

# User-Centered Design and Development

Instructor: **Franz J. Kurfess**

Computer Science Dept.  
Cal Poly San Luis Obispo



# Copyright Notice

- These slides are a revised version of the originals provided with the book “Interaction Design” by Jennifer Preece, Yvonne Rogers, and Helen Sharp, Wiley, 2002.
- I added some material, made some minor modifications, and created a custom show to select a subset.
  - Slides added or modified by me are marked with my initials (FJK), unless I forgot it ...

# 484-W09 Quarter

- The slides I use in class are in the Custom Show "484-W09". It is a subset of the whole collection in this file.
- Since the time for lectures in week 3 is very short due to the UCD tools presentations, I'm using only a very small subset from this chapter.

# Chapter 3

## Understanding Users

# Chapter Overview

- Cognition
- Physical world vs. digital world
- Conceptual frameworks for cognition
  - mental models
  - information processing
  - external cognition

# Motivation

- Well-designed user interfaces and user interactions require an understanding of the way users think and feel with respect to the product
- Cognitive science provides some models and other hints that can be used for interaction design.
- Different types of cognitive approaches may be appropriate for different users, situations, or tasks.

# Objectives

- Become familiar with some concepts from cognitive science that help with the design of user interaction.
- Identify the appropriate cognitive model for a particular task, user, or situation.
- Know when to transfer knowledge about interaction in the physical world to the digital world.
- Utilize methods and principles from cognitive science and related fields to improve interaction design.



# Understanding users



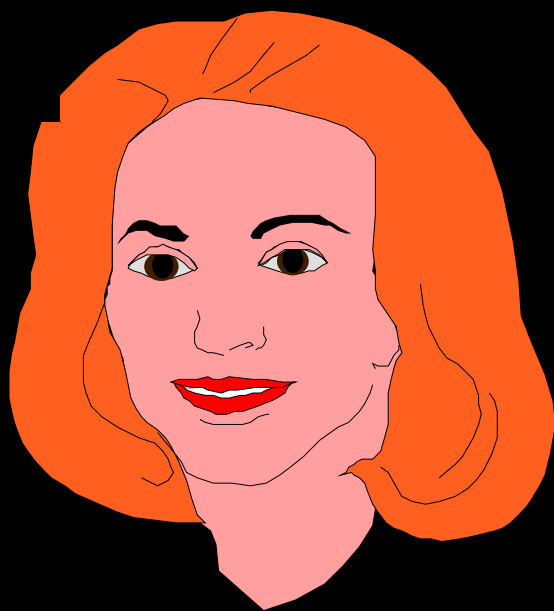


# Overview

- 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



# 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
  - percepts contain many potential items of interest
  - at a given point in time
- Focussed and divided attention
  - enables us to be selective
  - competing stimuli
  - limits our ability to keep track of all events
- Information provided at the interface
  - structured to capture the attention of users
    - use perceptual boundaries (windows), **color**, 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
  - color, ordering, spacing, underlining, sequencing and animation
- Avoid cluttering the interface
  - crisp, simple design
    - e.g. [google.com](http://google.com)
- Avoid using too much
  - just because the software allows it

# An example of over-use of graphics



**Our Situation**

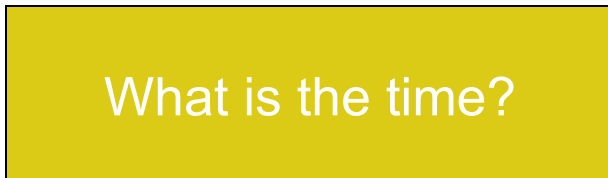
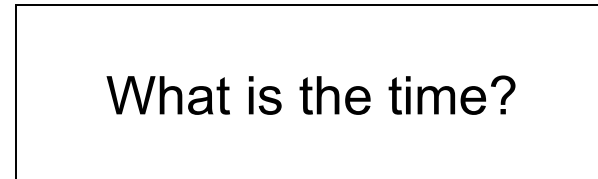
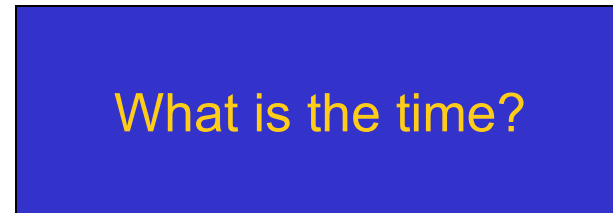
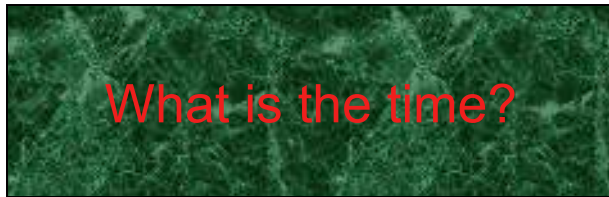
- u State the bad news
- u Be clear, don't try to obscure the situation

# Perception and Recognition

- Information acquisition
  - collection percepts about the world
  - transformation into experiences
- Design representations that are readily perceivable
  - 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
- Recognition over recall
  - We recognize familiar things much better than being able to recall these things
  - GUI vs. command-based interfaces
- Better at remembering images than words
  - use of icons rather than names
  - interpretation of icons can be problematic

