CS1092 Object-Oriented Programming with Java

HCI: Human Computer Interaction

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School of Computer Science

Semester 2, 2004-2005

Introduction

Humane Computer Interaction (HCI)

- Two lectures
- . . . probably the most important two lectures in CS1081/CS1092
- . . . and nothing to do with Java programming!!
- Long-term, multi-disciplinary, active area of research, e.g. some old references (from Johnson):
  - Bartlett (1932!) : Remembering: A Study in Experimental and Social Psychology
  - Miller (1956!!): The magical number seven, plus or minus two
  - Broadbent (1958): Perception and Communication
  - Garner (1974): The Processing of Information and Structure

Supporting Material

- Johnson, P (1992): HUMAN-*computer* INTERACTION

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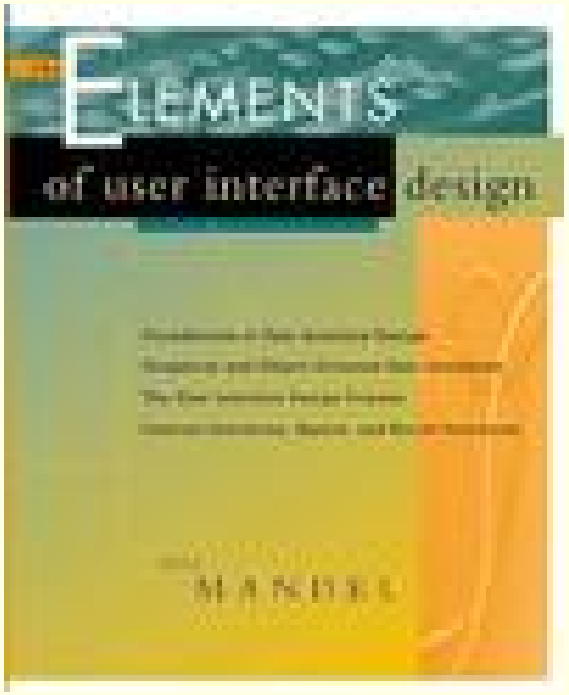
- Acknowledgments: Roger Hubbold; Robert Stevens (CS2341)



(publisher: Wiley)

Two Lectures: Contents

- What is HCI?
- Mainly Human (not so much Computer)
- Interaction
- Evaluation
- Experiments
- Case Studies
- Guidelines

What Is HCI?

HCI (Human Computer Iteration) is:

- "the study of the interaction between people, computers and tasks" (Johnson)

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  and so it goes on" (Dix et. al)
- i.e. Teamwork and a recognition of non-Computer Science specialisms

Hmm . . . perhaps not so helpful

"Psychologists have enough trouble understanding people even when they are not using computers;

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computer scientists have enough trouble getting programmes [sic] to work even when they are not being used by people."
(Thimbleby)

- Computer-Computer Interaction
  - well-defined protocols (e.g. TCP/IP)
  - restricted
  - no margin for ‘error’
- Human-Human Interaction
  - the ideal form of interaction?
  - evolving
  - informal
  - error-prone, but corrective

Background

Human-Computer Interation

- Human: User's Conceptual Model (UCM) — **very important!**
- Computer:
  - limited by technology
  - designed by a Human
    (the Designer's Conceptual model?)
- So is it really Human-Human Interaction 'by proxy' after all??
- Study of task
- Evaluation of interfaces (experimentation)
- Design Guidelines

UI design must be an integral part of system design process, not a last-minute add-on.

Why is the study of HCI important?

- Evolving International Standards (EC Directive 90/270/EEC; ISO 9241)
- Understanding of users (Mandel...)
- Effective: fit for task
- Learnable and Usable
- Aesthetic Experience
- Mutable: task and user
- Accuracy and reliability
- Productivity (Thimbleby...)
- Managing Complexity
- Safety and Security

Some Interfaces

- PC/laptop
- Washing machine
- MiniDisk
- Mobile
- Remote control
- Industrial plant
- Car
- iPod and iPod shuffle
- Motorway roadsigns!


