Midterm Review

CS160: User Interfaces

Maneesh Agrawala

Upcoming Schedule

- Midterm next Tuesday March 18
- Interactive Prototype + Presentations (due Apr 1)
  - First working implementation
  - Can include Wizard of Oz parts where justified

Topics

- Gestalt Principles
- Midterm Review

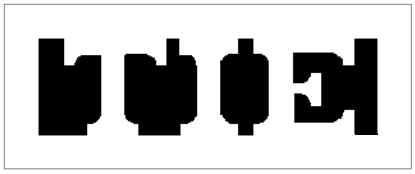
Gestalt Principles

Principles

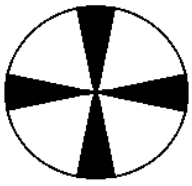
- figure/ground
- proximity
- similarity
- symmetry
- connectedness
- continuity
- closure
- common fate
- transparency

Figure/Ground

Ambiguous



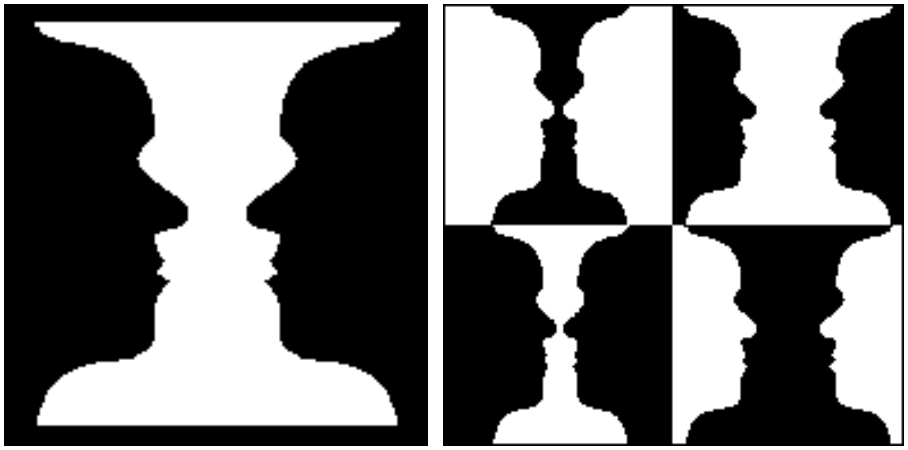
Principle of surroundedness



Principle of relative size

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html

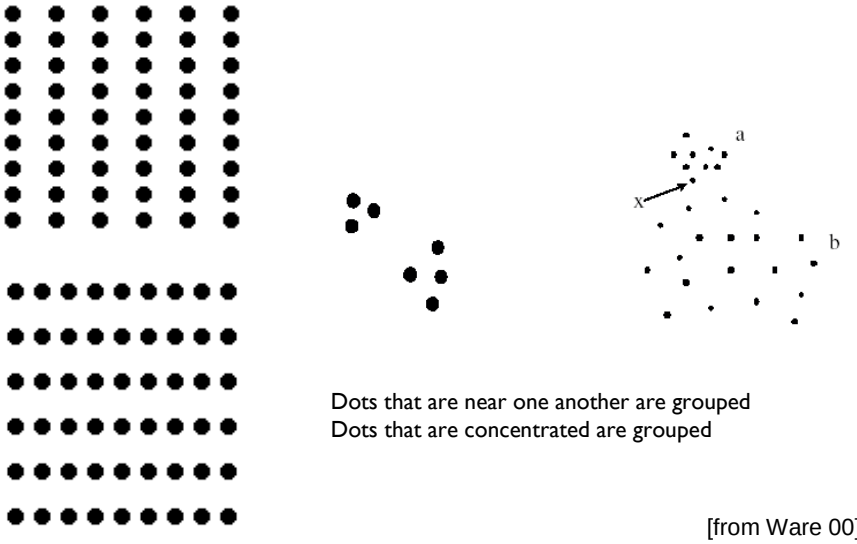
Figure/Ground



Ambiguous Unambiguous

http://www.aber.ac.uk/media/Modules/MC10220/visper06.html

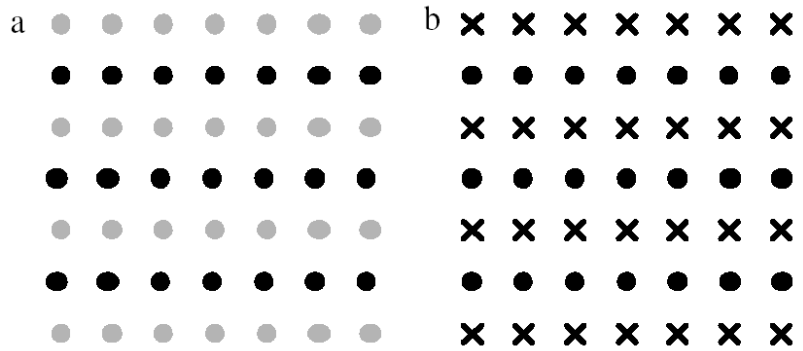
Proximity



Dots that are near one another are grouped
Dots that are concentrated are grouped

