CS160: User Interface Design
Midterm Review 3/15/2010

Upcoming Schedule
Low-Fi Prototype Assignment & Heuristic Evaluation due Today
In-class midterm on Wednesday March 17
Interactive Prototype Assignment due April 5
First working implementation
Can include Wizard of Oz parts where justified
Interactive Prototype Presentations
April 5th, 7th
Groups randomly assigned to days

General Information
Closed book, no cheat sheets, no electronic devices

Format
Short answer and longer answer questions
Will involve some recall (We 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
Design
Prototype
Evaluate
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

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### Observing Users

Don’t just trust your intuition to make design decisions.

Observation Techniques: Task Analysis, Contextual Inquiry

**Goal:** Understand user’s activities in context to inform (re-)design of information technology.

### 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?**

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**Principles of Contextual Inquiry**

1. Context
2. Partnership
3. Interpretation
4. Focus

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**Affordances**

- What is an affordance?

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**… 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
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?

Design Model
User's Model
System Image

Norman's Design Principles
Make controls visible
Make sure mapping is clear
Provide feedback

Action Cycle

Goals
Execution
Intention to act
Sequence of actions
Execution of actions
Evaluation
Evaluation of interpretations
Interpreting the perception
Perceiving the state of the world

The World

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

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

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 approaches?

Input Devices

**Why is the mouse a near-optimal pointing device?**

**How can Fitts’ law guide UI design?**

3-State Model of Input

Input Devices are not equivalent – why does this matter for UI design?

![3-State Model of Input](image)

Event Dispatch Loop

**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
Event Dispatch

Event Queue
- Mouse moved (t_0, x, y)
- Mouse pressed (t_1, x, y, 1)
- Mouse dragged (t_2, x, y, 1)
- Key typed (t_3, ‘F1’)
- ...
(queues and dispatches incoming events in a dedicated thread)

Model-View-Controller

Architecture for interactive apps
introduced by Smalltalk developers at PARC

Partitions application in a way that is scalable maintainable

Storyboarding
Series of key frames depicting key steps in reaching a goal
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 prototype?

What are the disadvantages of Low- and High-fidelity prototypes?
Review: Memory

Working memory is small
- Temporary storage
- Maintenance
- Interference

Long term memory
- Rehearsal
- 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 making 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

\[ T_n = T_1 \mu^n + c \]

where \( a \approx 0.4 \), \( c \) = limiting constant

Applies to skilled behavior
Sensory
Motor

Fitts’ Law

Hand movement based on series of microcorrections
\[ X_i = \text{remaining distance after } i\text{th move} \]
relative movement accuracy remains constant
\[ \frac{X_i}{X_{i-1}} = \epsilon \]

Then
\[ T = I_n \log_2 \left( \frac{2D}{S} \right) \]
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
  \[ t_K = 0.08 \cdot 1.2s \] (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
  \[ t_D = 0.9n + .16l \]
- **M**: Mentally prepare
  \[ t_M = 1.3s \]
- **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
- 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

## 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

**Independent variables (factors)**
Attributes we manipulate/vary in each condition
Levels – values for independent variables

**Dependent variables (response variables)**
Outcome of experiment (measurements)
Usually measure user performance

**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

Common Metrics in HCI

**Performance metrics:**
- Task success (binary or multi-level)
- Task completion time
- Errors (slips, mistakes) per task
- Efficiency (cognitive & physical effort)
- Learnability

**Satisfaction metrics:**
- Self-report on ease of use, frustration, etc.

Between vs. Within Subjects

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

**Within subjects**
All participants try all conditions
+ As: Compare one person across conditions to isolate effects of individual diff
+ Requires fewer participants
- Fatigue effects
- Illus due to ordering/learning effects
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** \((p\text{ value})\)
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)

Next Time

Midterm Exam