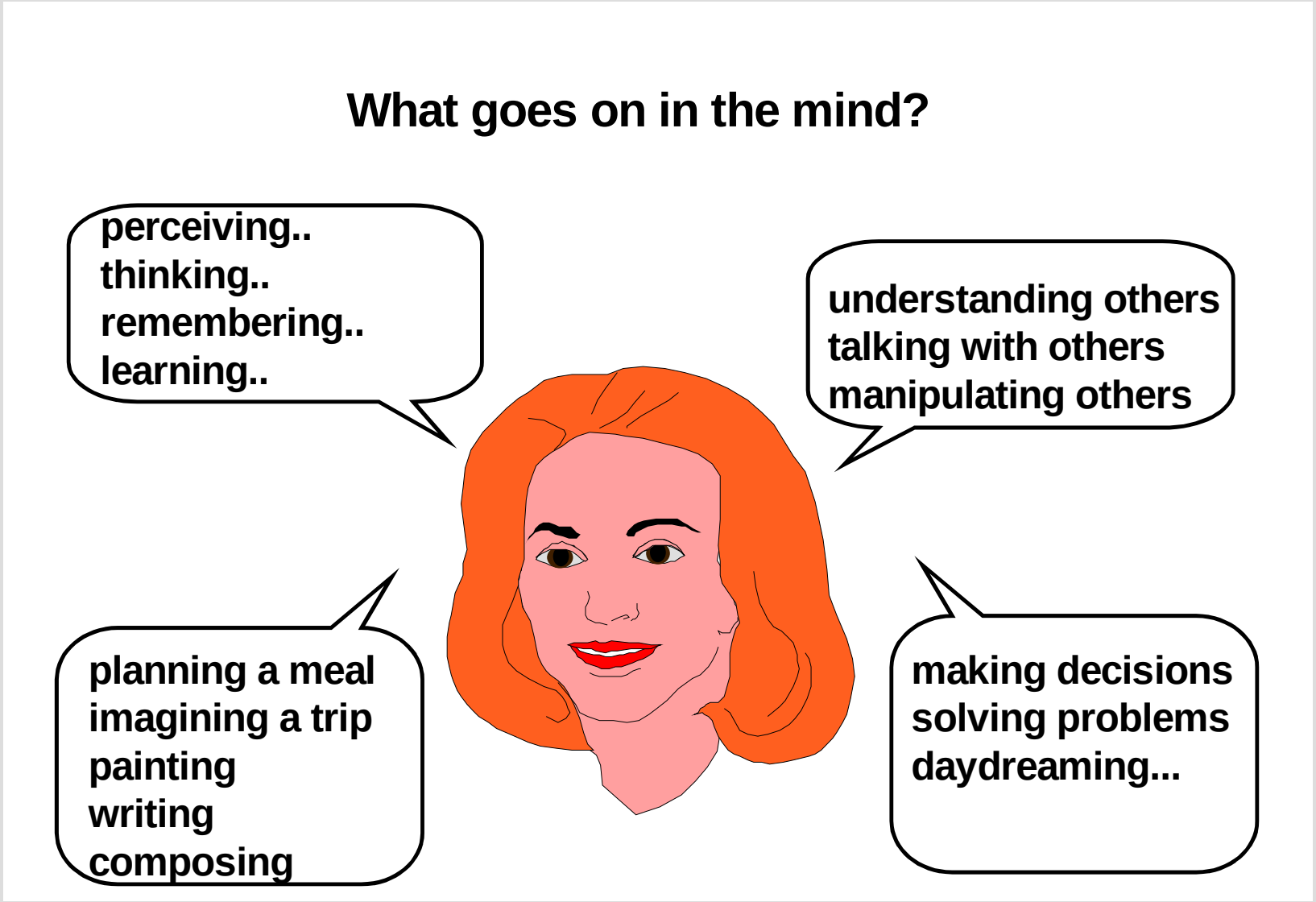
Based on the slides available at www.id-book.com

Overview

- What is cognition ?
- What are users good and bad at ?
- Mental models
- External Cognition
- Influence to Interaction Design

Based on the slides available at www.id-book.com

Cognition



Based on the slides available at www.id-book.com

Core cognitive aspects

- Attention
- Perception and recognition
- Memory
- Reading, speaking and listening
- Problem solving, planning, reasoning and decision making
- Learning
- Focus: attention, perception & recognition, memory

