User Interface Design, Prototyping, and Evaluation

(1) Action Analysis
(2) Automated Evaluation

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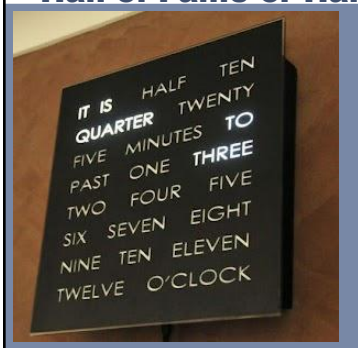
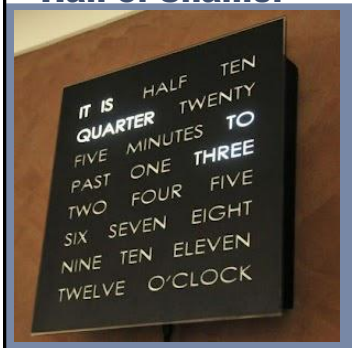
University of Washington
Spring 2012

April 3, 2012

Hall of Fame or Hall of Shame?



Hall of Shame!



- Clock
- What is the purpose?
- This slows you down!

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Outline

- Action analysis
- GOMS? What's that?
- The G, O, M, & S of GOMS
- How to do the analysis
- Automated evaluation tools

Action Analysis Predicts Performance

- Cognitive model ?
  - model some aspect of human understanding, knowledge, intentions, or processing
  - two types
    - competence
      - predict behavior sequences
    - performance
      - predict performance, but limited to routine behavior
- Action analysis uses performance model to analyze goals & tasks
  - generally done hierarchically (similar to TA)

GOMS – Most Popular AA Technique

- Family of UI modeling techniques
  - based on Model Human Processor cognitive model
- GOMS stands for (?)
  - Goals
  - Operators
  - Methods
  - Selection rules
- Input: detailed description of UI/task(s)
- Output: qualitative & quantitative measures

Quick Example

- Goal (the big picture)
  - go from hotel to the airport
- Methods (or subgoals)?
  - walk, take bus, take taxi, rent car, take train
- Operators (or specific actions)
  - locate bus stop; wait for bus; get on the bus;...
- Selection rules (choosing among methods)?
  - Example: Walking is cheaper, but tiring and slow
  - Example: Taking a bus is complicated abroad

Goals

- Something the user wants to achieve
- Examples?
  - go to airport
  - delete file
  - create directory
- Hierarchical structure
  - may require many subgoals

Methods

- Sequence of steps to accomplish a goal
  - goal decomposition
  - can include other goals
- Assumes method is *learned* & *routine*
- Examples
  - drag file to trash
  - retrieve from long-term memory command

Operators

- Specific actions (small scale or atomic)
- Lowest level of analysis
  - can associate with times
- Examples
  - Locate icon for item on screen
  - Move cursor to item
  - Hold mouse button down
  - Locate destination icon
  - User reads the dialog box

Selection Rules

- If > 1 method to accomplish a goal, Selection rules pick method to use
- Examples
  - IF <*condition*> THEN accomplish <*GOAL*>
  - IF <*car has automatic transmission*> THEN <*select drive*>
  - IF <*car has manual transmission*> THEN <*find car with automatic transmission*>

GOMS Output

- Execution time
  - add up times from operators
  - assumes ?
    - experts (mastered the tasks) & error free behavior
  - very good rank ordering
  - absolute accuracy ~10-20%
- Procedure learning time (NGOMSL only)
  - accurate for relative comparison only
  - doesn't include time for learning domain knowledge

GOMS Output Used To

- Ensure frequent goals achieved quickly
- Making hierarchy is often the value
  - functionality coverage & consistency
    - does UI contain needed functions?
    - consistency: similar tasks performed similarly?
  - operator sequence
    - in what order are individual operations done?

How to do GOMS Analysis

- Generate task description
  - pick high-level user Goal
  - write Method for accomplishing Goal
    - may invoke subgoals
  - write Methods for subgoals
    - this is recursive
    - stops when Operators are reached
- Evaluate description of task
- Apply results to UI
- Iterate!

