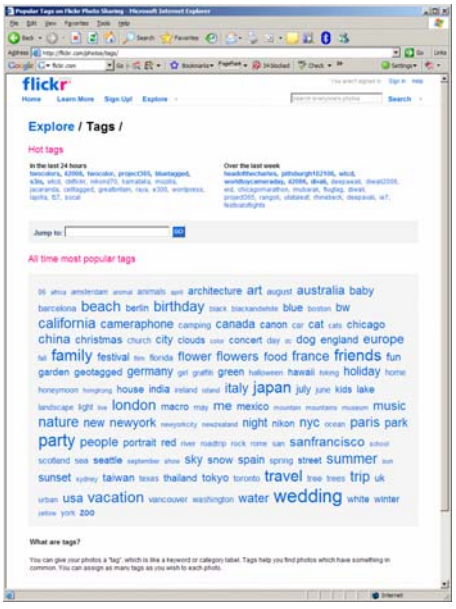
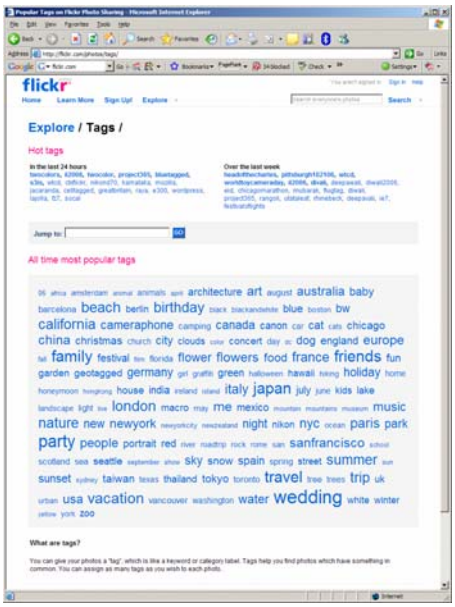
Qualitative Evaluation

CS160: User Interfaces

Maneesh Agrawala and Jeffrey Nichols





Pros

- See what's popular
- Context

Cons

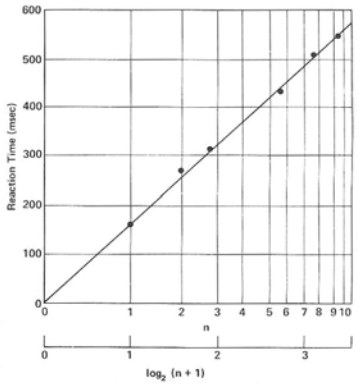
- Tag meaning unclear
- No pictures
- Does tag ordering mean anything?