Attention

- Select thing to concentrate – a way to focus on parts of our sensory input
- Focussed and divided attention enables us to be selective in terms of the mass of competing stimuli but limits our ability to keep track of all events
- Information at the interface should be structured to capture users' attention, e.g. use perceptual boundaries (windows), colour, reverse video, sound and flashing lights

Design implications for attention

- Make information salient when it needs attending to
- Use techniques that make things stand out like colour, ordering, spacing, underlining, sequencing and animation
- Avoid clutturing the interface – follow the google.com example of crisp, simple design
- Avoid using too much because the software allows it

Auditory displays

- Attract and direct user's attention
  - Fire alarms, police sirens
  - Gaiger counter, heartbeat monitor

- Don't require field of view – 360 degrees
- Good design critical – smoke detectors
- Warning – a hazardous event may occur if circumstances prevail
- Alert – a hazardous event will occur soon if nothing is changed
- Alarm – a hazardous event is occuring and requires immediate response

Aircraft CockPits

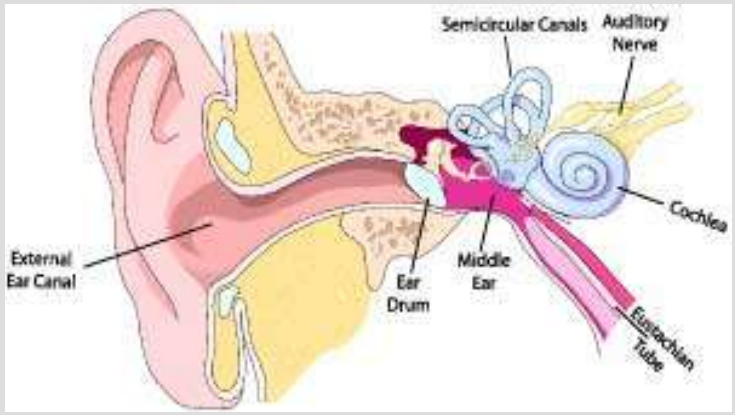
AirCraftType	#displays
DC8	172
DC10	481
Boeing707	188
Boeing747	455

Aircraft cockpits have complex visual and auditory displays. The number of these displays has steadily increased as aircraft have become more technologically sophisticated

Auditory Display Pitfalls

- Too loud
  - causes startle response – must be heard but not interrupt system performance
- Too frequent
  - causes auditory signals to be ignored
- Too many
  - causes confusion – signals must be distinguishable
- Too vague
  - causes uncertainty – each signal must convey a special meaning

Auditory System



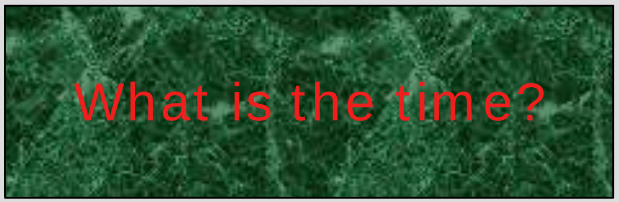
140dB – Jet aircraft start
100dB – Power chain saw
60dB - Normal conversation
30dB - whisper
10dB - recording studio
0dB - acute threshold of hearing

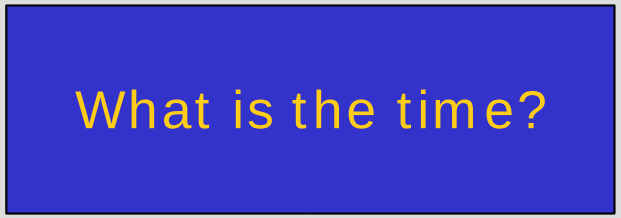
Human auditory system (HAS) extremely sensitive and responds to a wider range of stimuli than any other senses.
Dynamic range: 0 – 132 dB from softest sound to threshold of pain corresponds to 32×10^{12} or 32 trillion times
The softest sound we can hear moves the ear drum a distance equivalent to the diameter of a hydrogen molecule

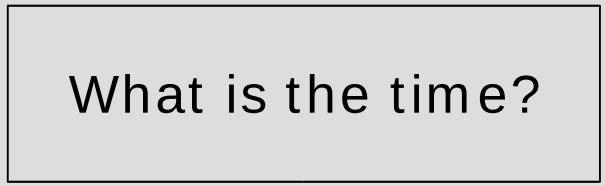
Based on the slides available at www.id-book.com

Perception and Recognition

- How information is acquired from the world and transformed into experiences
- Obvious implication is to design representations that are readily perceivable
  - Text should be legible
  - Icons should be easy to distinguish and read