Comparative Example – Unix shell

- Goal: Delete a File
- Method for accomplishing goal of deleting file
  - retrieve from Long term memory that command verb is "rm"
  - think of directory name & file name and make it the first listed parameter
  - accomplish goal of entering & executing command
  - return with goal accomplished

Comparative Example - Windows

- Goal: Delete a File
- Method for accomplishing goal of deleting file
  - find file icon
  - accomplish goal of dragging file to trash
  - return with goal accomplished

Comparative Example – Unix shell

- Goal: Remove a directory
- Method for accomplishing goal of removing a directory
  - ?????

Comparative Example – Unix shell

- Goal: Remove a directory
- Method for accomplishing goal of removing a directory
  - accomplish goal of making sure directory is empty
  - retrieve from long term memory that command verb is 'rmdir'
  - think of directory name and make it the first listed parameter
  - accomplish goal of entering & executing command
  - return with goal accomplished

Comparative Example - Windows

- Goal: Remove a directory
- Method for accomplishing goal of removing a directory
  - ????

Comparative Example - Windows

- Goal: Remove a directory
- Method for accomplishing goal of removing a directory
  - find folder icon
  - accomplish goal of dragging folder to trash
  - return with goal accomplished
- Note the consistency with delete file on the Windows! This makes it much easier.

What GOMS Can Model

- Task must be goal-directed
  - some activities are more goal-directed
    - creative activities may not be as goal-directed
- Task must use routine cognitive skills
  - as opposed to problem solving
  - good for things like machine operators

Applications of GOMS

- Compare different UI designs
- Profiling (time)
- Building a help system? Why?
  - modeling makes user tasks & goals explicit
  - can suggest questions users might ask & the answers

Real-world GOMS Applications

- Keystroke Level Model (KLM)
  - Mouse-based text editor
  - Mechanical CAD system
- NGOMSL
  - TV control system
  - Nuclear power plant operator's associate
- CPM-GOMS
  - Telephone operator workstation

Advantages of GOMS

- Gives qualitative & quantitative measures
- Model explains the results
- Less work than *large* user study – no users!
- Easy to modify when UI is revised
- Research: tools to aid modeling process since it can still be tedious

Disadvantages of GOMS

- Not as easy as HE, guidelines, etc.
- Takes lots of time, skill, & effort
- Only works for goal-directed tasks
- Assumes tasks performed by *experts without error*
- Does not address several UI issues,
  - readability, memorizability of icons, commands…

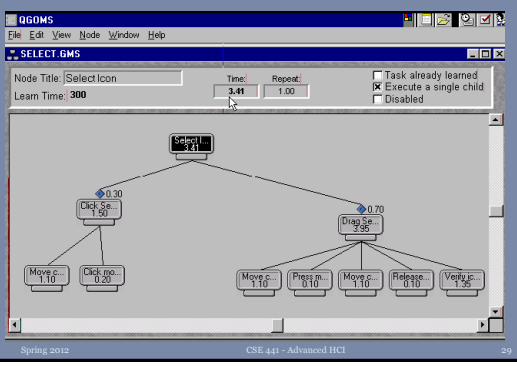
Rapid Iterative Design is the Best Practice for Creating Good UIs

We have seen how computer-based tools can improve the Design (e.g., Denim) & Prototyping (e.g., JustInTime) phases

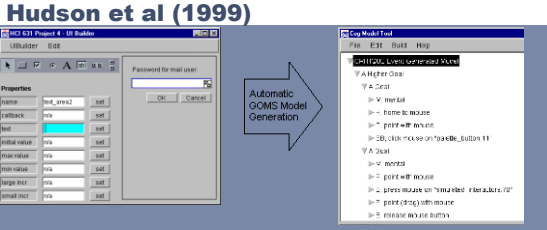
Automated GOMS Tools

- Can save, modify & re-use the model
- Automation of execution time calculation, etc.