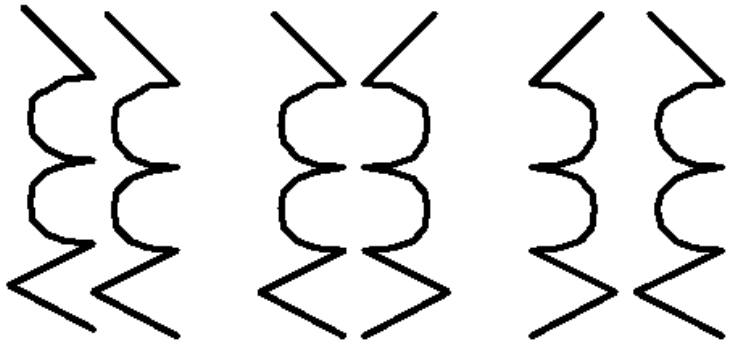
[from Ware 00]

Similarity



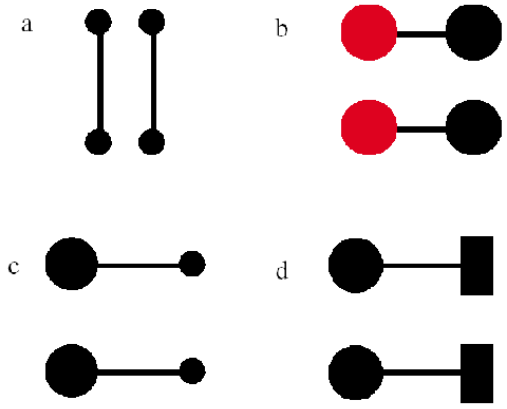
Rows dominate due to similarity [from Ware 04]

Symmetry



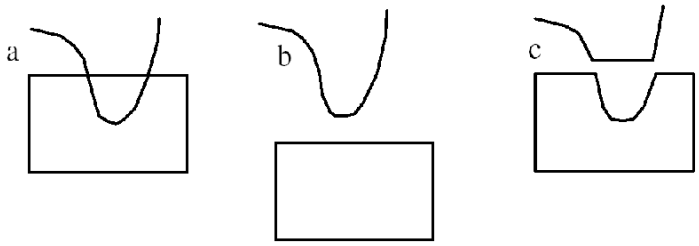
Bilateral symmetry gives strong sense of figure [from Ware 04]

Connectedness

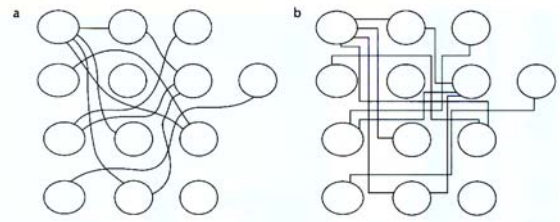


Connectedness overrules proximity, size, color shape [from Ware 04]

Continuity

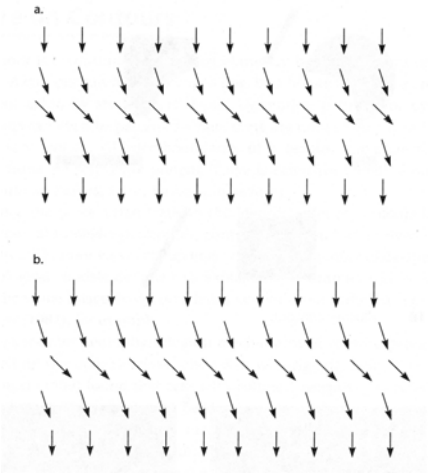


We prefer smooth not abrupt changes [from Ware 04]