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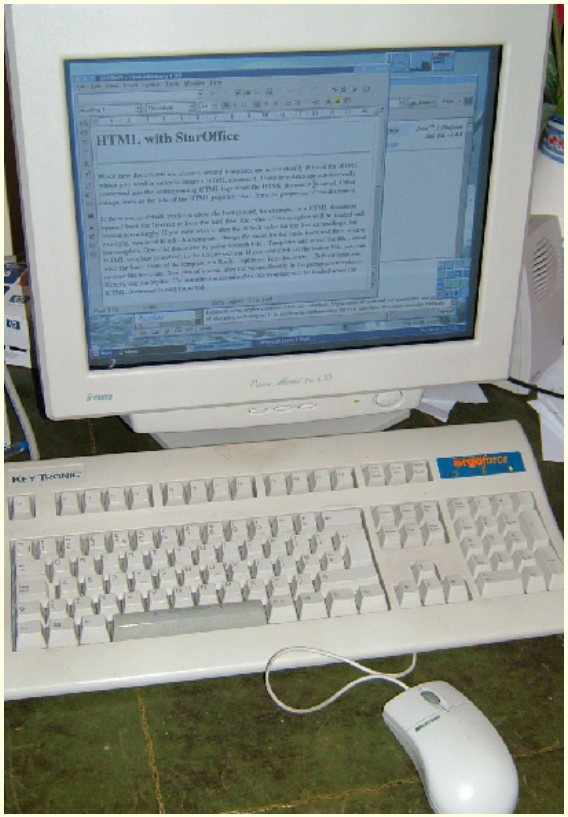
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GeForce


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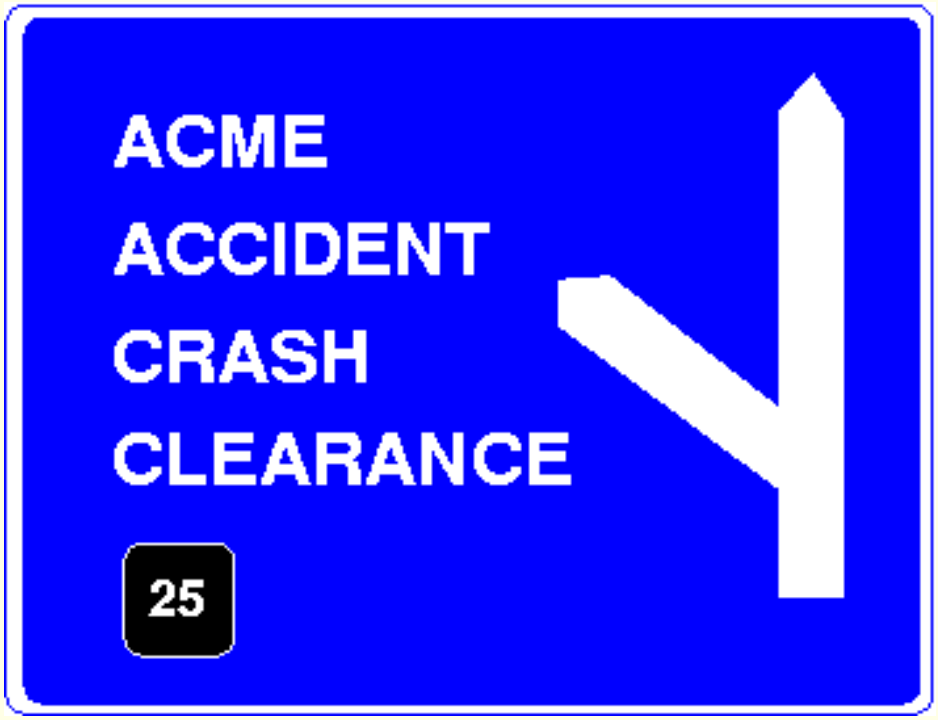
Motorway roadsigns

http://www.highwaycode.gov.uk/signs_index.htm
http://www.highwaycode.gov.uk/sign136.htm

No other roadside signs allowed on motorway

But still permitted in adjacent land — danger of interference:



The Human

- User's Conceptual Model (UCM)
  - skills, knowledge and prior experience
  - metaphors
  - patterns
  - associations
- Humans make mistakes
- . . . change their minds
- . . . are inconsistent
- . . . not good at quickly solving problems
- . . . forget things
- . . . overlook things

- BUT Humans are adaptable and able to learn
- Different kinds of users
- Different kinds of tasks
- UI design must account for Humans!