Based on the slides available at www.id-book.com

Memory

- Involves encoding and recalling knowledge and acting appropriately
- We don't remember everything – filtering and processing
- CONTEXT is important in affecting our memory
- Recognition is much better than recall
  - Rise of GUI over command-based interfaces
- Better at remembering images than words
  - Use of icons rather than names

The problem with the classic '7+/-2'

- George Miller's theory of how much information people can remember in short-term memory
- Immediate memory capacity limited but polymorphic
- Many designers have been led to believe that this is a useful finding in ID
- Example:
  - 3, 12, 6, 20, 9, 4, 0, 1, 19, 8, 97, 13, 84 (without writing down)

Some designers propose:

- 7 options in menu
- 7 icons in toolbar
- 7 bullets in list
- 7 tabs on webpage
- This is wrong. Why ?

Why ?

- Inappropriate application of the theory
- People can scan lists of bulltets, tabs, menu items until they see what they want
- No recall required just recognition
- Sometimes small number of items is good design
- Depends on task and screen real-estate not on Miller's theory

Application of memory research

- File management and retrieval is a real problems to most computer users
- Research on information retrieval by humans can be usefully applied
- Memory
  - Recall-directed
  - Recognition-directed scanning
- File management systems should be designed to optimize both kinds of memory processes with weights depending on the particular task

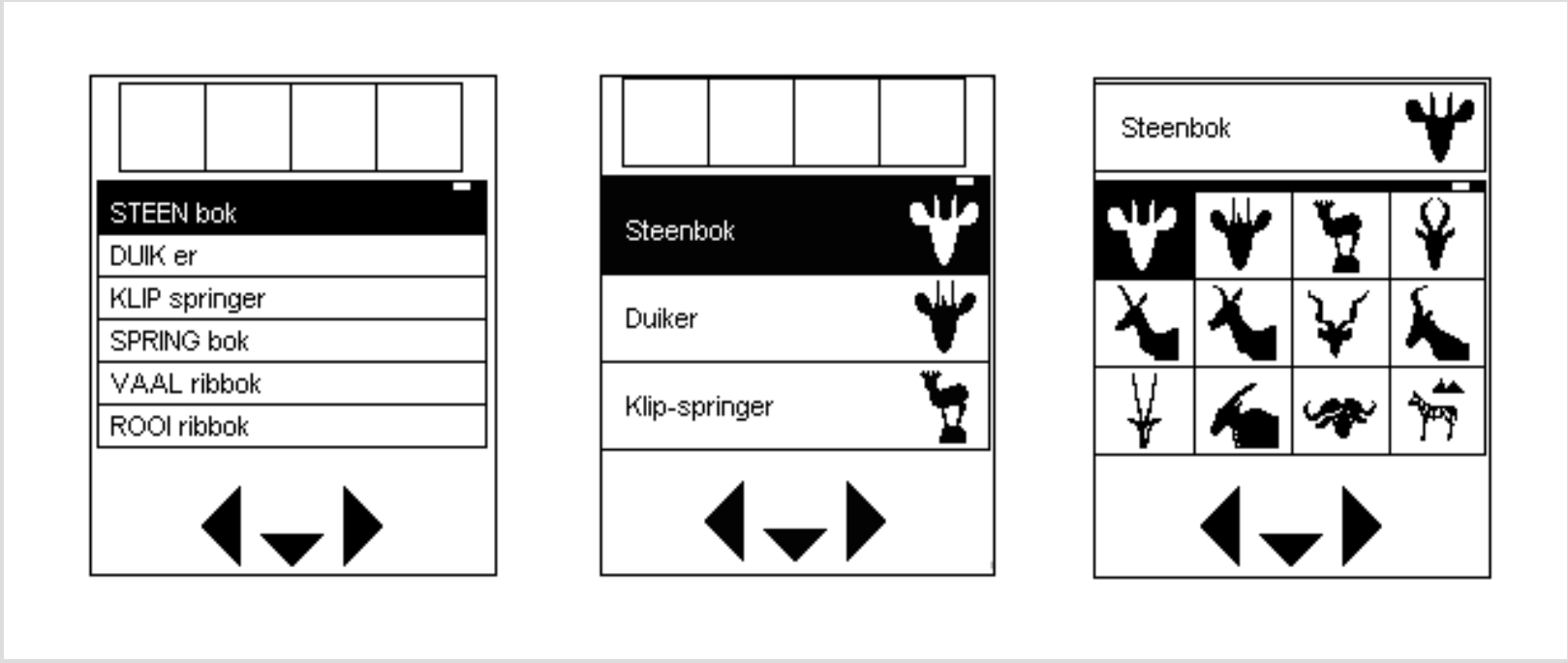
File Management

- Faciliate existing memory strategies and try to assist users when they get stuck
- Help users encode files in richer ways
  - Provide ways of saving files using color, flagging, image, flexible text, time stamping
- Help users retrieve files
  - Search, spelling-correction, suggestions
  - Organize information for presentation
    - see Preece book page 76