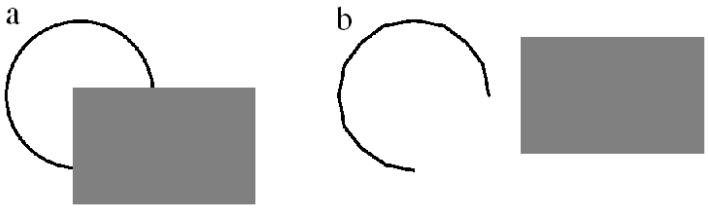
Connections are clearer with smooth contours [from Ware 04]

Continuity: Vector Fields

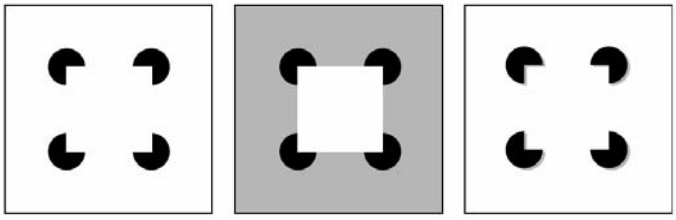


Prefer field that shows smooth continuous contours [from Ware 04]

Closure



We see a circle behind a rectangle, not a broken circle [from Ware 04]



Illusory contours [from Durand 02]

Common Fate

Dots moving together are grouped

http://coe.sdsu.edu/eet/articles/visualperc1/start.htm

Transparency

a

Requires continuity and proper color correspondence [from Ware 04]

Summary

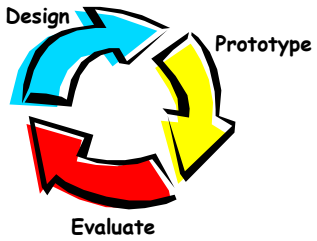
- Design is about communication, form and function
  - Simplicity and elegance are keys to good design
  - Minimalism constrains you and reduces chances of bad design
- Use a small palette of colors
  - Let others pick them for you (colorbrewer.org)
- Human vision is organized by Gestalt Principles
  - Be aware of these principles as you design the visual look

Midterm Review

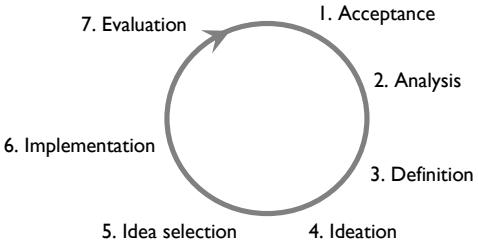
General Information

- Closed book, no cheatsheets, no electronic devices
- Format
  - Short answer and longer answer questions
  - Will involve some recall (I know this is bad interface design)
- Test-taking strategy
  - Questions will not be ordered in difficulty
  - Go through entire test, read questions, answer simple ones first
  - Read questions thoroughly
- Covers all material in lectures, sections and readings
  - Lectures mostly go over material in readings
  - Use lectures as guide to most important aspects of readings

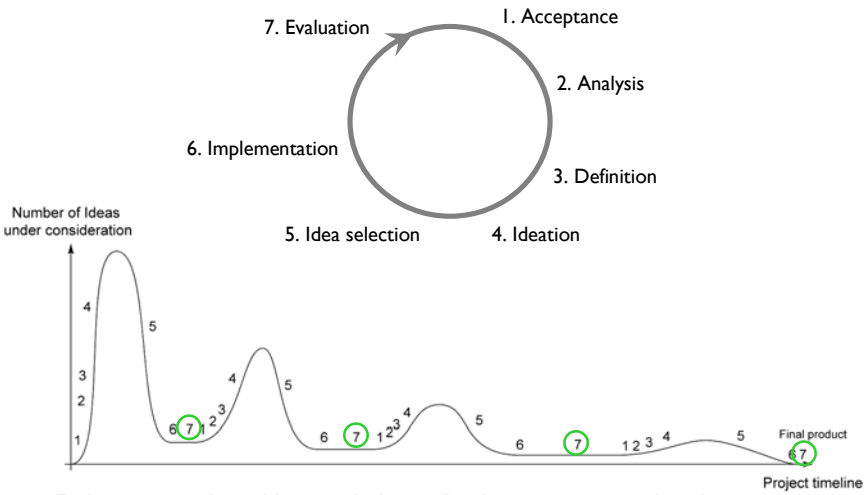
The Design Cycle



[Koberg & Bagnall]



Design Cycle Over Project Lifespan



Evaluation reveals problems with design. Re-design requires cycling the process.