Human Memory: Model Human Processor

- Developed and tested via numerous experimental studies
- Card, Moran, Newell (1983) The Psychology of Human-Commuter Interaction
- A simple 'computer' architecture:
  - Perceptual processor + memory
  - Short-term memory (STM)
  - Cognition processor: rehearsal
  - Long-term memory (LTM): episodic and semantic
- each has capacity, operating speed etc

Perceptual processor:

- 200ms decay
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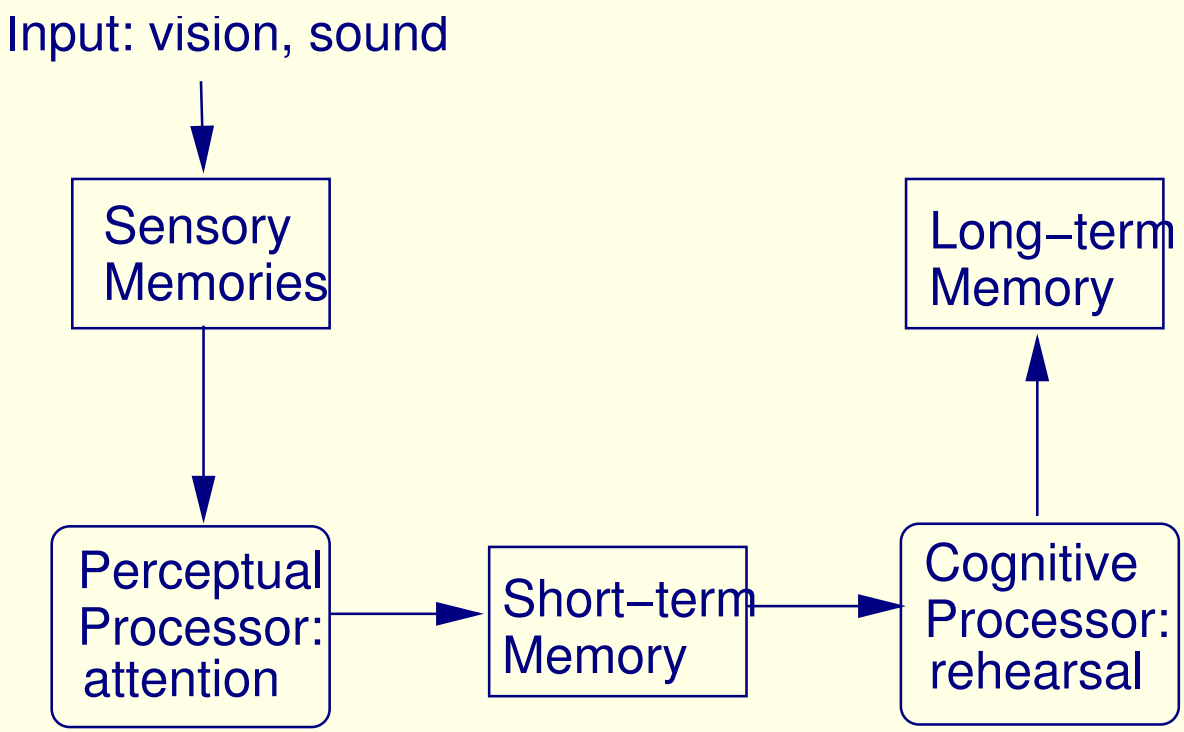
Short-term Memory (STM)

- limited capacity: 7 (plus or minus 2) items
- decay: a few seconds
- recency
- chunking: make the 'items' bigger