Cybertracker

http://www.cybertracker.org

Icons vs text
Cultural differences in memory organization



Based on the slides available at www.id-book.com

Mental Model

- Users develop an understanding of a system through learning & using it
- Knowledge is often described as a mental model
  - How to use the system ? (what to do next)
  - What to do unfamiliar systems or unexpected situations ? (how the system works)
- People make inferences using mental models of how to carry out tasks

Mental Models

- Craik (1943) described mental models as internal constructions of some aspect of the external world enabling predictions to be made
- Involves unconscious and conscious processes, where images and analogies are activated
- Deep vs shallow models (e.g how to drive a car vs how it works)

Incorrect mental models

- Many people have erroneous mental models (Kempton, 1996)
- Classic example
  - General valve theory, more is more (e.g gas pedal, water faucet, radio volume)
  - Thermostat is based on model of on-off switch
- Same in interactive devices and computers
  - Poor, incomplete, easily confusable based on inappropriate analogies and superstition
  - e.g. Frozen cursor/screen – most people will bash all manner of keys

Information Processing

- Conceptualizing the mind
  - Steam engine
  - Telephone network
  - Digital computer
- Human-Processing Model (page 97, Preece)
  - Card, Moran and Newell (1980,1983)
  - Goals (insert word), operators (press-arrow key, drag-mouse), methods (move cursor to desired location by following a sequence of arrow keys)

Information Processing Critique

- (Norman 1990 from Preece book page 97)
- Pure intellect, isolated from distractions and artificial aids
- Closed, isolated rooms and arbitrary tasks
- Theoretical analyses are self-contained little structures, isolated from the world, isolated from any other knowledge or abilities of the person
- Current trend
  - Cognitive activities studied “in the wild”

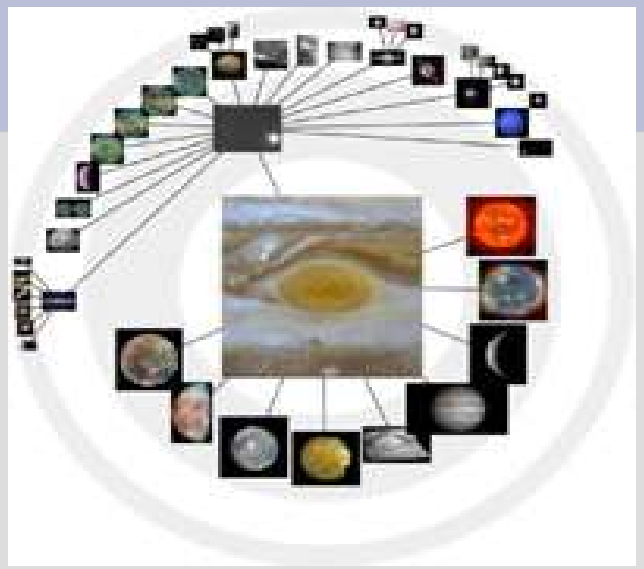
External Cognition

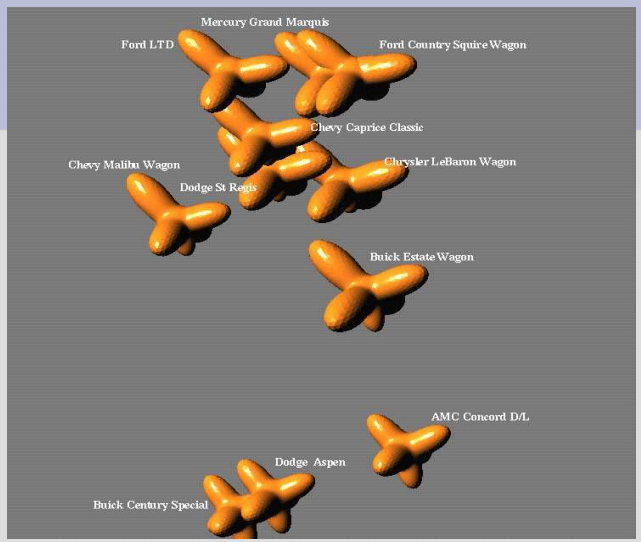
- Humans are superb toolmakers
  - Bow and arrows (physical)
  - Painting, hieroglyphs, (ancient Egyptian equivalent to computer icons), rhyming (cognitive)
- Interaction with external representations
  - Maps, notes, diagrams
- Computer is the ultimate external cognition tool
  - The age of spiritual machines (Kurzweil)
  - Darwin among the machine (Dyson)