Review: 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

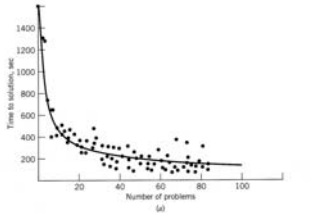


Review: Practice

Task time on the nth trial follows a power law

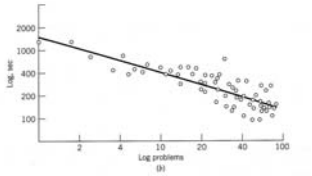
$$T_n = T_1 n^{-a} + c$$

where a = .4, c = limiting constant

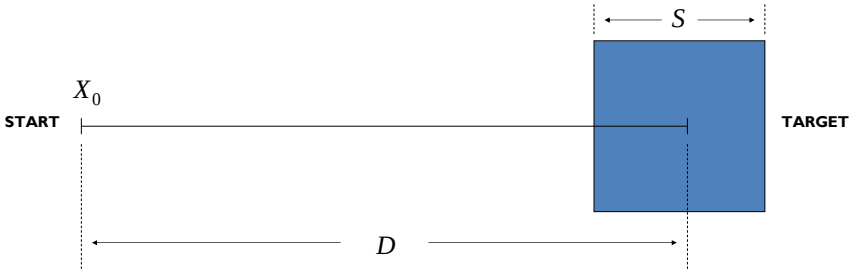


Applies to skilled behavior

- Sensory
- Motor



Review: 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

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

```
* Expansion of MOVE-TEXT goal
GOAL: MOVE-TEXT
.       GOAL: CUT-TEXT
.       .   GOAL: HIGHLIGHT-TEXT
.       .   .   [select**: GOAL: HIGHLIGHT-PHRASE-COMPOSED-OF-WORDS
.       .   .                  . MOVE-CURSOR-TO-FIRST-WORD          1.10
.       .   .                  . DOUBLE-CLICK-MOUSE-BUTTON          0.40
.       .   .                  . MOVE-CURSOR-TO-LAST-WORD           1.10
.       .   .                  . SHIFT-CLICK-MOUSE-BUTTON           0.40
.       .   .                  . VERIFY-HIGHLIGHT                   1.35
.       .   .                  GOAL: HIGHLIGHT-ARBITRARY-TEXT
.       .   .                  . MOVE-CURSOR-TO-BEGINNING-OF-TEXT
.       .   .                  . PRESS-MOUSE-BUTTON
.       .   .                  . MOVE-CURSOR-TO-END-OF-TEXT
.       .   .                  . RELEASE-CLICK-MOUSE-BUTTON
.       .   .                  . VERIFY-HIGHLIGHT]
.       .   GOAL: ISSUE-CUT-COMMAND
.       .   .   MOVE-CURSOR-TO-EDIT-MENU                            1.10
.       .   .   CLICK-MOUSE-BUTTON                                  0.20
.       .   .   MOVE-CURSOR-TO-CUT-ITEM                             1.10
.       .   .   VERIFY-HIGHLIGHT                                    1.35
.       .   .   CLICK-MOUSE-BUTTON                                  0.20
.       GOAL: PASTE-TEXT
.       .   GOAL: POSITION-CURSOR-AT-INSERTION-POINT
.       .   .   MOVE-CURSOR-TO-INSERTION-POINT                      1.10
.       .   .   CLICK-MOUSE-BUTTON                                  0.20
.       .   .   VERIFY-POSITION                                     1.35
.       .   GOAL: ISSUE-PASTE-COMMAND
.       .   .   MOVE-CURSOR-TO-EDIT-MENU                            1.10
.       .   .   CLICK-MOUSE-BUTTON                                  0.20
.       .   .   MOVE-CURSOR-TO-PASTE-ITEM                           1.10
.       .   .   VERIFY-HIGHLIGHT                                    1.35
.       .   .   CLICK-MOUSE-BUTTON                                  0.20
TOTAL TIME PREDICTED (SEC)                                         16.25
```

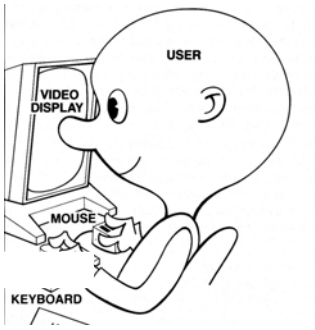
Is all this feedback in order?

Issuing commands will be used a lot! Can we shorten this procedure? Consider keyboard shortcuts.

Review: Keystroke Level Model

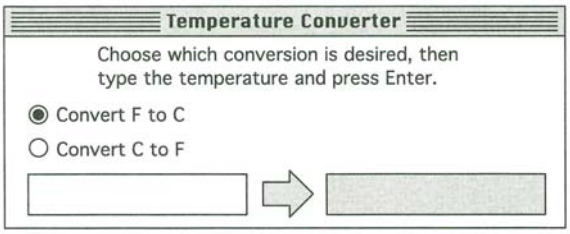
Describe the task using the following operators:

- 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



Converting Temp. Design I

Convert 92.5



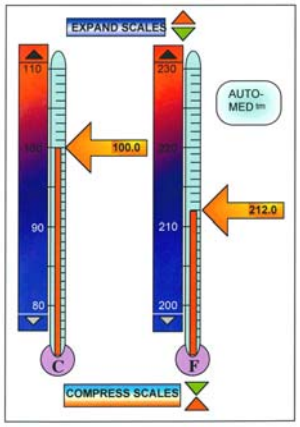
Assume the focus is on the dialog box, so typing on the keyboard will enter text in the text field directly

