



Understanding users



Overview

- What is cognition?
- What are users good and bad at?
- Mental models
- External cognition
- Using this understanding to inform system design

Why do we need to understand users?

- Interacting with technology is cognitive
- We need to take into account cognitive processes involved and cognitive limitations of users
- We can provide knowledge about what users can and cannot be expected to do
- Identify and explain the nature and causes of problems users encounter
- Supply theories, modelling tools, guidance and methods that can lead to the design of better interactive products

What goes on in the mind?

perceiving..
thinking..
remembering..
learning..

understanding others
talking with others
manipulating others

planning a meal
imagining a trip
painting
writing
composing



making decisions
solving problems
daydreaming...

Core cognitive aspects

- Attention
- Perception and recognition
- Memory
- Reading, speaking and listening
- Problem-solving, planning, reasoning and decision-making, learning
- Here we focus on attention, perception & recognition, & memory

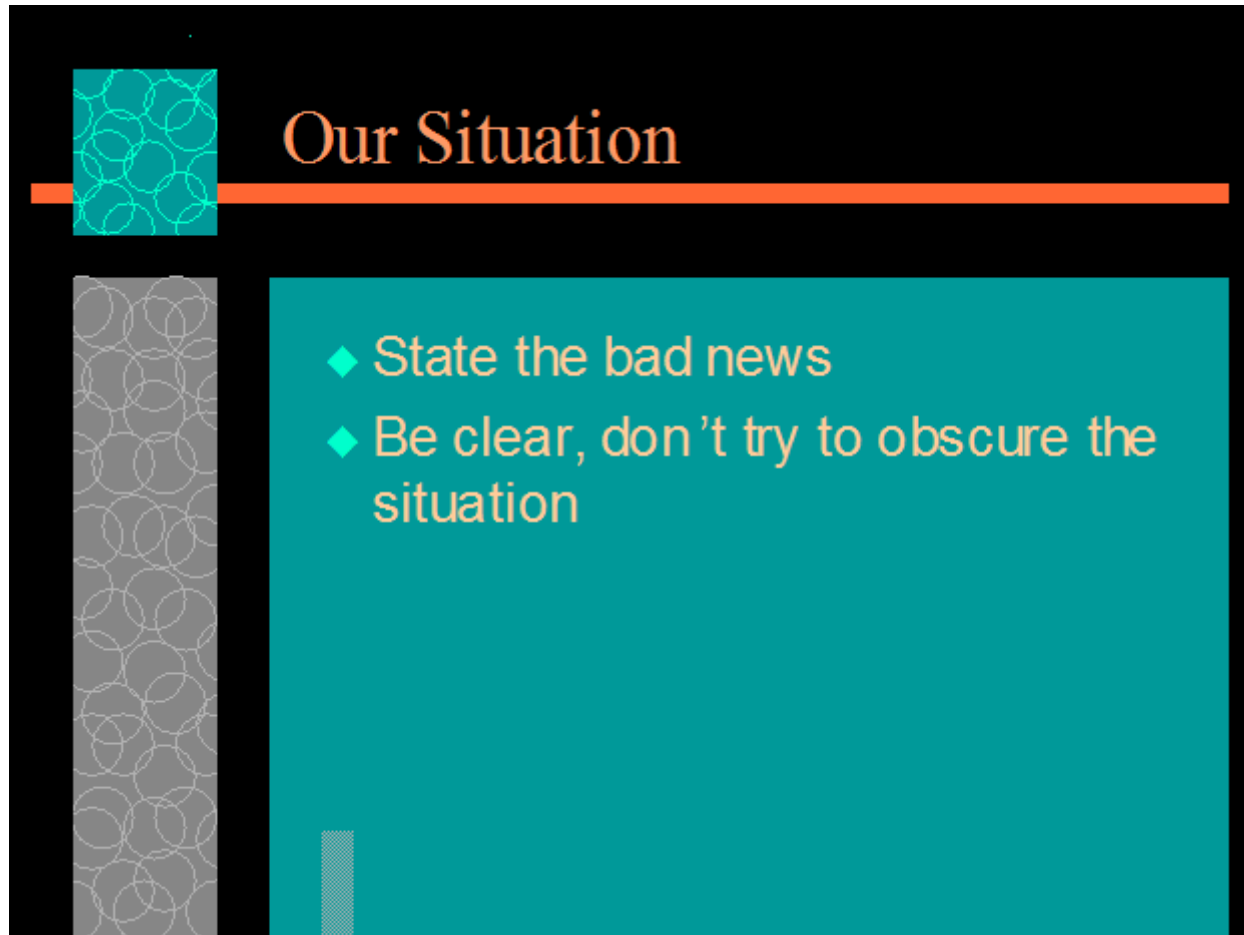
Attention

- Selecting things to concentrate on from the mass around us, at a point in time
- 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 cluttering the interface - follow the google.com example of crisp, simple design
- Avoid using too much because the software allows it