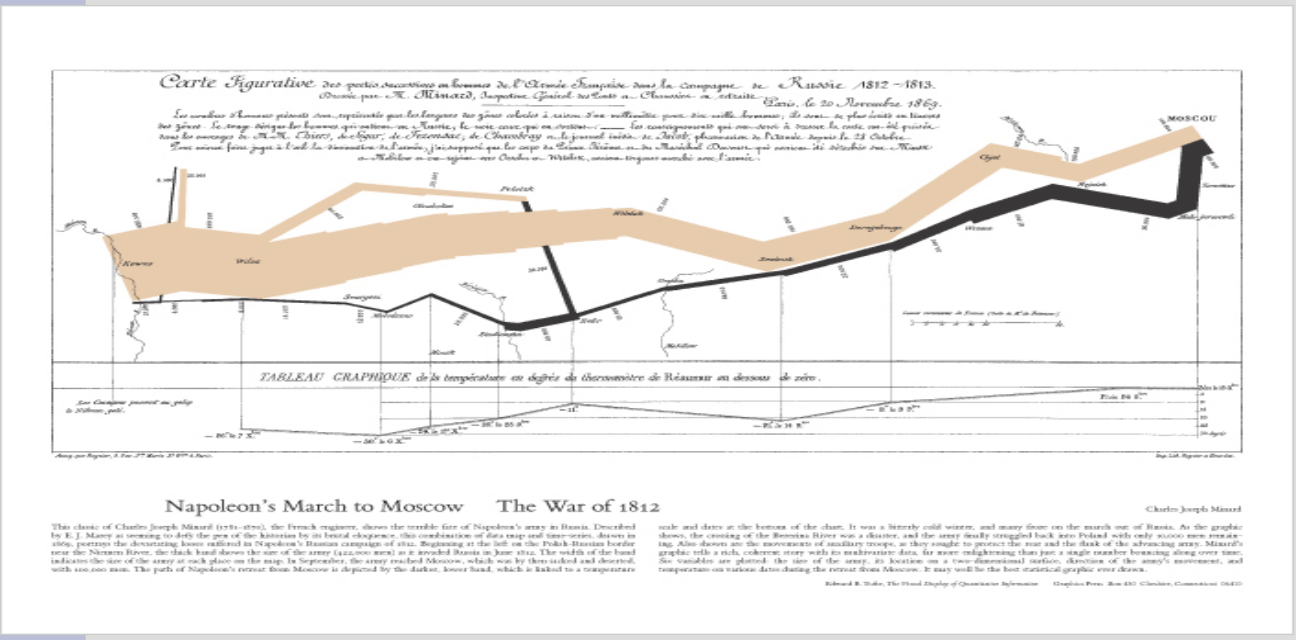
Externalizing to reduce memory load

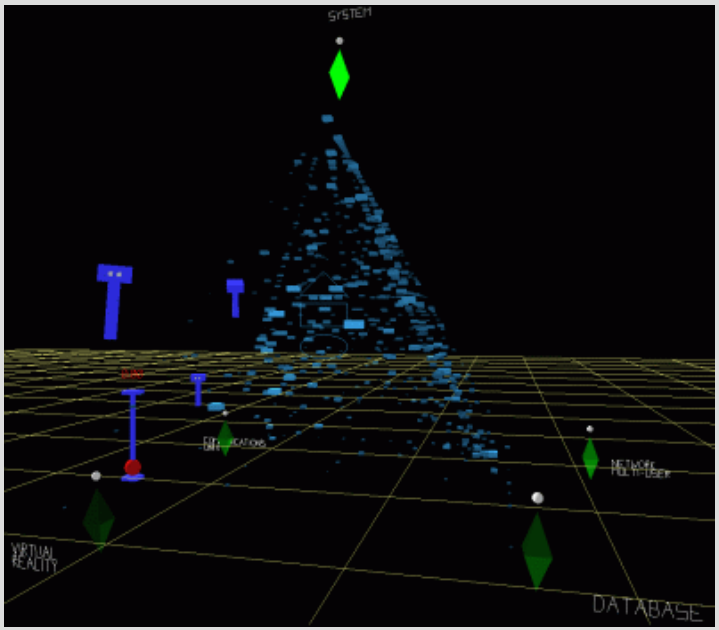
- Diaries, calendars, notes, shopping lists
  - Remind what to do
- Post-it, piles, marked emails
  - Remind us priorities
- Computational offloading
  - Tool in conjuction with external representation
  - Multiply 234 * 456 in head/ with pen and paper
  - CCXXXIIII * CCCXXXXXXVI
  - Importance of representations
- Annotating – crossing off items
- Cognitive tracing – scrabble, shuffling of letters