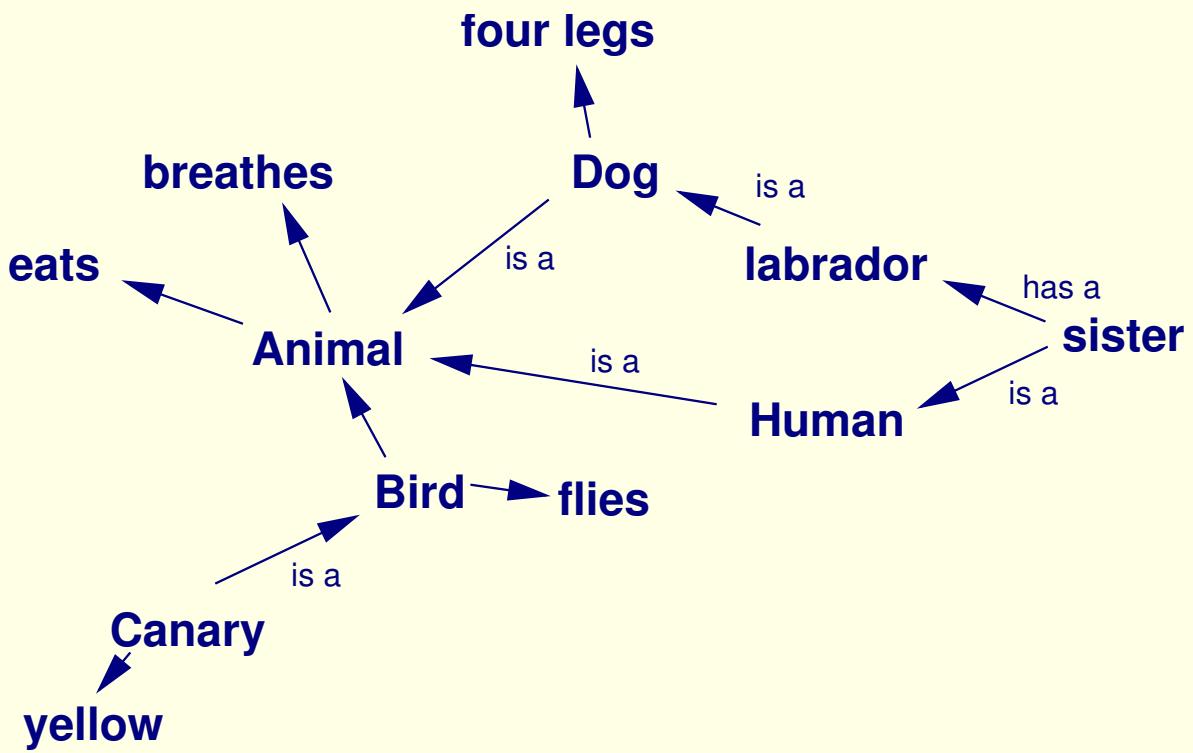
Long-term Memory (LTM)

- limitless capacity?
- no decay?? (but imperfect retrieval)
- semantic networks
- reasoning
- recall vs recognition
- association; priming; gist
- interference

Model Human Processor



Semantic Network



Evaluation

- Observations
- Interviews
- Experiments:
  - What to measure?

    efficiency, learning, errors, aesthetics
  - How to measure it?

    during or after design?

    prototyping
  - Sound experimental methodology: how to obtain meaningful, reliable results

Models:

- Task Action Grammar (TAG): to describe interaction sequences
- State Transition Networks
- Process algebras; temporal logics
- Keystroke-level models, e.g. Fitts' Law
- Guidelines: distillation of design and experimental results

Fitts' Law

$$T_{move} = a + blog(D/S + 1)$$

D: distance to move S: size of target

In other words, to reduce time taken:

- Small movement
- Big target

. . . or just use the keyboard and do not use the mouse at all??

Heuristic Evaluation — Nielsen's 10 heuristics:

1. Visibility of system status
2. Match between system and the real world
3. User control and freedom
4. Consistency and standards
5. Error prevention
6. Recognition rather than recall
7. Flexibility and efficiency of use
8. Aesthetic and minimalist design
9. Errors: recognise, diagnose and recover
10. Help and documentation

(Dix et al.)