MKKKKMK (3.7s)

Average: 5.4s

HMPKHMKKKKMK (7.15s)

Converting Temp. Design 2



HMPKPK (4.35s)

Average: 13.125s

H + 3(MPKSK) + MPKPK (21.9s)

Converting Temp. Design 3

Simple text interface with the following prompt:

"To convert temperatures, type the numeric temperature, followed by C if it is in degrees Celsius or F it is in degrees Fahrenheit. Then press enter key. The converted temperature will be displayed"

Converting Temp. Design 3

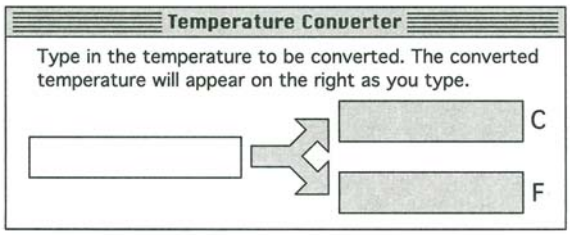
Simple text interface with the following prompt:

"To convert temperatures, type the numeric temperature, followed by C if it is in degrees Celsius or F it is in degrees Fahrenheit. Then press enter key. The converted temperature will be displayed"

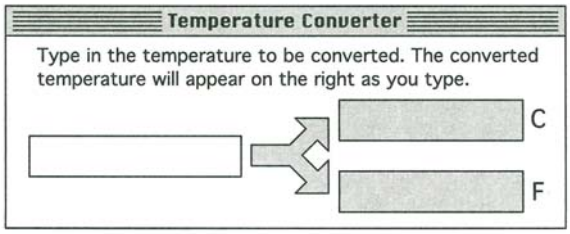
MKKKKKMK (3.9s)

Average: 3.9s

Converting Temp. Design 4



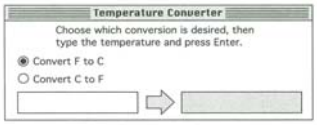
Converting Temp. Design 4

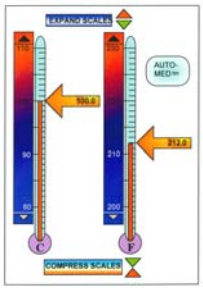


MKKKK (2.15s)

Average: 2.15s

Pros and Cons





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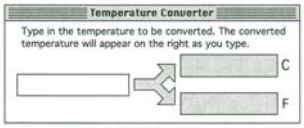


What GOMS Can Model

Task must be goal-directed

- – Some activities are more goal-directed
  - Creative activities may not be as goal-directed

Task must be a routine cognitive skill

- – As opposed to problem solving
- – Good for things like machine operators

Serial & parallel tasks (CPM-GOMS)

Advantages of GOMS

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

Research: Need tools to aid modeling process since it can still be tedious

Disadvantages of GOMS

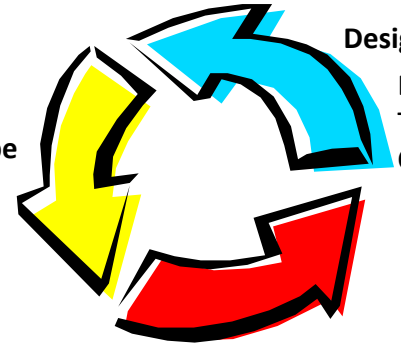
- Not as easy as other evaluation methods
  - Heuristic evaluation, guidelines, etc.
- Takes lots of time, skill, & effort
- Only works for goal-directed tasks
- Assumes tasks **expert** performance without **error**
- Does not address several UI issues,
  - readability, memorizability of icons, commands

Today's Topics

- Discount Usability Engineering
- Heuristic Evaluation
- The Process of Heuristic Evaluation
- Pros and Cons of Heuristic Evaluation

Discount Usability Engineering

Iterative Design



Design
Brainstorming
Task analysis
Contextual inquiry

Prototype
Low-fi, paper

Evaluate
Low-fi testing,
Qualitative eval
Quantitative eval

Discount Usability Engineering

Cheap
- No special labs or equipment needed
- The more careful you are, the better it gets

Fast
- On order of 1 day to apply
- Standard usability testing may take a week

Easy to use
- Can be taught in 2-4 hours

Quantitative Testing is Costly

Its very expensive – you need to schedule (and normally pay) many subjects.