Information Visualization





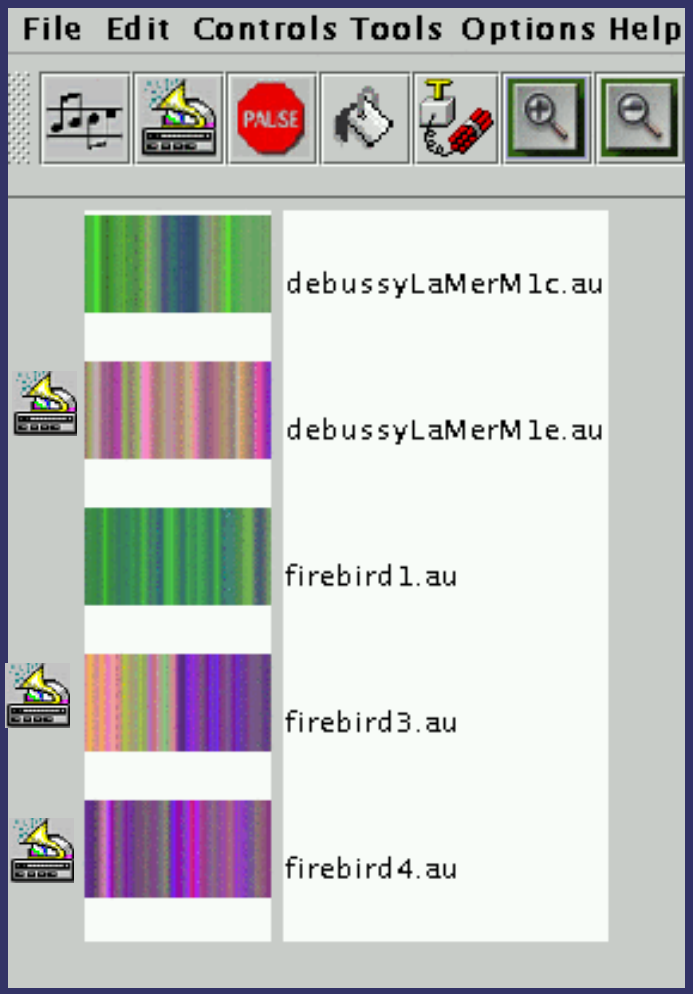


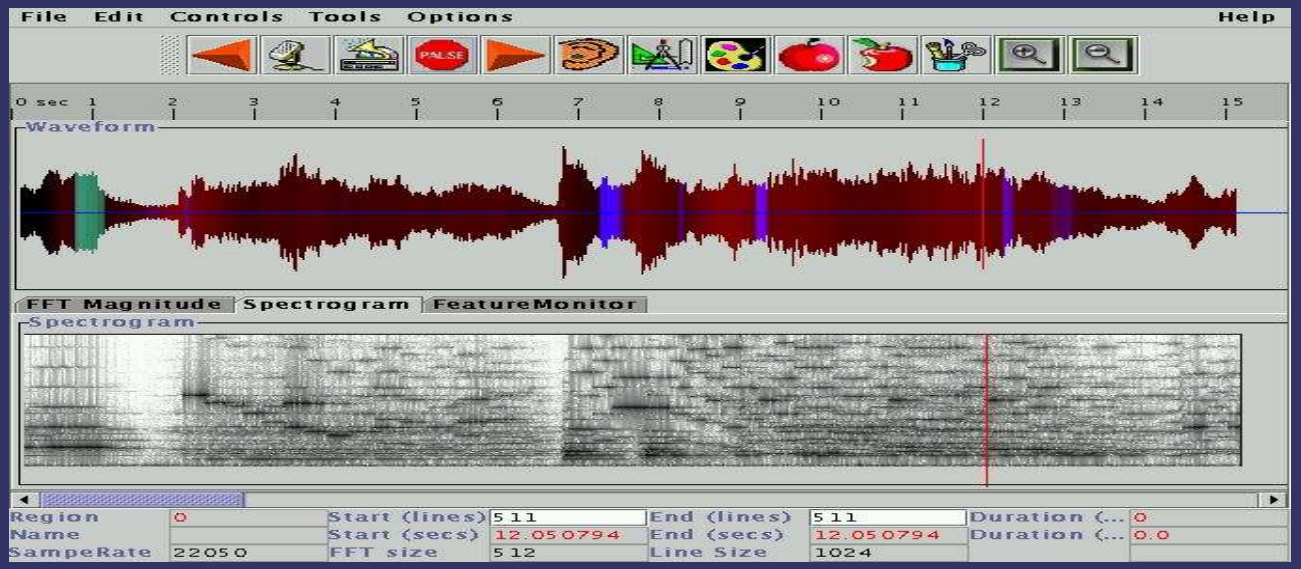


Based on the slides available at www.id-book.com

Timbregrams