Command-Line interfaces: Advantages

- quick and powerful for experienced users
- user-controlled interaction
- minimal amount of typing (no mouse use)
- can be used in conjunction with other user interfaces (see below)

Disadvantages

- little or no prompting
- requires user's knowledge of system, programs
- relies on recall of commands and syntax
- difficult to learn
- error prone

(Mandel)

Menu interfaces: Advantages

- Users don't have to memorize complex commands
- Structured navigation benefits novices and casual users
- Can shorten user learning time and effort
- Supports recognition memory

Disadvantages

- May not be appropriate or efficient for some users and tasks
- Can force user through many levels of menus
- Users may get lost in menu hierarchies
- Menu terms and names may not be meaningful to users
- Use of modes forces users to follow the system's path

(Mandel)

Example: Visual Appearance

E.g. Use Colour with care (obvious, right?!):

Here is some text where the choice of colour is not ideal — a good thing it does not say anything too important!

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the background to increase the contrast. . .

But what if it is viewed in black and white?

Think carefully about this

Interface Design Examples

1. WWW
2. Interesting Metaphors
3. Text-processing: (emacs + LaTeX+ xfig +...) vs Word
4. Lab mark processing: ARCADE vs Excel

"My simple text editor was no longer a tool that could provide the functional capability or the interface for the tasks ... to finish the book"

(Mandel, p20)

The World-Wide Web

One of the most important developments ever, but leading to some of the worst user interfaces ever!

- Broken links
- Broken pages (browser version-dependent)
- Slow upload
- Underlining of non-links
- New browser pane pop-up
- Distracting visuals
- Poor layout; poor appearance (colour, font style/size)
- Interactive: having to repeat information (e.g. travel dates required)
- Forms: choices in poor order, or unavailable

Interesting Metaphors

- the desktop itself: windows, folders
- buttons (with suggestive icons), sliders
- icons: waste basket, mailbox, printer, scissors
- *visiting* a website (you're not going anywhere!)
- *downloading* an email attachment (it's already there in the message, just hidden!)

emacs + LaTeX

```
\begin{mscslide}{Interface Design Examples}
\begin{enumerate}
\item WWW
\item Interesting Metaphors
\item Text-processing: (emacs + \LaTeX + xfig +\ldots) vs Word
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the book''
\end{center}

(Mandel, p20)
\end{mscslide}

\endinput
```
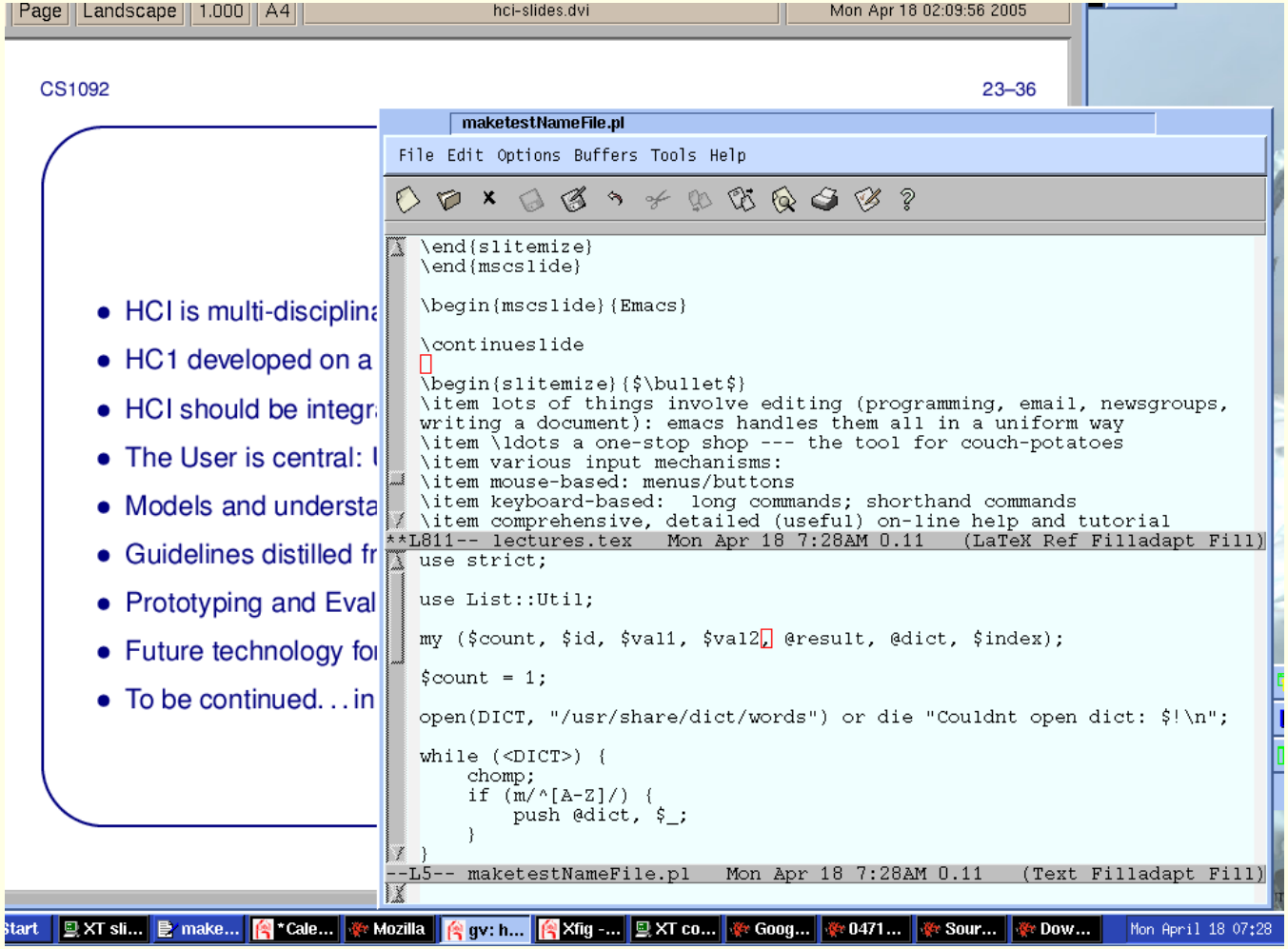