IDEO's Brainstorming Rules

1. Sharpen the Focus
2. Playful Rules
3. Number your Ideas
4. Build and Jump
5. The Space Remembers
6. Stretch Your Mental Muscles
7. Get Physical

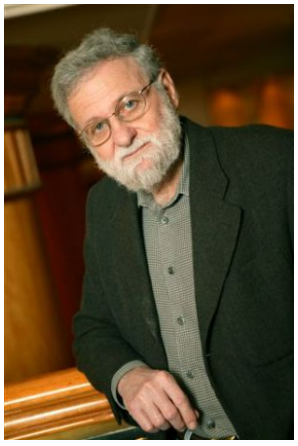
Aim for quantity

Hope for quality

Affordances

What is an affordance?

"… the term **affordance** refers to the *perceived* and *actual* properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.



Some affordances obvious

- Knobs afford turning
- Buttons afford pushing
- Glass can be seen through

Some affordances learned

- Glass breaks easily
- Floppy disk
  - Rectangular – can't insert sideways
  - Tabs prevent backwards insertion

The Design of Everyday Things. 1988. Don Norman

Why Mobile Devices Matters

6.5 billion people in the world
- 1.5 billion cell phones worldwide
- 500 million PCs (?)
- 46 million PDAs
- 1 million TabletPCs

Cell phone is the primary medium for communication
Question: How can we improve it's interface?

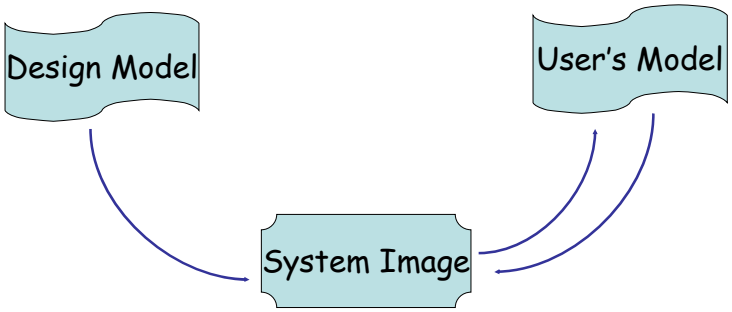
Key Challenges

- Limited Physical Resources
  - CPU, Memory, Screen Size, Input Devices, Battery Life etc
- Diversified Context of Use
- Different Activities
- Limited Attention

Comparisons

- Mobile vs. Desktop
- Mobile vs. Laptop
- Mobile vs. Paper Notebook

Conceptual Models



- What is the user's conceptual model?
- How does the user form the conceptual model?
- What if the designers model doesn't match the user's model?

Norman's Design Principles

- Make controls visible
- Make sure mapping is clear
- Provide feedback

Task Analysis Questions

1. Who is going to use system?
2. What tasks do they now perform?
3. What tasks are desired?
4. How are the tasks learned?
5. Where are the tasks performed?
6. What's the relationship between user & data?
7. What other tools does the user have?
8. How do users communicate with each other?
9. How often are the tasks performed?
10. What are the time constraints on the tasks?
11. What happens when things go wrong?

What is the purpose of task analysis?

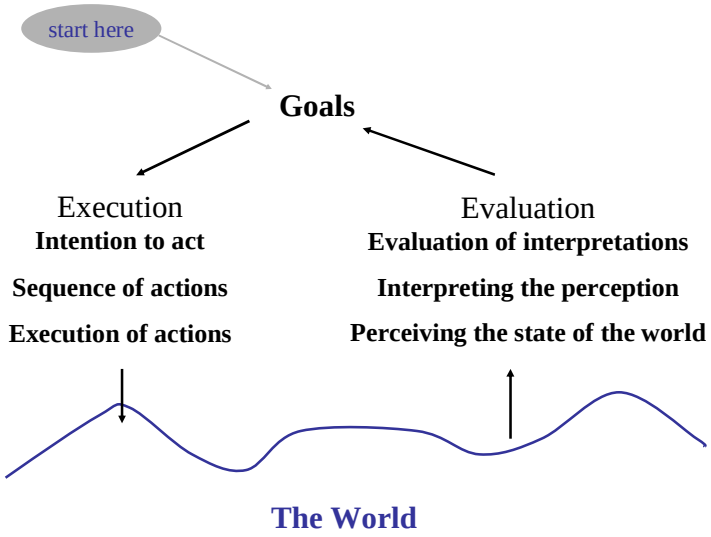
Master-Apprentice Model

Allows user to teach us what they do

- Master (user) works & talks
- We interrupt to ask questions as they go
- Each step reminds master of the next
  - Better than asking user to summarize work habits

What are other models?
How do other models compare?
What is a persona?