An example of over-use of graphics



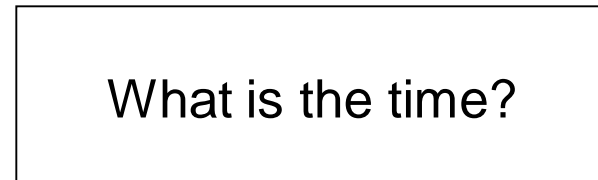
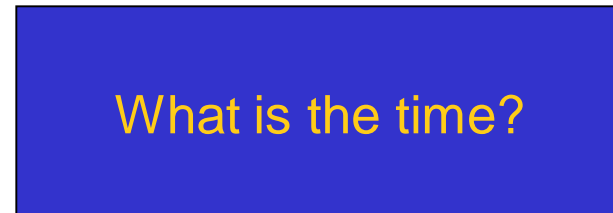
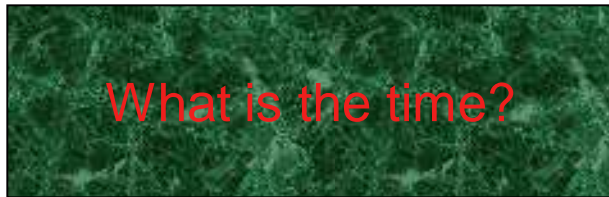
Our Situation

- ◆ State the bad news
- ◆ Be clear, don't try to obscure the situation

Perception and recognition

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

Which is easiest to read and why?



Memory

- Involves encoding and recalling knowledge and acting appropriately
- We don't remember everything - involves filtering and processing
- Context is important in affecting our memory
- We recognize things much better than being able to recall things
 - The rise of the GUI over command-based interfaces
- Better at remembering images than words
 - The use of icons rather than names

The problem with the classic ' 7 ± 2 '

- George Miller's theory of how much information people can remember
- People's immediate memory capacity is very limited
- Many designers have been led to believe that this is useful finding for interaction design

What some designers get up to...

- Present only 7 options on a menu
- Display only 7 icons on a tool bar
- Have no more than 7 bullets in a list
- Place only 7 items on a pull down menu
- Place only 7 tabs on the top of a website page

– But this is wrong? Why?



Why?

- Inappropriate application of the theory
- People can scan lists of bullets, tabs, menu items till they see the one they want
- They don't have to recall them from memory having only briefly heard or seen them
- Sometimes a small number of items is good design
- But it depends on task and available screen estate

More appropriate application of memory research

- File management and retrieval is a real problem to most users
- Research on information retrieval can be usefully applied
- Memory involves 2 processes
 - recall-directed and recognition-based scanning
- File management systems should be designed to optimize both kinds of memory processes

File management

- Facilitate existing memory strategies and try to assist users when they get stuck
- Help users encode files in richer ways
 - Provide them with ways of saving files using colour, flagging, image, flexible text, time stamping, etc

Mental models

- 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 with 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 versus shallow models (e.g. how to drive a car and how it works)

Everyday reasoning & mental models

- (a) You arrive home on a cold winter's night to a cold house. How do you get the house to warm up as quickly as possible? Set the thermostat to be at its highest or to the desired temperature?
- (b) You arrive home starving hungry. You look in the fridge and find all that is left is an uncooked pizza. You have an electric oven. Do you warm it up to 375 degrees first and then put it in (as specified by the instructions) or turn the oven up higher to try to warm it up quicker?

Heating up a room or oven that is thermostat-controlled

- Many people have erroneous mental models (Kempton, 1996)
- Why?
 - General valve theory, where 'more is more' principle is generalised to different settings (e.g. gas pedal, gas cooker, tap, radio volume)
 - Thermostats based on model of on-off switch model

Heating up a room or oven that is thermostat-controlled

- Same is often true for understanding how interactive devices and computers work:
 - Poor, often incomplete, easily confusable, based on inappropriate analogies and superstition (Norman, 1983)
 - e.g. frozen cursor/screen - most people will bash all manner of keys

Exercise: ATMs

- Write down how an ATM works
 - How much money are you allowed to take out?
 - What denominations?
 - If you went to another machine and tried the same what would happen?
 - What information is on the strip on your card? How is this used?
 - What happens if you enter the wrong number?
 - Why are there pauses between the steps of a transaction? What happens if you try to type during them?
 - Why does the card stay inside the machine?
 - Do you count the money? Why?