It takes many hours of the evaluation team's time.

A user test can easily cost $10k's

Examples: Discount Usability Eng.

- Walkthroughs
  - Put yourself in the shoes of a user
  - Like a code walkthrough

Cognitive Walkthrough

Formalized technique for imagining user's thoughts and actions when using an interface

- Given detailed description of interface
- Select task
- Tell a story motivating user actions required to do task
- Interface should give motivations via prompts/feedback
- Breakdown in motivations imply problem with interface

Walkthroughs are difficult to do when tasks are ill defined and can be accomplished in many ways

Examples: Discount Usability Eng.

- Walkthroughs
  - Put yourself in the shoes of a user
  - Like a code walkthrough
- Action analysis
  - GOMS (add times to formal action analysis)
- ***Heuristic evaluation***

- Low-fi testing
- On-line, remote usability tests
  - E.g. Mechanical Turk

Heuristic Evaluation

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

Heuristic Evaluation

Developed by Jakob Nielsen (1994)

Can be performed on working UI or sketches

Small set (3-5) of evaluators (experts) examine UI

- Check compliance with usability heuristics
- Different evaluators will find different problems
- Evaluators only communicate afterwards to aggregate findings
- Use violations to redesign/fix problems

Original Heuristics

H1-1: Simple and natural dialog

H1-2: Speak the users' language

H1-3: Minimize users' memory load

H1-4: Consistency

H1-5: Feedback

H1-6: Clearly marked exits

H1-7: Shortcuts

H1-8: Precise & constructive error messages

H1-9: Prevent errors

H1-10: Help and documentation

Revised Heuristics

Also developed by Nielsen.

- Based on factor analysis of 249 usability problems
- A prioritized, independent set of heuristics

Revised Heuristics

H2-1: Visibility of system status

H2-2: Match system and real world

H2-3: User control and freedom

H2-4: Consistency and standards

H2-5: Error prevention

H2-6: Recognition rather than recall

H2-7: Flexibility and efficiency of use

H2-8: Aesthetic and minimalist design

H2-9: Help users recognize, diagnose and recover from errors

H2-10: Help and documentation

Heuristic: Visibility (Feedback)

H2-1: Visibility of system status

- Keep users informed about what is going on
- Example: pay attention to response time
  - 0.1 sec: no special indicators needed
  - 1.0 sec: user tends to lose track of data
  - 10 sec: max. duration if user to stay focused on action
- Short delays: Hourglass
- Long delays: Use percent-done progress bars
  - Overestimate usually better

Heuristic: Visibility (Feedback)

Users should always be aware of what is going on

- So that they can make informed decision
- Provide redundant information

Heuristics: Match System & World

H2-2: Match between system & real world

- Speak the users' language
- Follow real world conventions
- Pay attention to metaphors

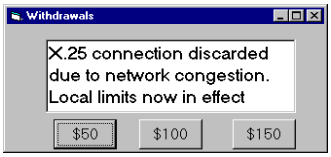
Bad example: Mac desktop

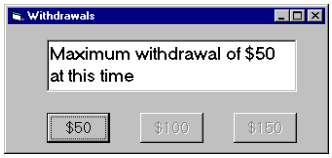
- Dragging disk to trash
- Should delete it, **not** eject it

Heuristics: Match System & World

Speak the users' language (H1-2)

