Human Information Processing (Perception)

CS160: User Interfaces

Maneesh Agrawala

Android Assignment

Due today

Assignment (due Mar 11)

Low-Fidelity Prototype

- Identify project mission statement
- Create low-fidelity prototype that supports 3 tasks
  - 1 easy, 1 moderate, 1 difficult task as found in the last assignment
- Test the prototype with target users
  - No one from this class
  - Not your friends

Review: Creating Lo-Fi Prototypes

Set a deadline

- Don't think too long - build it!

Draw a window frame on large paper

- **Draw at a large size, but use correct aspect ratio**

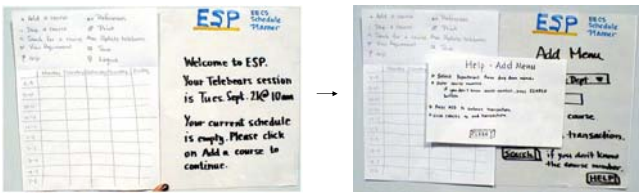
Put different screen regions on cards

- Anything that moves, changes, appears/disappears

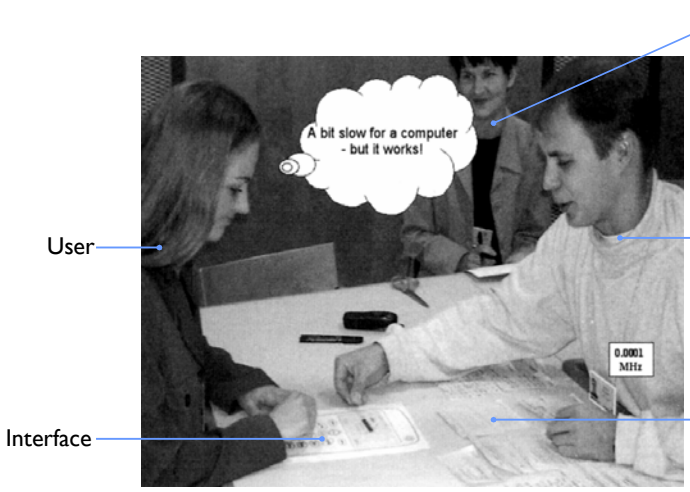
Ready response for any user action

- e.g., Have those pull-down menus already made

Use photocopier to make many versions



Review: Testing Prototypes



Review: Exercise

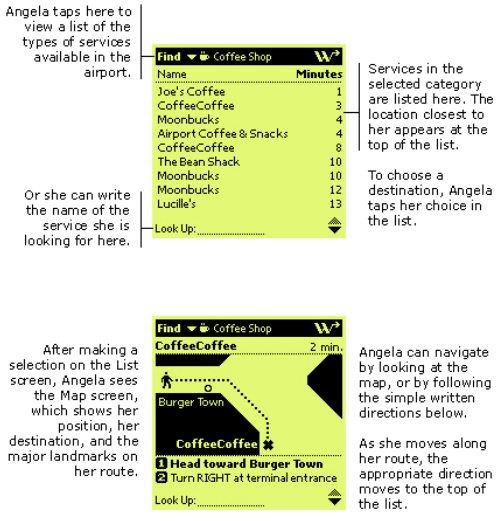
Target persona: Angela, ~31, business traveler
- Wants to travel without hassle
- 30 minute layover in unfamiliar airport
- What might she want to do in this time?
- What kind of interface would support her tasks?

