External Design: Human Factors and User Interface

Not half of what you need to know, but better than nothing

We know a few things ...

from psychology and human factors research

- Characteristics of human memory
- Characteristics of perception
- Problem solving behavior

Human Memory

- Short-term memory
  - Fast but very small (5 +/- 2 items)
  - Does not last long
- Long-term memory
  - Very large, but slow
    - retrieval time and difficulty depends on frequency of use
    - some tasks are harder than others (e.g., recall vs. recognition)
  - Highly organized: users discover and exploit rules
- Usable designs minimize memory “load”

Frequency of Use

- Consider two users of an airline reservations system
  - Professional travel agent: Uses the system every day, for hours at a time
  - Traveler with an online account (EZ-Sabre, etc.): Uses the system less than once a week
- Frequent user can memorize commands
  - Optimize for few keystrokes, short command sequences, few transaction waits
- Infrequent user will not memorize

Know Your User

The first and most important principle of interface design

- User characteristics
  - Novice or expert?
  - Frequent or infrequent user?
- Make appropriate tradeoffs
  - Ease of learning vs. ease of use
  - Helpfulness vs. speed

What Does Your User Know?

- Frequent mistake: Assuming the user knows what you know
  - Seen a lot in project 1, e.g., documents that don't mention how to start the program
- Remedies:
  - Observe untrained users (and not yourselves)
    - Really observe: Diagnose their mistakes
  - See the system through their eyes
    - A supplement, not a replacement for real observation

Recognition vs. Recall

A— Can you name all the nations of Europe?

B— Is Luxembourg a nation in Europe?

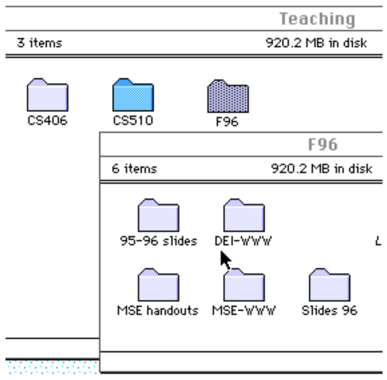
- B is easier than A because recognition is easier than recall
- So: We should replace recall tasks with recognition tasks

Replacing Recognition with Recall

- Most important for
  – Novice users
    - Mainly because they have fewer clues for guessing
  – Infrequent users (even experts)
    - Long-term memory, e.g. of commands, depends on frequency of use
    - Very frequent users can and will memorize
      – from use, not from a user manual; disclose shortcuts during normal operation
  – Information that changes
    - ex: file names

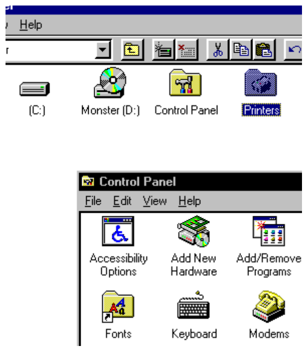
Visual Representation of State

Example: Folder Display on Mac Desktop



- Finder displays folder contents
- Icon indicates state (Open or Closed)
- Window bar indicates currently active window
- But ...
  - this snapshot was saved as a file that was not visible on the desktop

Visual Representation of State (Oops, Microsoft blew it)



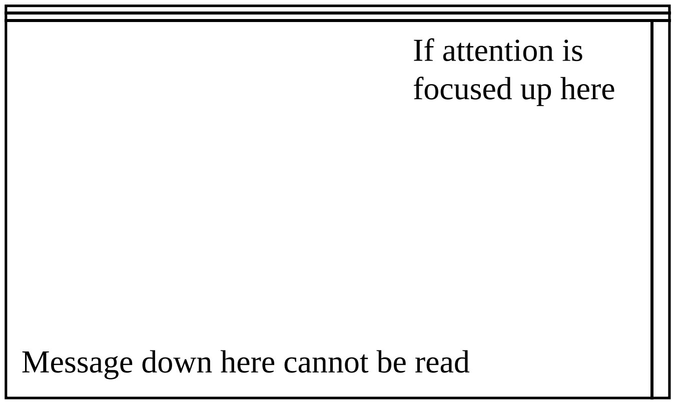
- Windows95 desktop looks almost like a Macintosh
  - but doesn't behave like it
- Open/closed state of folder is not indicated by folder icon
- Result: User mistakes
  - Attempting to open folders that are already open
- But ...
  - At least the snapshot was saved like cut-and-paste selections