Action Cycle



Metaphor

Definition

The transference of the relation between one set of objects to another set for the purpose of brief explanation

Examples?

When are they effective?

When are they not effective?

Direct Manipulation

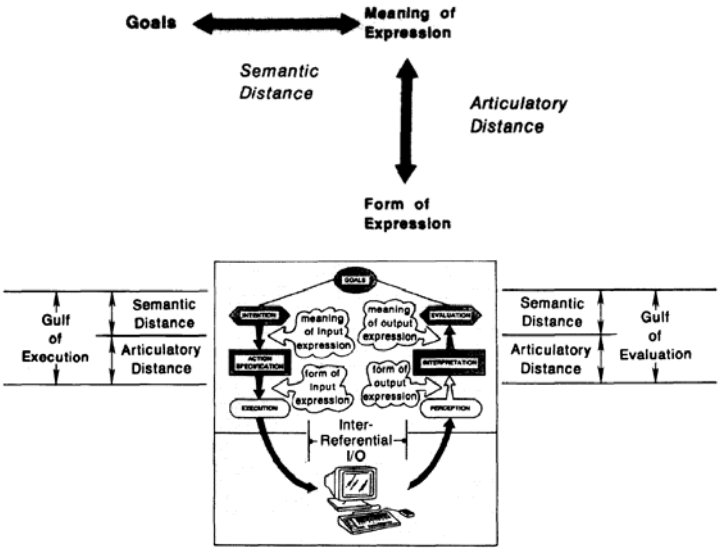
Direct Manipulation

- An interface that behaves as though the interaction was with a real-world object rather than with an abstract system

Central ideas

- Visibility of the objects of interest
- Rapid, reversible, incremental actions
- Manipulation by pointing and moving
- Immediate and continuous feedback

Semantic & Articulatory Distance



Cognition


Jef Raskin

Cognetics
- Ergonomics of the mind
- What does that mean?

Cognitive Conscious/Unconscious
- What are they?

Locus of Attention
- What is it?
- Why locus rather than focus?

Modes

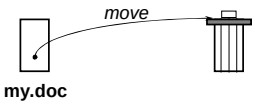
Definition

- The same user actions have different effects in different situations

Noun-Verb *VS* Verb-Noun

Noun-Verb: Select object, *then* perform action
Verb-Noun: Select action, then perform it on object

What are some examples of these two approaches?
What are the pros and cons of these two approachs?



Event Driven Interfaces

Mouse moved (t_0,x,y)

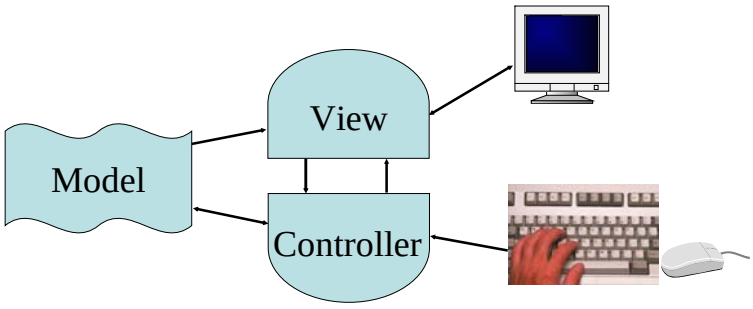
Event Queue
- Queue of input events

Event Loop (runs in dedicated thread)
- Remove next event from queue
- Determine event type
- Find proper component(s)
- Invoke callbacks on components
- Repeat, or wait until event arrives

Component
- Invoked callback method
- Update application state
- Request repaint, if needed

Model-View-Controller

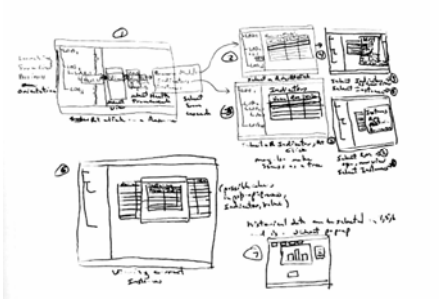
Architecture for interactive apps
- Model: Info the application manipulates
- View: Visual display of the model
- Controller: Receives input & decides what they do