Tzanetakis & Cook DAFX00, ICAD01



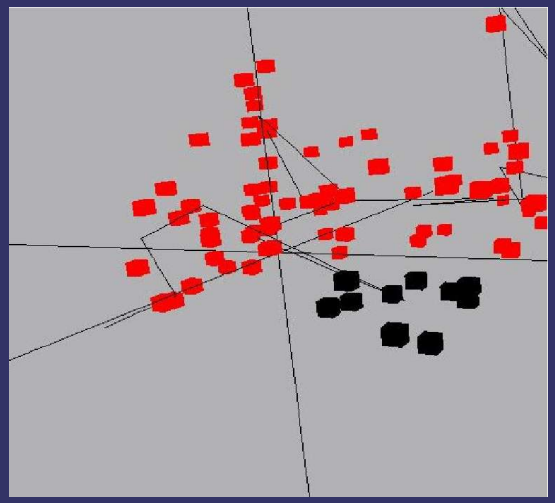


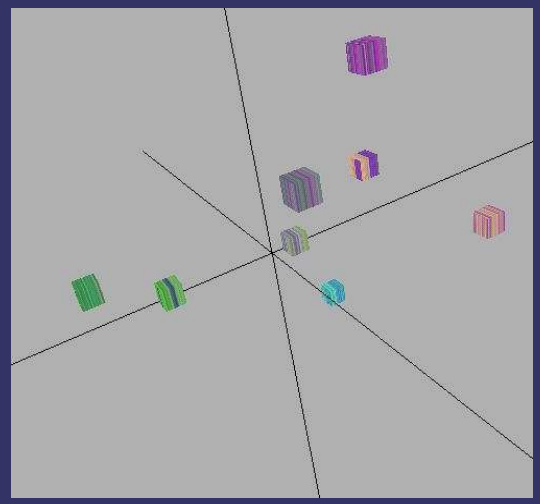
Content and context similarity and periodic structure using color