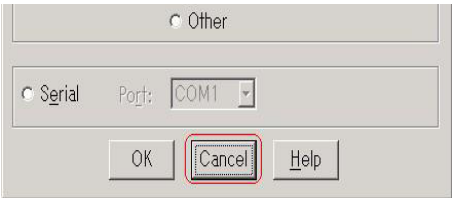
- Withdrawing money at ATM





- Use meaningful mnemonics, icons and abbreviations

Heuristics: Control & Freedom



H2-3: User control & freedom

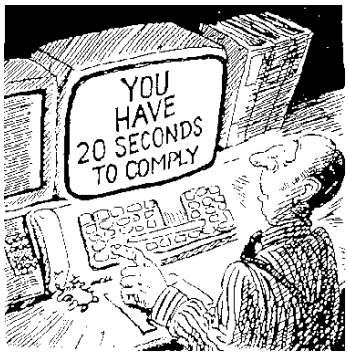
- "Exits" for mistaken choices, undo, redo
- Don't force down fixed paths like the old BART ticket machine…

Wizards

- Must respond to Q before going to next
- Good
  - For infrequent task (e.g. Internet Config)
  - Beginners (2 versions in WinZip)
- Not good
  - For common tasks

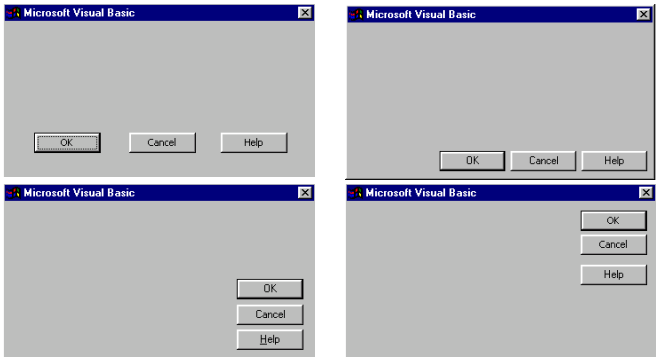
Heuristics: Control & Freedom

- Mark exits: Users don't like to be trapped!



- Strategies
  - Cancel button (or Esc key) for dialog
    - Make the cancel button responsive!
  - Universal undo

Heuristics: Consistency



H2-4: Consistency and standards

Heuristics: Errors and Memory

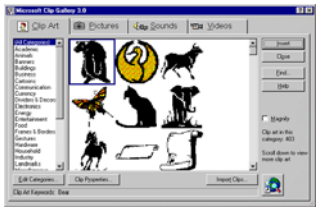
H2-5: Error prevention

H2-6: Recognition rather than recall

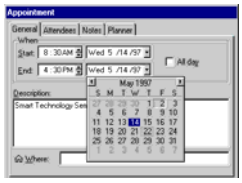
- Make objects, actions, options, & directions visible or easily retrievable

Heuristic: Errors and Memory

- Promote recognition over recall
  - Recognition is easier than recall



- Describe expected input clearly
  - Don't allow for incorrect input



- Create orthogonal command systems
  - Using generic commands that can be applied to all interface objects

Preventing Errors

Error types

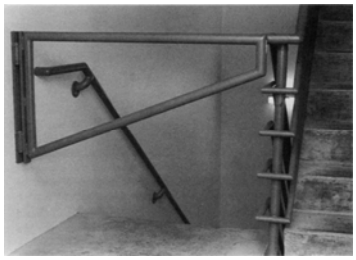
- Mistakes
  - Conscious decision with unforeseen consequences
- Slips
  - Automatic behaviors kicking in
    - Drive to the store, end-up in the office
    - Press enter one time too many…
  - Mode errors
    - Forget the mode the application is in
  - Loss of activation
    - Forget what your goals were

Forcing Functions

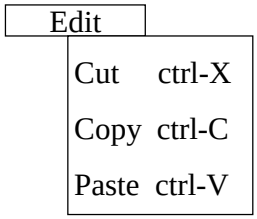
Interlock mechanisms
- – Switching from P to D in a car