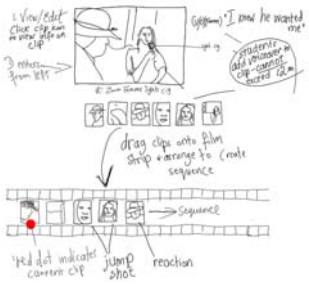


Storyboarding

Series of key frames depicting key steps in reaching a goal

- Can use a pin board for easy rearrangement/editing
- Describe the interaction in context
- Often useful to show user in at least 1st frame (establishing shot)





Fidelity in Prototyping

Fidelity refers to the level of detail

High fidelity,

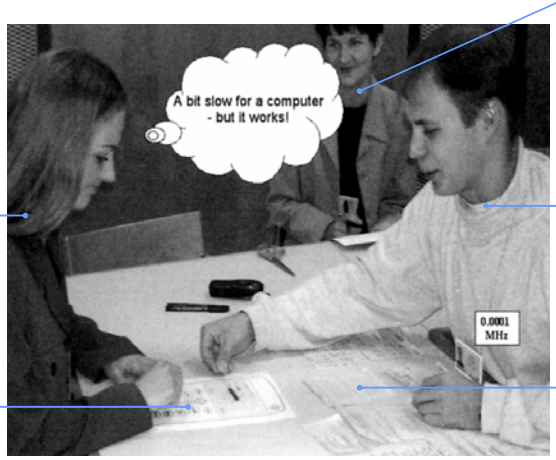
- Prototypes look like the final product

Low fidelity,

- Artists renditions with many details missing

Why do we create prototypes?

Testing Prototypes



Observer
(or video camera)

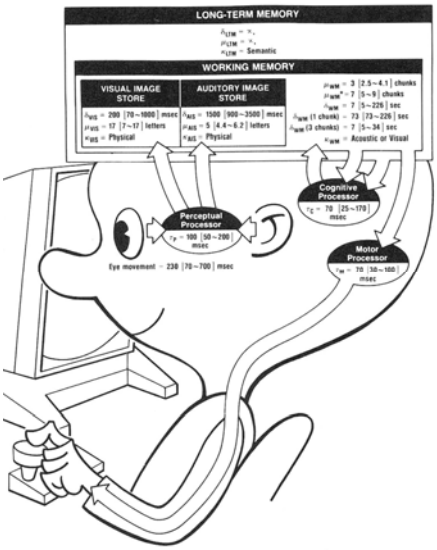
User

"Computer"

Interface

Interface elements

Model Human Info Processor



5 Parts
- Perceptual
- Cognitive
- Motor
- Working memory
- Long-term memory

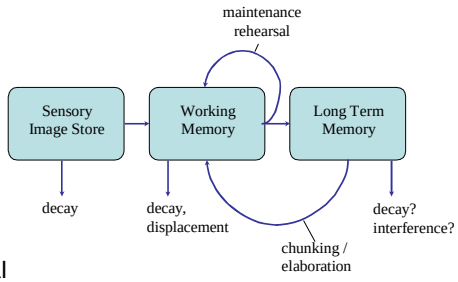
Unified model
- Probably inaccurate
- Predicts perf. well
- Very influential

Review: Memory

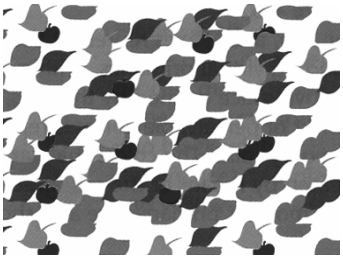
Working memory is small
- Temporary storage
  - decay
  - displacement

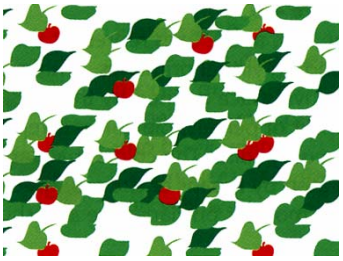
Long term memory
- Rehearsal
- Relate new to learned material
- Link to existing knowledge
- Attach meaning
  - Make a story

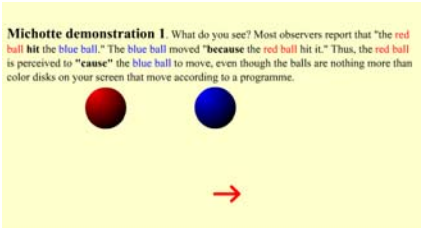
Design interface to facilitate retrieval
- Recognition rather than recall