emacs + LaTeX

- a different paradigm from Word
- separation of content-editing and formatting
- concentrate on task at hand
- formatting commands embedded in ASCII-text file
- LaTeX is extensible — ease of global style changes; takes care of formatting as document is changed (e.g. placement of graphics on relevant physical page)
- automatic processing (indexing; sectioning; lists; references)

Emacs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CS1092 23–36
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HCI should be integr
The User is central: I
Models and understa
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Prototyping and Eval
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\begin{slitemize}{$\bullet$}
\item lots of things involve editing (programming, email, newsgroups, writing a document): emacs handles them all in a uniform way
\item \ldots a one-stop shop --- the tool for couch-potatoes
\item various input mechanisms:
\item mouse-based: menus/buttons
\item keyboard-based: long commands; shorthand commands
\item comprehensive, detailed (useful) on-line help and tutorial
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use strict;
use List::Util;
my ($count, $id, $val1, $val2, @result, @dict, $index);
$count = 1;
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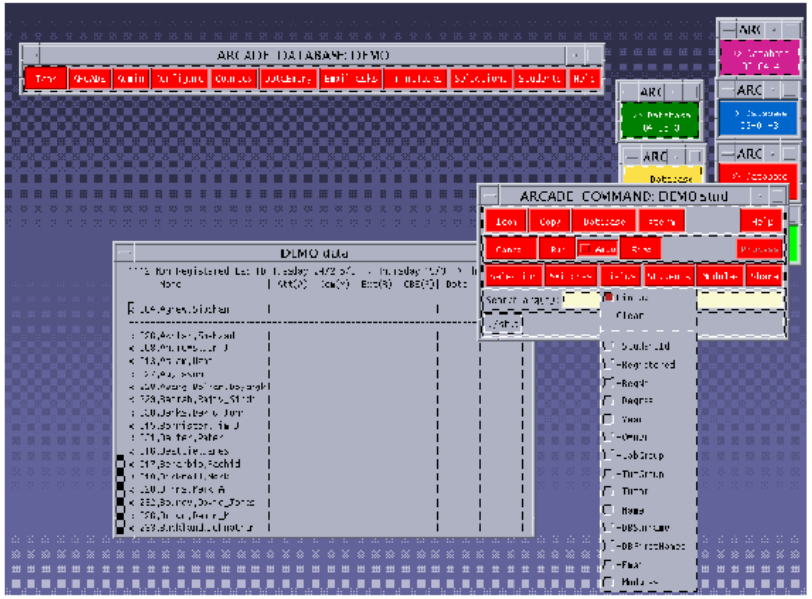
- lots of things involve editing (programming, email, newsgroups, writing a document): emacs handles them all in a uniform way
- . . . a one-stop shop — the tool for couch-potatoes
- various input mechanisms:
- mouse-based: menus/buttons
- keyboard-based: long commands; shorthand commands
- comprehensive, detailed (useful) on-line help and tutorial
- undo; auto-save; auto-backup
- suitable from novice to expert
- customizable
- different modes support editing (e.g. of LaTeX files)
- kitchen sink icon says it all. . .