Lockin mechanisms
- – No eject button for floppy disk on Mac

Lockout mechanisms
- – Exit stairways

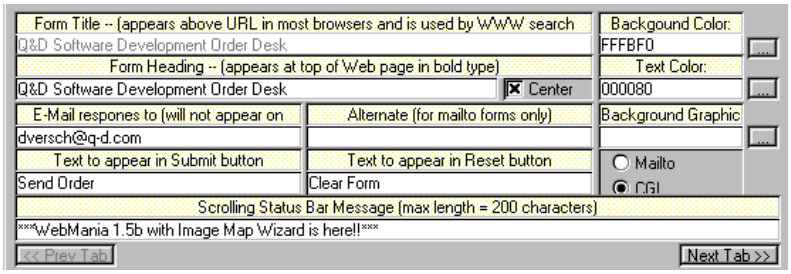


Heuristics: Flexibility



H2-7: Flexibility and efficiency of use
- – Accelerators for experts (e.g., gestures, shortcuts)
- – Allow users to tailor frequent actions (e.g., macros)

Heuristics: Aesthetics



H2-8: Aesthetic and minimalist design

– No irrelevant information in dialogues

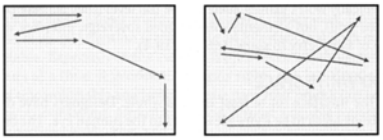
Hueristic: Aesthetics

From Cooper's "The inmates are running the asylum"

Heuristic: Aesthetics

Simple and natural dialog (H1-1)

Present information in natural order



From Cooper's "About face 2.0"

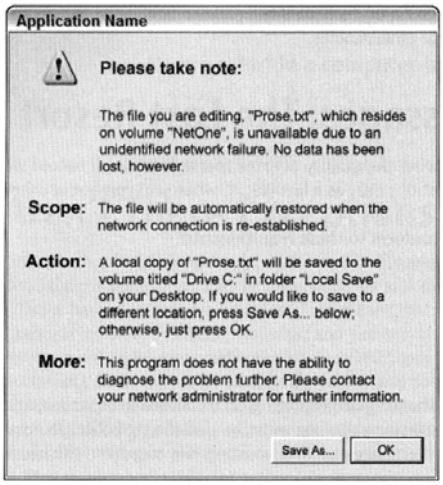
- Occam's razor
  - Remove or hide irrelevant or rarely needed information
    - They compete with important information on screen
      - Pro: Palm Pilot
      - Against: Dynamic menus
  - Use windows frugally
    - Avoid complex window management

Heuristics: Help Users

H2-9: Help users recognize, diagnose, and recover from errors

- Error messages in plain language
- Precisely indicate the problem
- Constructively suggest a solution

Good Error Messages

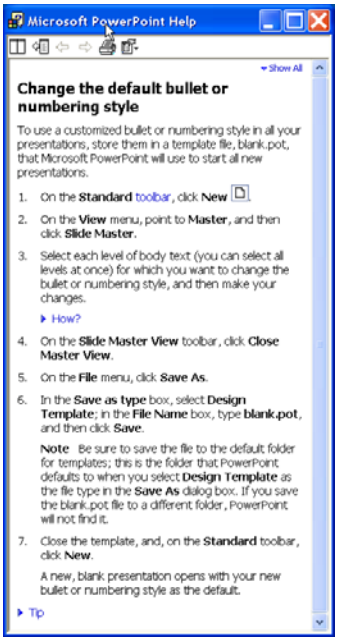


From Cooper's "About Face 2.0"

Heuristics: Docs

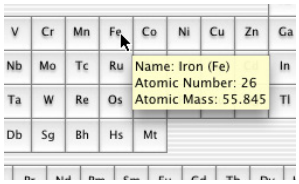
H2-10: Help and documentation

- Easy to search
- Focused on the user's task
- List concrete steps to carry out
- Not too long



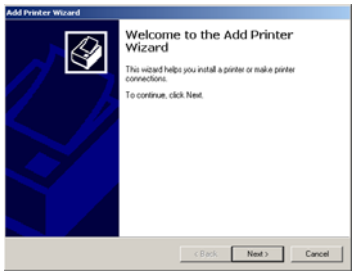
Types of Help

- Tutorial and/or getting started manuals
  - Presents the system conceptual model
    - Basis for successful explorations
  - Provides on-line tours and demos
    - Demonstrates basic features
- Reference manuals
  - Designed with experts in mind
- Reminders
  - Short reference cards, keyboard templates, tooltips…