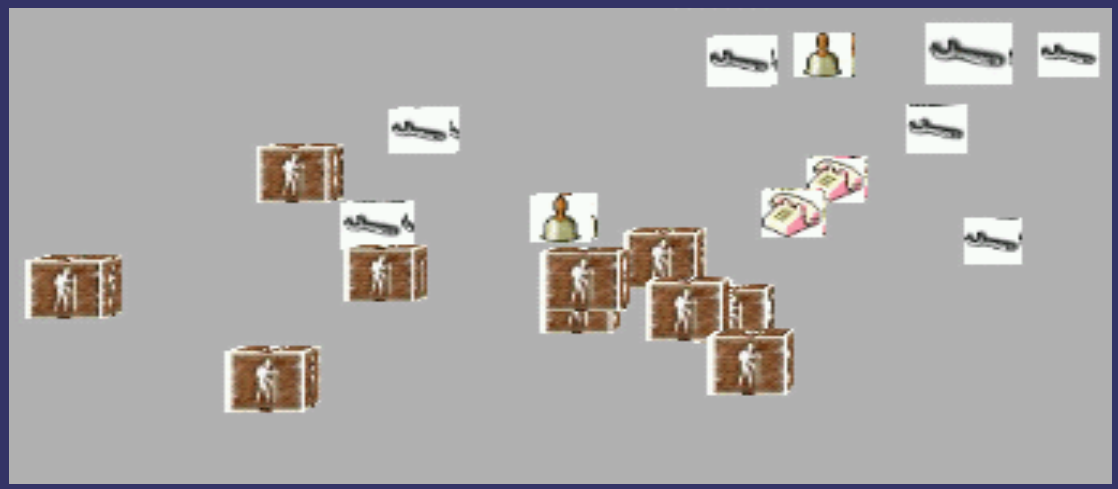
Principal Component Analysis

TimbreSpace Browser 2D,3D DEMO

Tzanetakis & Cook DAFX00, ICAD01



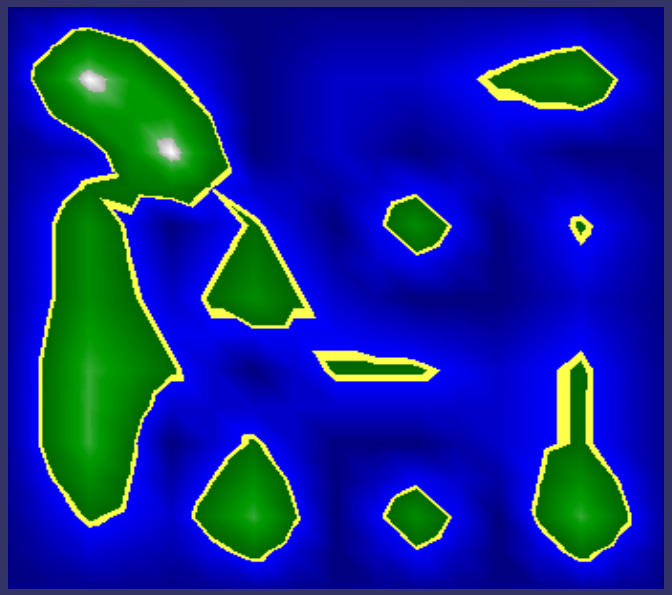


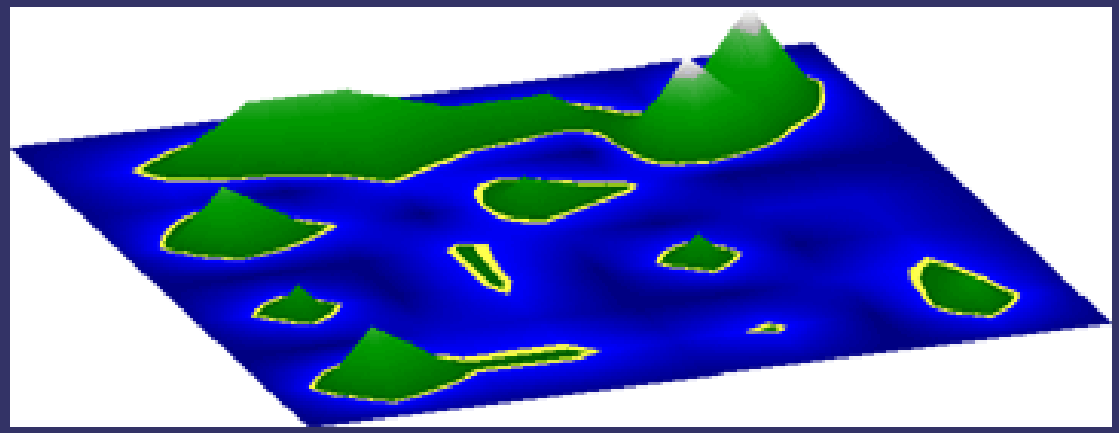


- Automatic coloring
- Hierarchical zooming
- Automatic positioning
- Principal Component Analysis for dimensionality reduction

Islands of Music

Pampalk, ISMIR 02





Automatic analysis

Feature vectors

Self-Organizing Map (SOM)

Informing design based on our understanding of users

- How can we use knowledge about users to inform system design ?
- Provide guidance and tools
  - Design principles and concepts
  - Design rules
- Provide analytic tools
  - Methods for evaluating usability

Mental Models and System Design

- Notion of mental models has been used as a basis for conceptual models
- Assumption is that if you can understand how people develop mental models then you can help them develop more appropriate mental models of system functionality
- Design principle of transparency
  - State of system and mode of operation are easy to determine

Transparency

- NOT to be understood literally
- Useful feedback
- Easy to understand
- Intuitive to use
- Clear and easy to follow instructions
- Appropriate online help
- Context-sensitive guidance of how to proceed when stuck

Key points

- Cognition involves many processes including attention, perception, memory and learning
- The way an interface is designed can greatly affect how well users can perceive, attend, learn and remember how to do their tasks
- The conceptual frameworks of 'mental models' and 'external cognition' provide ways of understanding how and why people interact with devices, which can lead to thinking about how to design better devices