Contraints
- PDA/Smart phone class hardware
- Wireless infrastructure available
- Low resolution location information available

Your Tasks
- Brainstorm about Angela's goals
- **Create an initial low fidelity prototype**
- **Debug interface with users from another group**
  - **Does the interface meet Angela's needs?**
  - **Is the interface hassle-free?**
  - **Is the interface confusing or difficult?**

Cooper Design's storyboard

Solution from Cooper Design



Topics

- The Model Human Processor
- Memory

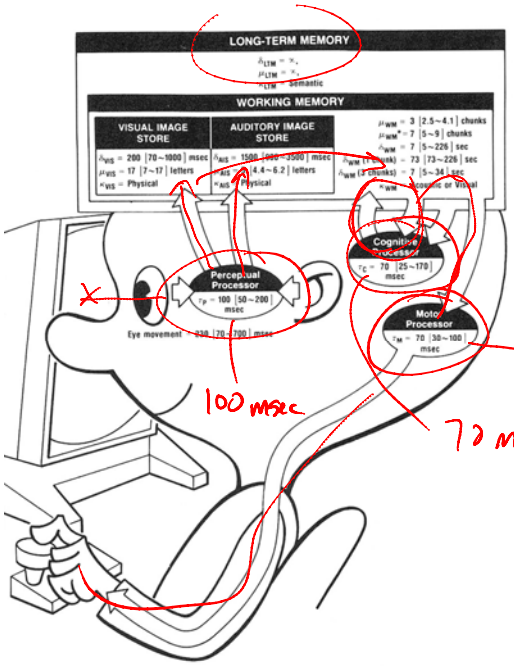
The Model Human Processor

Why Model Human Performance?

Why Model Human Performance?

To predict impact of new technology/interface

- Apply model to predict effectiveness
- We could build a simulator to evaluate user interface designs



Human Info. Processor
- Perceptual
- Cognitive
- Motor (will discuss later)
- Working memory
- Long-term memory

Unified model
- Probably inaccurate
- Predicts perf. well
- Very influential

$\delta = 200$ msec

δ_{WM} (1 chunk) = 73 sec

$\delta = \infty$

Perceptual Processor

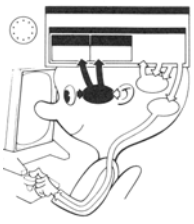
Physical store from our senses: sight, sound, touch, …
- Code directly based on sense used
  - Visual, audio, haptic, … features

Selective
- Spatial
- Pre-attentive: color, direction…

Capacity
- Example: 17 letters

Decay 200ms

Recoded for transfer to working memory
- Progressive: 10ms/letter



How many 3's

```
12817687561389765469845069856049828267 62
98098584582245098564589450984509809435 85
90910302099059595957725646750506789045 67
88457898098216776548763649085609129496 86
```

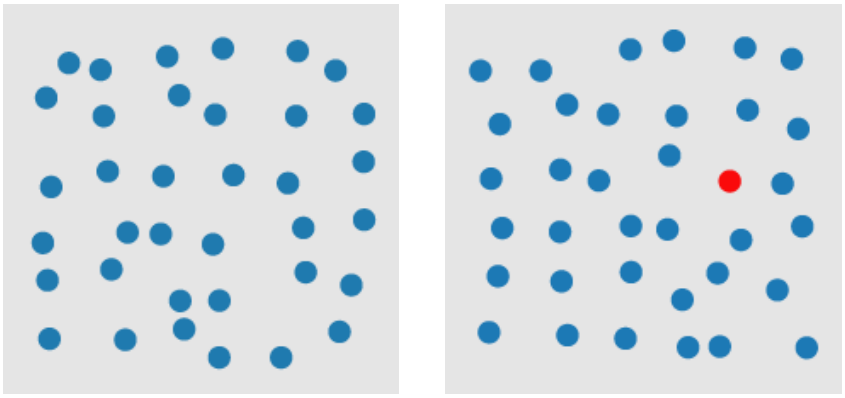
[based on slide from Stasko]

How many 3's

```
12817687561389765469845069856049828267 62
98098584582245098564589450984509809435 85
90910302099059595957725646750506789045 67
88457898098216776548763649085609129496 86
```