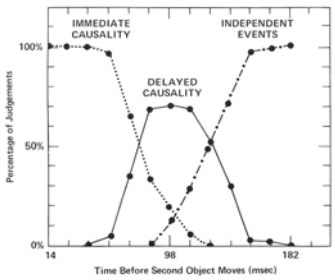


Review: Pop-Out and Causality









Recognition over Recall

Recall
- Information reproduced from memory

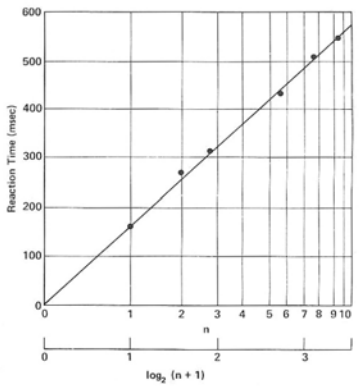
Recognition
- Presentation of info helps retrieve info (helps remember it was seen before)
- Easier because of cues to retrieval

Decision Making

Hick's Law – cost of taking a decision:

$$T = a + b\log_2(n+1)$$

- Time depends on number of options
  - Choosing a movie at Blockbuster

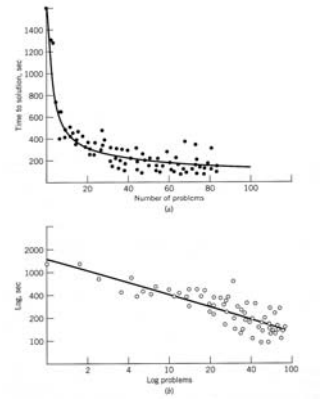


Power Law of Practice

Task time on the nth trial follows a power law

$$T_n = T_1 n^{-a} + c$$

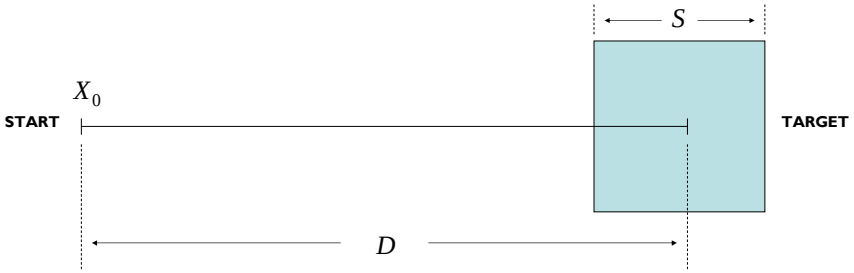
where a = .4, c = limiting constant



Applies to skilled behavior

- Sensory
- Motor

Fitts' Law



Hand movement based on series of microcorrections

X_i = remaining distance after ith move

relative movement accuracy remains constant ➔ $\frac{X_i}{X_{i-1}} = \varepsilon$

Then

$$T = I_m \log_2 \left(\frac{2D}{S} \right)$$

Fitts' Law

$$T = a + b\log_2(D/S + 1)$$

a, b = constants (empirically derived)
D = distance
S = size

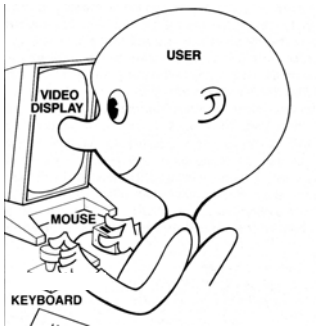
ID is Index of Difficulty = $\log_2(D/S+1)$

- Models well-rehearsed selection task
- T increases as the ***distance*** to the target increases
- T decreases as the ***size*** of the target increases

KLM

Describe the task using the following operators:

- K: pressing a key or a pressing (or releasing) a button
  t_K = 0.08 - 1.2s (0.2 good rule of thumb)
- P: pointing
  t_P = 1.1s (without button press)
- H: Homing (switching device)
  t_H = 0.4s
- D(*n*,*l*): Drawing segmented lines
  t_D = 0.9*n + .16*l
- M: Mentally prepare
  t_M = 1.35s
- R(*t*): system response time
  t_R = t



GOMS Advantages/Disadvantages

Advantages

- Gives qualitative & quantitative measures
- Model explains the results
- Less work than user study – no users!
- Easy to modify when UI is revised

Disadvantages

- Not as easy as other evaluation methods
  - Heuristic evaluation, guidelines, etc.
- Takes lots of time, skill, & effort
- Only works for goal-directed tasks
- Assumes tasks **expert** performance without **error**
- Does not address several UI issues,
  - readability, memorizability of icons, commands