# The Classic ' $7\pm2$ '

- George Miller's theory of how much information people can remember
  - $7\pm2$  "chunks" of information
- People's immediate memory capacity is very limited
  - short-term memory
  - not under conscious control
- Implications for interaction design
  - relevant for some aspects, but not others
  - prone to oversimplification

# 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
- Scanning vs. recalling
  - People can scan lists of bullets, tabs, menu items until 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
  - depends on task and available screen estate

# 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
  - visual option
  - text-based, command-line option

# File Management

- User support
  - facilitate existing memory strategies
  - try to assist users when they get stuck
  - enforce or encourage consistency
- Organization
  - multiple ways of organizing and presenting files and their properties
  - color, flagging, image,
  - flexible text, time stamping, etc

# Mental models

- User's understanding of a system
  - through learning and using it
- Knowledge capturing
  - often done through 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)
- Using mental models
  - inferences about how to carry out tasks
  - expected outcomes of actions



# History of Mental Models

- Craik (1943)
  - internal constructions of some aspect of the external world
  - enables predictions to be made
- Involves unconscious and conscious processes
  - where images and analogies are activated
- Deep versus shallow models
  - how to drive a car
  - how it works

# Everyday Reasoning and 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?
- thermostat
  - radiator dial
  - wood-burning stove
- (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)
  - general valve theory
    - 'more is more' principle is generalised to different settings (e.g. gas pedal, gas cooker, tap, radio volume)
  - on-off switch model
  - measured vs. perceived temperature
  - translation from dial markings to comfort level

# 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

- Interaction with external representations
  - physical
    - maps, notes, diagrams ...
  - digital
- Cognitive benefits
  - what processes are involved
  - how do they extend our cognition
- Computer-based representations
  - can offer additional support
  - multiple representations, explanations, legends, memory aids, ...

# 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
    - to buy something for mother's day
  - remind us of what to do
    - buy a card
  - remind us when to do something
    - send a card by a certain date



# Activity: Examples of External Cognition Support

- identify cases where you use computers as tools for external cognition support

# Computational Offloading

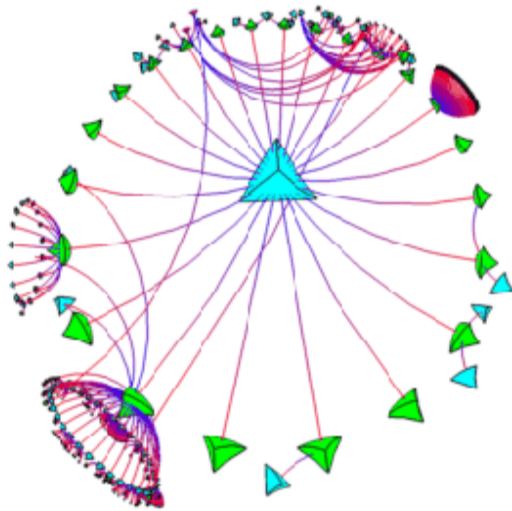
- Tools
  - a tool is used in conjunction with an external representation to carry out a computation
    - pen and paper
- Try doing the two sums below (a) in your head, (b) on a piece of paper and c) with a calculator.
  - $234 \times 456 = ??$
  - CCXXXIIII  $\times$  CCCCXXXXXVI = ??
- Which is easier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

# Annotation and Cognitive Tracing

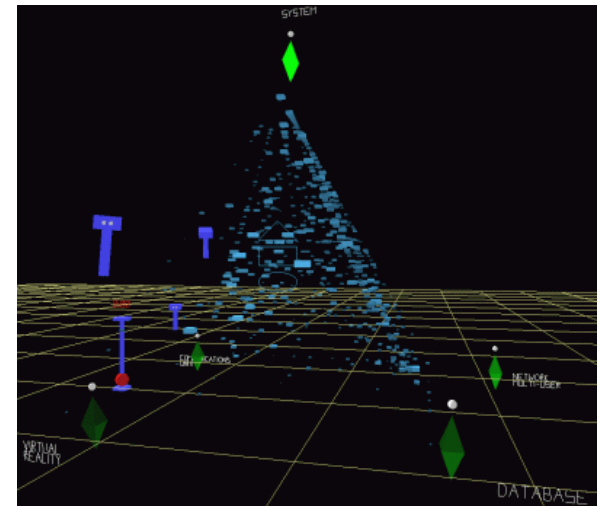
- Annotation
  - modification of existing representations through making marks
  - e.g. crossing off, ticking, underlining, highlighting
- Cognitive tracing
  - external manipulation of items into different orders or structures
  - e.g. playing scrabble, playing cards

# Design Implications

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



Information visualizations for quick interpretation and decision making



# 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

- mental models and conceptual models
  - mental models of users may not be accurate or explicit
- emergent mental models
  - understanding how people develop mental models can be used to design interfaces and interactions appropriately
  - users can easily develop accurate models
- transparency design principle
  - people can understand systems better
  - they know what to do via their mental model

# The design principle of transparency



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

# 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
- 'Mental models' and 'external cognition'
  - provides ways of understanding how and why people interact with products
  - can be used to design better products