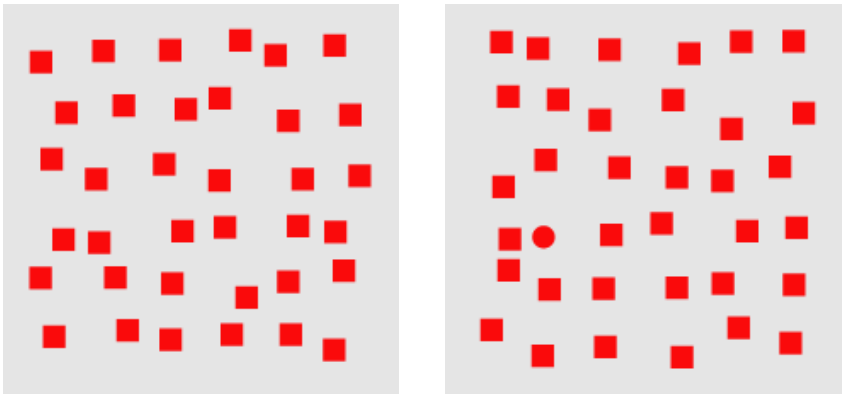
[based on slide from Stasko]

Visual Pop-Out: Color



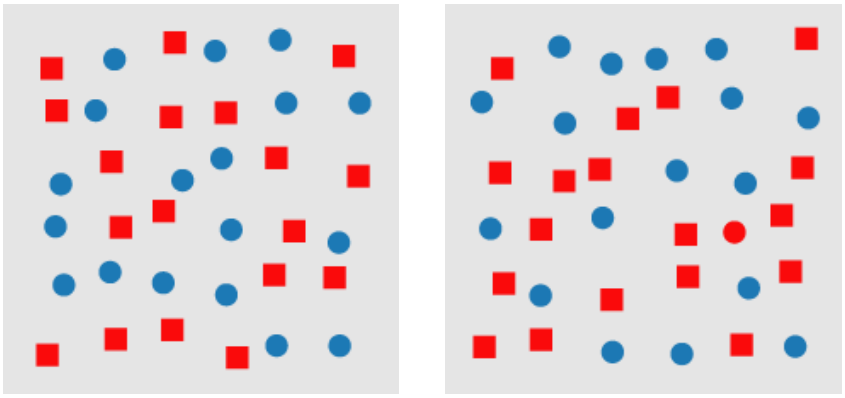
http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Visual Pop-Out: Shape



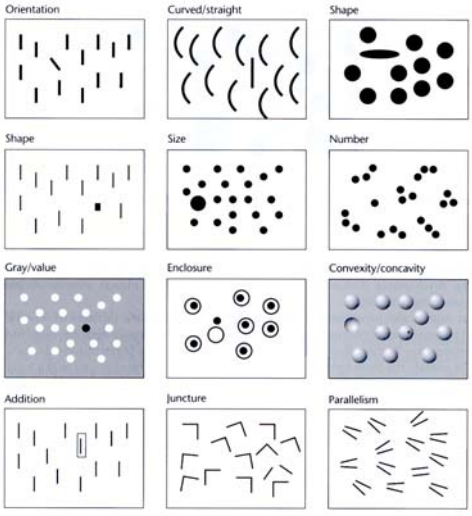
http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Feature Conjunctions



http://www.csc.ncsu.edu/faculty/healey/PP/index.html

Preattentive Features

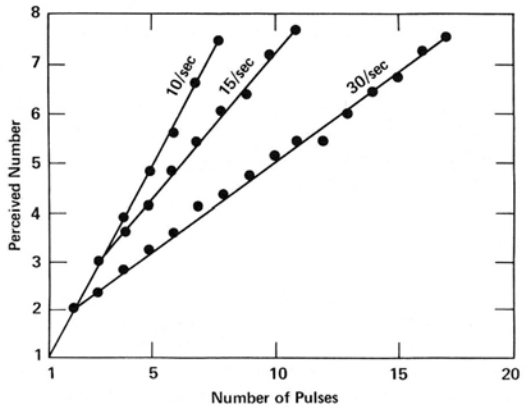


[Information Visualization. Figure 5. 5 Ware 04]