Usability Heuristics

"Rules of thumb" describing features of usable systems
- Can be used as design principles
- Can be used to evaluate a design

Example: *Minimize users' memory load*

Pros and cons
- Easy and inexpensive
  - Performed by experts
  - No users required
  - Catch many design flaws
- More difficult than it seems
  - Not a simple checklist
  - Cannot assess how well the interface will address user goals

Phases of Heuristic Eval. (1-2)

1) Pre-evaluation training
- Provide the evaluator with domain knowledge if needed

2) Evaluation
- Individuals evaluate interface then aggregate results
  - Compare interface elements with heuristics
- Work in 2 passes
  - First pass: get a feel for flow and scope
  - Second pass: focus on specific elements
- Each evaluator produces list of problems
  - Explain why with reference to heuristic or other information
  - Be specific and list each problem separately

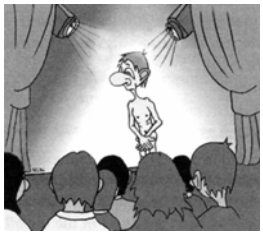
Phases of Heuristic Eval. (3-4)

3) Severity rating
   - Establishes a ranking between problems
     - Cosmetic, minor, major and catastrophic
   - First rate individually, then as a group

4) Debriefing
   - Discuss outcome with design team
   - Suggest potential solutions
   - Assess how hard things are to fix

Review: Managing Participants

- Testing is distressing
- Treat participants with respect
  - Follow human subjects protocol
  - Obtain informed consent
  - Make sure experiment is ethical



Steps in Designing an Experiment

1. State a lucid, testable hypothesis
2. Identify variables (independent, dependent control, random)
3. Design the experimental protocol
4. Choose user population
5. Apply for human subjects protocol review
6. Run pilot studies
7. Run the experiment
8. Perform statistical analysis
9. Draw conclusions

Experiment Design

Testable hypothesis
- Precise statement of expected outcome

Factors (independent variables)
- Attributes we manipulate/vary in each condition
- Levels – values for independent variables

Response variables (dependent variables)
- Outcome of experiment (measurements)
- Usually measure user performance
  - Time
  - Errors

Experiment Design

Control variables
- Attributes that will be fixed throughout experiment
- Confound – attribute that varied and was not accounted for
  - Problem: Confound rather than IV could have caused change in DVs
- Confounds make it difficult/impossible to draw conclusions

Random variables
- Attributes that are randomly sampled
- Increases generalizability

Between vs. Within Subjects

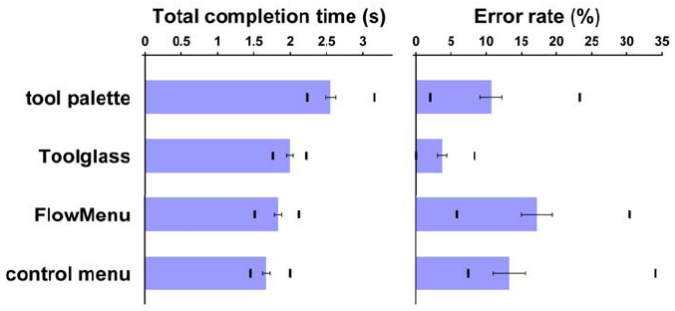
Between subjects
- Each participant uses one condition
  - +/- Participants cannot compare conditions
  - + Can collect more data for a given condition
  - - Need more participants

Within subjects
- All participants try all conditions
  - + Compare one person across conditions to isolate effects of individual diffs
  - + Requires fewer participants
  - - Fatigue effects
  - - Bias due to ordering/learning effects

Results: Statistical Analysis

Compute central tendencies (descriptive summary statistics) for each independent variable

- Mean
- Standard deviation



Are the Results Meaningful?

Hypothesis testing

- **Hypothesis:** Manipulation of IV effects DV in some way
- **Null hypothesis:** Manipulation of IV has no effect on DV
- Null hypothesis assumed true unless statistics allow us to reject it

Statistical significance (p value)

- Likelihood that results are due to chance variation
- $p < 0.05$ usually considered significant (Sometimes $p < 0.01$)
  - Means that < 5% chance that null hypothesis is true

Statistical tests

- T-test (1 factor, 2 levels)
- Correlation
- ANOVA (1 factor, > 2 levels, multiple factors)
- MANOVA (> 1 dependent variable)

Explaining Psychological Statistics
Barry H. Cohen

Next Time

Midterm Exam