ARCADE



- supports precise modelling of real-life labs + exercises
- originally text-based (TUI); now GUI as well
- lots of commands; lots of switches and options — difficult to remember
- . . . but fantastic for using with shell scripts
- automatically generated GUI add-on, collecting together tools
- consistent layout
- privilege-dependent GUI configuration
- tools may appear in several menus
- provides way of presenting options
- different users work in different ways (JTL/AlaW)
- Example: Data input: highly optimized interface, lots of automation to facilitate fast and accurate input
- change history (who did what, when); undo; backup
- constraints: only valid input accepted (e.g. marks/dates)
- audio support (studentIds)

Guidelines

Shneiderman's 8 Golden Rules:

1. Consistency
2. Shortcuts for frequent/trained users
3. Provide informative feedback
4. Design dialogues to yield 'closure'
5. Error prevention and handling
6. Easy reversal
7. Internal locus of control
8. Reduce short-term memory load

(Dix et al.)

Other Guidelines:

- Think ‘user’; place users in control:
  - use modes carefully
  - flexibility (e.g. keyboard, mouse)
  - meaningful and immediate feedback
  - accessibility for users with different requirements and skill levels
  - customization
- locale; internationalisation
- Make interface consistent
- Try it out: iteration and prototyping
- Involve the users: they are central

- Reduce Memory Load
  - recognition rather than recall...
  - ...but allow shortcuts
  - inform; visual clues
  - accurate use of real-world metaphors
  - undo, redo, defaults: engineer for user 'errors'
  - visual clarity
  - progressive disclosure

- From Experiments:
  - 'chunk' data, e.g. group menu items
  - limit data, e.g. keep menus/options short
  - consistency, e.g. keep menus in same place/order
  - appearance of graphical objects, e.g. visually indicate 'pressing' of button

(Dix et al.; Mendel)

Look at Guidelines: Apple, Microsoft, IBM...

Summary

- HCI is multi-disciplinary
- HC1 developed on a large body of scientific work
- HCI should be integral to system design

The User is Central: User's Conceptual Model

- Models and understanding of users important
- Guidelines distilled from scientific work can be useful

Prototyping and Evaluation

- Future technology for interfaces

  e.g. virtual reality; 3D; audio

This story is to be continued. . . in the 2nd Year (CS2341 etc)

Some Experiments

1. How Quick Can you Txt? (Interface Design)
2. Spot the Difference (Change Blindness)
   `http://www.psych.ubc.ca/~rensink/flicker/`
3. Remembering Numbers (Chunking)
4. Remembering a Story: Where is McDonald's? (Gist)
5. Remembering Lists of Things (Memory Models)
6. ABC (Association)
7. Opposites (Association)
8. Direction (Flawed Communication)
   `http://www.rvs.uni-bielefeld.de/`
   `publications/Incidents/DOCS/FBW.html`

Question: What implications do these experimental results have for your HCI design??

Oh, and did you spot the typos in ‘Human-Computer Interaction’ or ‘HCI’?