Perceptual Processor

Cycle time

- Quantum experience: 100ms
  - Percept fusion



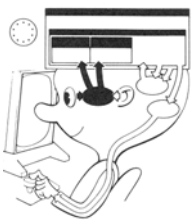
Perceptual Processor

Cycle time

- Quantum experience: 100ms
  - Percept fusion
- Frame rate necessary for movies to look continuous?
  - time for 1 frame < Tp (100 msec) -> 10 frame/sec.
- Max. morse code rate can be similarly calculated

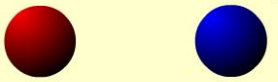
Perceptual causality

- Two distinct stimuli can fuse if the first event appears to *cause* the other
- Events must occur in the same cycle



Perception of Causality [Michotte 46]

Michotte demonstration 1. What do you see? Most observers report that "the red ball **hit** the blue ball." The blue ball moved "**because** the red ball hit it." Thus, the red ball is perceived to **"cause"** the blue ball to move, even though the balls are nothing more than color disks on your screen that move according to a programme.

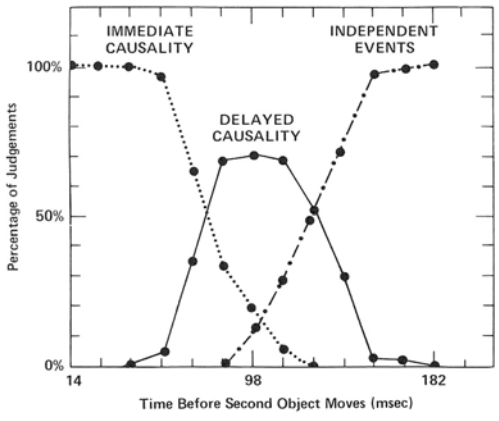


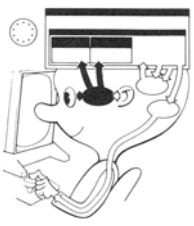
http://cogweb.ucla.edu/Discourse/Narrative/Heider_45.html

Perceptual Processor

Cycle time

- Quantum experience: 100ms
  - Causality

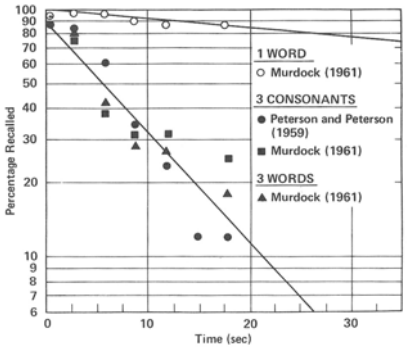


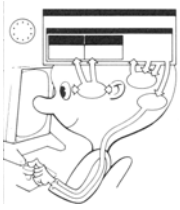


Working Memory

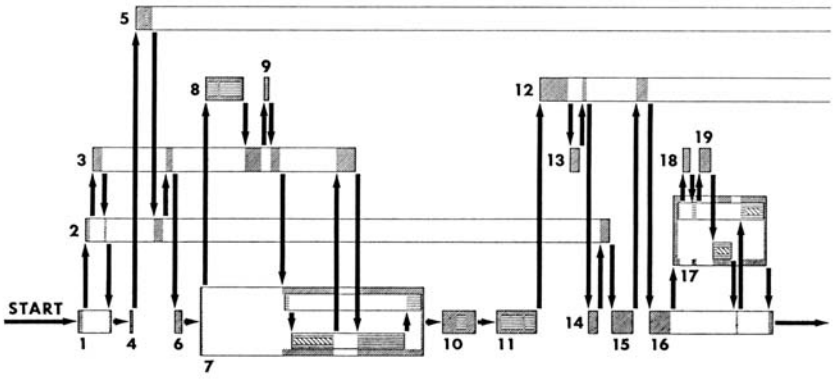
Access in chunks
- Task dependent construct
- 7 +/- 2 (Miller)

Decay
- Content dependant
  - 1 chunk 73 sec
  - 3 chunks 7 sec
- Attention span
  - Interruptions > decay time



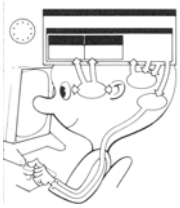


Task Structure



Long Term Memory

- Very large capacity
  - Semantic encoding
- Associative access
  - Fast read: 70ms
  - Expensive write: 10s
    - Can also move from WM to LTM via rehearsal
- Context at the time of acquisition key for retrieval