Perception

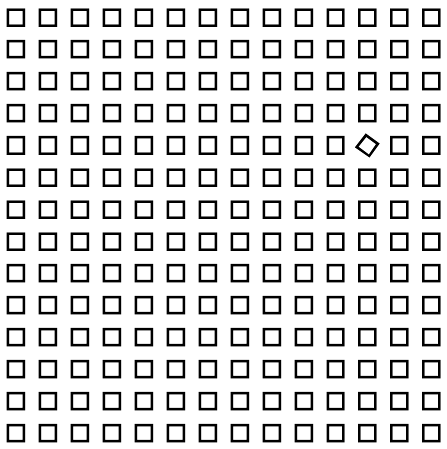
- Visual perception is excellent for patterns and variations
  - But hearing is much faster
- Visual perception has a narrow “fovea”
  - Wide field of view is partly an illusion; we see details outside the fovea only by shifting attention
  - Shifting the fovea is “expensive” in effort and lost concentration

Designing for the Fovea

- Avoid scattering detail information


If attention is focused up here
Message down here cannot be read

Patterns and Attention



- People are very good at focusing on variations and ignoring regularity
  - Avoid “noise”
  - Use variation or change to draw attention (but only when needed)

Feedback

- Another aspect of reducing memory load
  - Principle: User should never need to remember or guess the current state
  - Techniques
    - Maintain a visual representation of state
      - e.g., screen editor vs. line editor
    - ☞Acknowledge every user action immediately
    - ☞For long operations, provide progress indicators

Time
Response time requirements don't have to be arbitrary

- 30hz or better looks continuous
  - Not important just for video — e.g., consider drawing with the mouse
- 10hz or better seems "immediate"
  - All forms of "echo" should take less than 0.1 second, including keystrokes and (graphic) button pushes
- Attention shifts in approximately 1 second
  - User speed and accuracy falls rapidly when response exceeds 1 second

Ears are faster than eyes!

- Sound is under-used in interface design
  - Mostly for gaining attention, or just for entertainment
- If very fast temporal patterns are required, sound is our most developed sense
  - Both for minimum relative spacing, and for complex temporal patterns

Making Difficult Tasks Simple

- Seven principles from *The Design of Everyday Things*, Donald A. Norman, 1988 (ISBN 0-385-26774-6)
    - Use both knowledge in the world and knowledge in the head
    - Simplify the structure of tasks
    - Make things visible: bridge the gulfs of Execution and Evaluation
    - Get the mappings right
    - Exploit constraints, both natural and artificial
    - Design for error
    - When all else fails, standardize

Knowledge in the world

- “Affordances” indicate how to use things
    - Example: shape of door handle says “push” or “pull”
        - If it needs a label, it is badly designed
- How to use an object should be obvious
    - If it looks like a button, push it!
- Constraints prevent mistakes
    - ☞Ex., “greying out” inapplicable commands

Permissive vs. Preemptive

- Principle: The user should be in charge
- Permissive interfaces allow the user to choose any sensible next action
- Preemptive interfaces restrict choice
- Example:
  - Enter file name: ls

Avoiding Preemption

- Commands instead of prompts
  - or in addition
- Multiple contexts (e.g., windows)
- Postfix syntax (esp. with mouse)
- Limit modes

Modes

A mode *is a state that lasts for a period of time, is not associated with a particular object, and has no role other than to place an interpretration on operator input.*
(Larry Tessler)

- Example: vi is a “modal” editor because the *insert* and *command* modes place an interpretation on keyboard input (e.g., “j”).
- Drawing program “tools” are usually modes

Modes are Sometimes O.K.

- *Modes are sometimes useful*
  - Long term (mode ≈ program)
    - choosing an appropriate conceptual model or metaphor
  - Short term — allows shorter commands
- Modes can be ok if:
  - preemption is minimal
  - easy exit
    - Mode in restricted context (e.g., window)
    - spring-loaded modes
  - Clear visual indication of mode
    - Example: cursor shape

Principle of Least Astonishment

- Consistency is difficult to design, but you know you have achieved it when users make the right guesses
  - Rules should be few and general
  - Use clues from non-computer context when appropriate (metaphor)

Recommended reading

- D. Norman, *The Design of Everyday Things*
- N. Borenstein, *Programming as if Users Mattered*