QGOMS tool

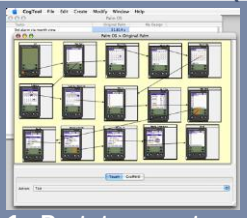


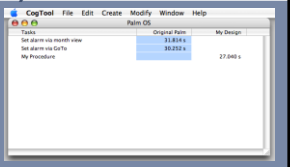
CRITIQUE
Hudson et al (1999)



1. Prototype system by programming
   - in this case with the SubArctic toolkit
2. Demonstrate a task
   - record events
   - apply rules
3. Automatically generate KLMs
4. Semi-automatically generate classic GOMS models

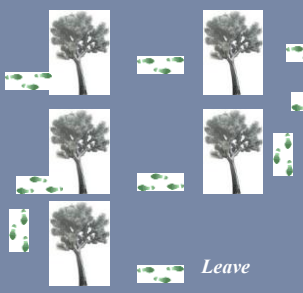
CogTool
John & Salvucci (2005)





1. Prototype system by *storyboarding*
2. Demonstrate a task
   - record events
   - apply rules
3. Automatically generate ACT-R model

The Trouble With Most Web Site Analysis Tools



Leave

Unknowns
- Who?
- What?
- Why?
- Did they find it?
- Satisfied?

NetRaker Usability Research
See how customers accomplish real tasks on site

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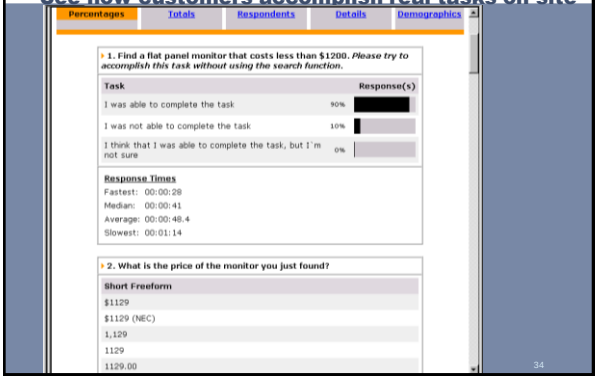
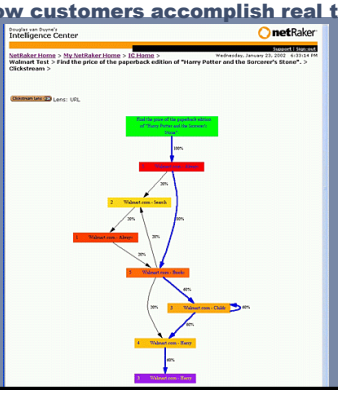
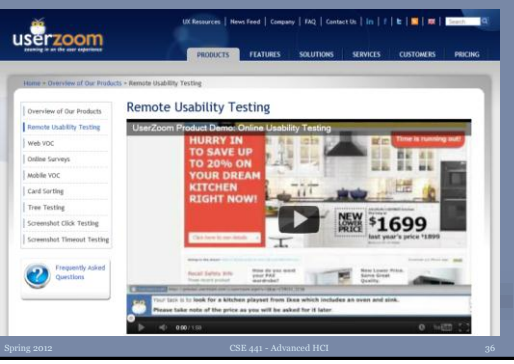
See how customers accomplish real tasks on site



NetRaker Usability Research
See how customers accomplish real tasks on site



UserZoom



Advantages of Remote Usability Testing

- Fast
  - can set up research in 3-4 hours
  - get results in 36 hours
- More accurate
  - can run with large samples (50-200 users → stat. sig.)
  - uses real people (customers) performing tasks
  - natural environment (home/work/machine)
- Easy-to-use
  - templates make setting up easy
- Can compare with competitors
  - indexed to national norms

Disadvantages of Remote Usability Testing

- Miss observational feedback
  - facial expressions
  - verbal feedback (critical incidents)
- Need to involve human participants
  - costs some amount of money (typically $20-$50/person)
- People often do not like pop-ups
  - need to be careful when using them

Summary

- GOMS
  - provides info about important UI properties
  - doesn't tell you everything you want to know about UI
    - only gives performance for expert, error-free behavior
  - hard to create model, but still easier than user testing
    - changing later is much less work than initial generation
- Automated usability
  - faster than traditional techniques
  - can involve more participants → convincing data
  - easier to do comparisons across sites
  - tradeoff with losing observational data

Next Time

- Group Heuristic Evaluation assignment
- Tue Lecture on Mobile UI Design