Cognitive Processor

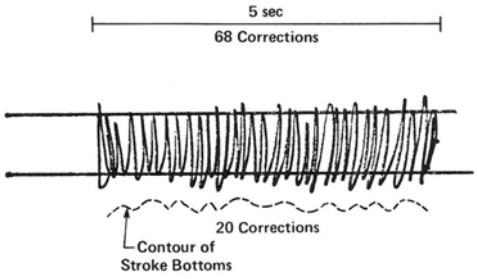
- Cycle time: 70ms
  - Can be modulated
- Typical matching time
  - Digits: 33ms
  - Colors: 38ms
  - Geometry: 50ms…
- Fundamentally serial
  - One locus of attention at a time
    - Eastern 401, December 1972
      - Crew focused on landing gear indicator bulb,
      - Aircraft is loosing altitude (horn, warning indicator…),
      - Aircraft crashed in the Everglades
      - see "The Human Interface" by Raskin, p25
    - But what about driving and talking?

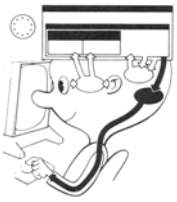
Motor Processor

Receive input from the cognitive processor

Execute motor programs

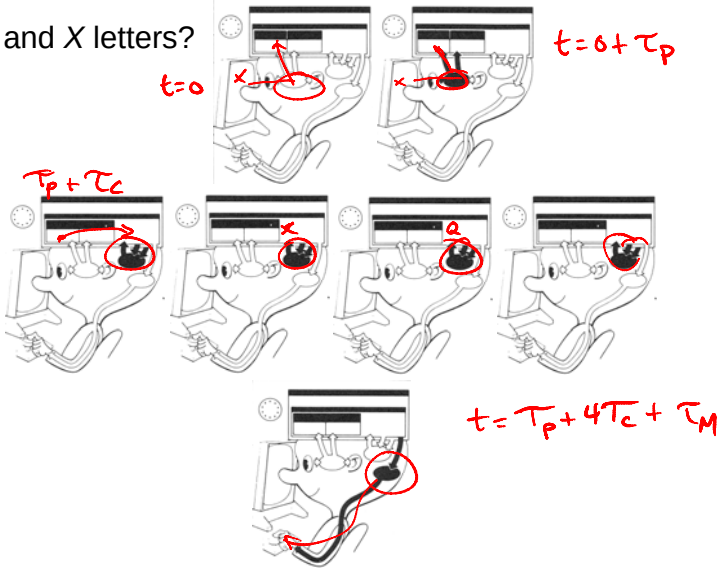
- Pianist: up to 16 finger movements per second
- Point of no-return for muscle action





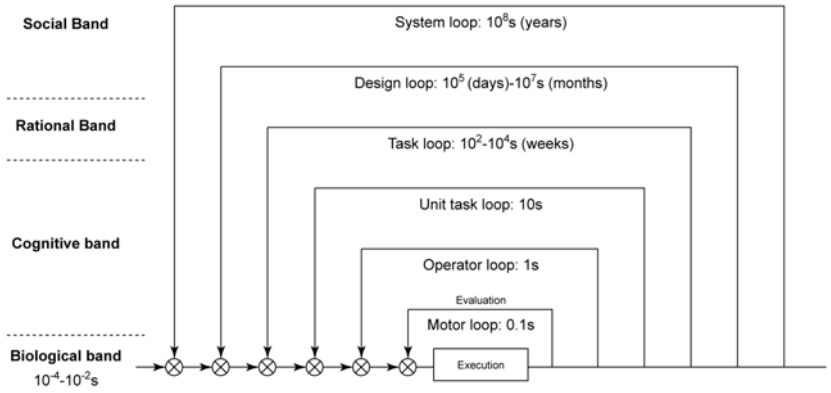
Recognize-Act Cycle

Are *Q* and *X* letters?