How did you fare?

- Your mental model
 - How accurate?
 - How similar?
 - How shallow?
- Payne (1991) did a similar study and found that people frequently resort to analogies to explain how they work
- People's accounts greatly varied and were often ad hoc

External cognition

- Concerned with explaining how we interact with external representations (e.g. maps, notes, diagrams)
- What are the cognitive benefits and what processes involved
- How they extend our cognition
- What computer-based representations can we develop to help even more?

Externalizing to reduce memory load

- Diaries, reminders, calendars, notes, shopping lists, to-do lists - written to remind us of what to do
- Post-its, piles, marked emails - where placed indicates priority of what to do
- External representations:
 - Remind us that we need to do something (e.g. to buy something for mother's day)
 - Remind us of what to do (e.g. buy a card)
 - Remind us when to do something (e.g. send a card by a certain date)

Computational offloading

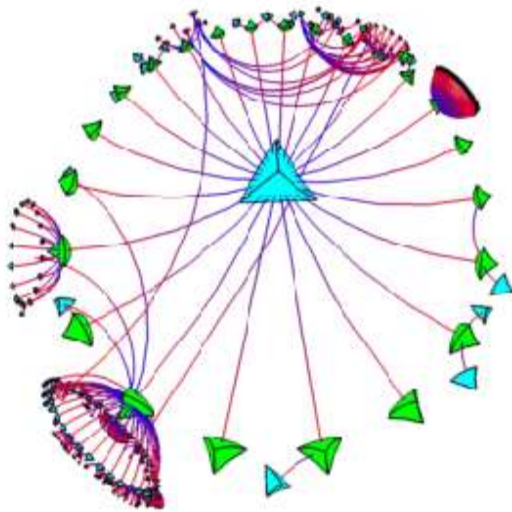
- When a tool is used in conjunction with an external representation to carry out a computation (e.g. pen and paper)
- Try doing the two sums below (a) in your head, (b) on a piece of paper and c) with a calculator.
 - $234 \times 456 = ??$
 - CCXXXIIII x CCCCXXXXXVI = ???
- Which is easiest and why? Both are identical sums

Annotation and cognitive tracing

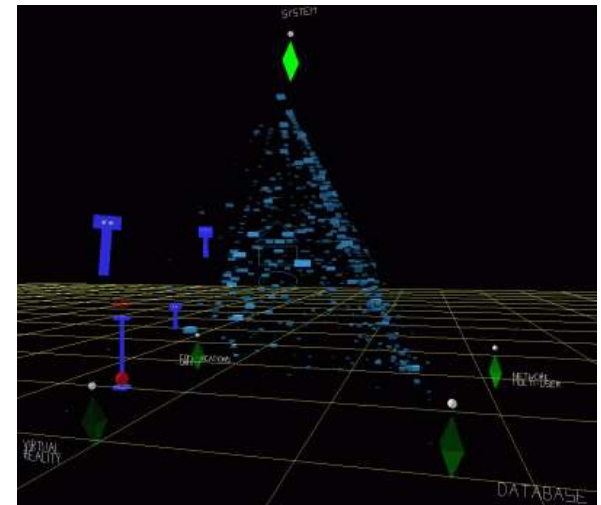
- Annotation involves modifying existing representations through making marks
 - e.g. crossing off, ticking, underlining
- Cognitive tracing involves externally manipulating items into different orders or structures
 - e.g. playing scrabble, playing cards

Design implication

- Provide external representations at the interface that reduce memory load and facilitate computational offloading



e.g. Information visualizations have been designed to allow people to make sense and rapid decisions about masses of data



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 & 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 can help them develop more appropriate mental models of system functionality
- For example, a design principle is to try to make systems transparent so people can understand them better and know what to do

The design principle of transparency



- NOT to be understood as literal
- useful feedback
- easy to understand
- intuitive to use
- clear & easy to follow instructions
- appropriate online help
- context sensitive guidance of how to proceed when stuck

Key points

- Cognition involves many processes including attention, memory, perception 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 framework of 'mental models' and 'external cognition' provide ways of understanding how and why people interact with products, which can lead to thinking about how to design better products