

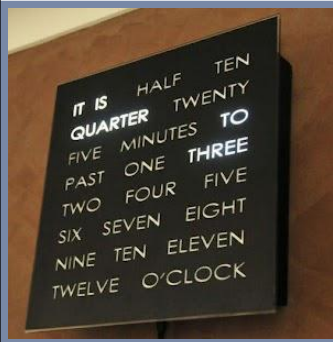
User Interface Design, Prototyping, and Evaluation

**(1) Action Analysis**  
**(2) Automated Evaluation**

Prof. James A. Landay  
University of Washington  
Spring 2012

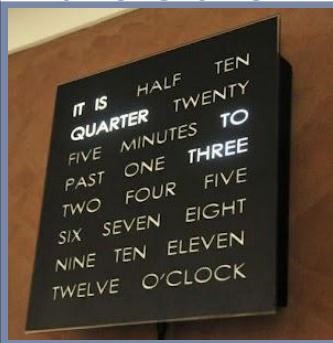
April 3, 2012

**Hall of Fame or Hall of Shame?**



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**Hall of Shame!**



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

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User Interface Design, Prototyping, and Evaluation

**(1) Action Analysis**  
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April 3, 2012

**Outline**

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

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**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)

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## 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

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## 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

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## Goals

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

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## 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

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## 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

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## 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>

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## 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

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## 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?

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## 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!

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## 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

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## 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

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## Comparative Example – Unix shell

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

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## 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

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## Comparative Example - Windows

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

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## 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.

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## 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

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## 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

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## 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

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## 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

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## 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...

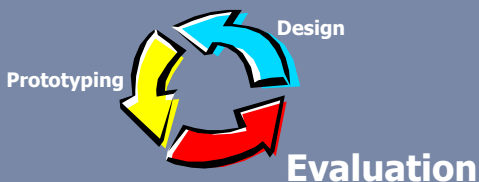
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## Rapid Iterative Design is the Best Practice for Creating Good UIs

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



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## Automated GOMS Tools

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

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## QGOMS tool

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## 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

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## CogTool

John & Salvucci (2005)

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

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## The Trouble With Most Web Site Analysis Tools

Unknowns

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

Leave

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## NetRaker Usability Research

See how customers accomplish real tasks on site

Please refer to the web site below for the following...

1. Find a flat panel monitor that costs less than \$1200. Please try to accomplish this task **without using the search function.**

I was able to complete the task

I was not able to complete the task

I think that I was able to complete the task, but I'm not sure

Home

- Laptops & Notebooks
- Desktop Computers
- Printers
- Monitors
- LCD Flat Panel Displays
- Video Cards
- Scanners
- Digital Cameras
- Palmtops

ACME Computers

LCD Flat Panel Displays

Mitsubishi 181N LCD PANEL	Compaq 181N TFT 20MM 1280X1024	IBM 181N 18.0V ANALOG TFT
\$3,460.00	\$3,839.00	\$4,099.00

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## NetRaker Usability Research

See how customers accomplish real tasks on site

Percentages Totals Respondents Details Demographics

1. Find a flat panel monitor that costs less than \$1200. Please try to accomplish this task **without using the search function.**

Task	Response(s)
I was able to complete the task	90%
I was not able to complete the task	10%
I think that I was able to complete the task, but I'm not sure	0%

Response Times

Fastest: 00:00:28  
 Median: 00:00:41  
 Average: 00:00:46.4  
 Slowest: 00:01:14

2. What is the price of the monitor you just found?

Short Freeform

\$1129
\$1129 (NEC)
1,129
1129
\$129.00

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## NetRaker Usability Research

See how customers accomplish real tasks on site

Intelligence Center

Find the price of the paperback edition of "Harry Potter and the Sorcerer's Stone".

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## UserZoom

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Remote Usability Testing

UserZoom Product Demo-Online Usability Testing

HURRY IN TO SAVE UP TO 20% ON YOUR DREAM KITCHEN RIGHT NOW!

NEW LOWEST PRICE \$1699

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### 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

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### 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

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### 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

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### Next Time

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

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