Human Interaction Loops

(Newell)



Principles of Operation

Interface should respect limits of human performance
- Preattentive features pop-out
- Events within cycle time fuse together
- Causality

Recognize-Act Cycle of the cognitive processor
- On each cycle contents in WM initiate cognitive actions
- Cognitive actions modify the contents of WM

Discrimination Principle
- Retrieval is determined by candidates that exist in memory relative to retrieval cues
- Interference by strongly activated chunks
  - Two strong cues in working memory
  - Link to different chunks in long term memory

Memory

Simple Experiment

Volunteer

Start saying **colors** you see in list of words
- When slide comes up
- As fast as you can

Say "done" when finished

Everyone else time it…

Paper
Home
Back
Schedule
Page
Change

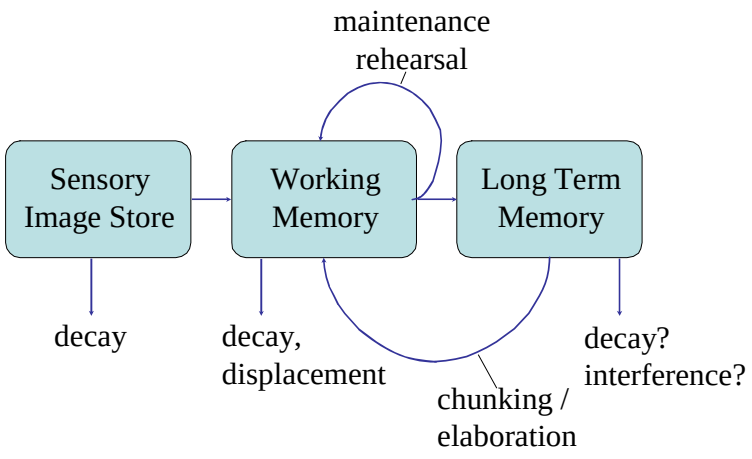
Simple Experiment

Do it again

Say "done" when finished

Blue
Red
Black
White
Green
Yellow

Stage Theory



Stage Theory

Working memory is small
- Temporary storage
  - decay
  - displacement

Maintenance rehearsal
- Rote repetition
- Not enough to learn information well

LTM and Elaboration

Recodes information

Organize (chunking)

Relate new material to already learned material

Link to existing knowledge, categories

Attach meaning
- Make a story

LTM Forgetting

Causes for not remembering an item?

1) Never stored: encoding failure
2) Gone from storage: storage failure
3) Can't get out of storage: retrieval failure

Interference model of forgetting

- One item reduces ability to retrieve another
- Proactive interference (3)
  - Earlier learning reduces ability to retrieve later info.
- Retroactive interference (3 & 2)
  - Later learning reduces the ability to retrieve earlier info.

Recognition over Recall

Recall

- Info reproduced from memory

Recognition

- Presentation of info helps retrieve info (helps remember it was seen before)
- Easier because of cues to retrieval

We want to design UIs that rely on recognition!

Recall

Write names of the 7 dwarves in Snow White?

Recognition

- Grouchy
- Sneezy
- Smiley
- Sleepy
- Pop
- Grumpy
- Cheerful
- Dopey
- Bashful
- Wheezy
- Doc
- Lazy
- Happy
- Nifty
- Sleepy

Facilitating Retrieval: Cues

Any stimulus that improves retrieval
- Example: giving hints
- Other examples in software?
  - icons, labels, menu names, etc.

Anything related to
- Item or situation where it was learned

Summary

Model human processor
- 5 parts
  - Perceptual processor
  - Working memory
  - Long term memory
  - Cognitive processor
  - Motor processor
- May not be biologically accurate
- But ...
  - Provides rough estimate of performance
  - Can help us compare and evaluate interfaces

Interfaces should both aid and exploit human capabilities

Next Time

Human Information Processing *continued*

– KLM, GOMS, Fitts' Law, Hick's Law

- Quantification. *The Humane Interface.* Chap 4. Raskin.