Types of Help

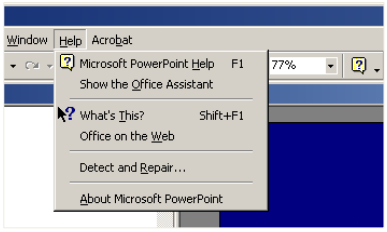
- Wizards
  - Walks user through typical tasks
    - Users feel they are losing control
    - What if I do not have the information requested?



- Tips
  - Migration path to learning new features
  - Can become boring and tedious

Types of Help

- Context sensitive help



The Process of Heuristic Evaluation

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

Examples

Can't copy info from one window to another

- Violates "Minimize the users' memory load" (H1-3)
- Fix: allow copying

Typography uses mix of upper/lower case formats and fonts

- Violates "Consistency and standards" (H2-4)
- Slows users down
- Fix: pick a single format for entire interface

- Probably wouldn't be found by user testing

Severity Rating

Used to allocate resources to fix problems

Estimates of need for more usability efforts

Combination of

- Frequency
- Impact
- Persistence (one time or repeating)

Should be calculated after all evaluations are in

Should be done independently by all judges

Levels of Severity

0 - don’t agree that this is a usability problem

1 - cosmetic problem

2 - minor usability problem

3 - major usability problem; important to fix

4 - usability catastrophe; imperative to fix

Severity Ratings Example

1. [H2-4 Consistency] [Severity 3][Fix 0]

The interface used the string "Save" on the first screen for saving the user's file, but used the string "Write file" on the second screen. Users may be confused by this different terminology for the same function.

Debriefing

- Conduct with evaluators, observers, and development team members
- Discuss general characteristics of UI
- Suggest improvements to address major usability problems
- Development team rates how hard things are to fix
- Make it a brainstorming session
  - Little criticism until end of session

Pros and Cons of Heuristic Evaluation

HE vs. User Testing

HE is much faster
- 1-2 hours each evaluator vs. days-weeks

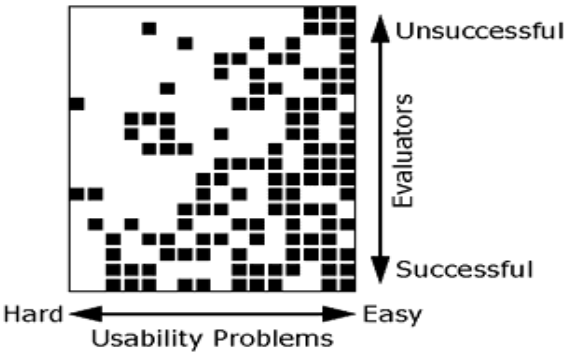
HE doesn't require interpreting user's actions

User testing is far more accurate (by def.)
- Takes into account actual users and tasks
- HE may miss problems & find "false positives"

Good to **alternate** between HE & user-based testing
- Find different problems
- Don't waste participants

Why Multiple Evaluators?

- Every evaluator doesn't find every problem
- Good evaluators find both easy & hard ones



Number of Evaluators

Single evaluator achieves poor results

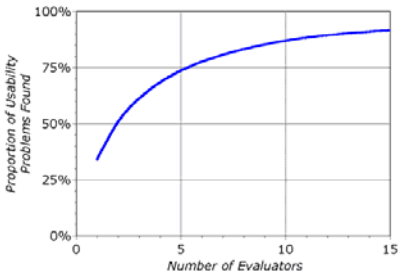
- Only finds 35% of usability problems
- 5 evaluators find ~ 75% of usability problems
- Why not more evaluators???? 10? 20?
  - Adding evaluators costs more
  - Many evaluators won't find many more problems

But always depends on market for product:

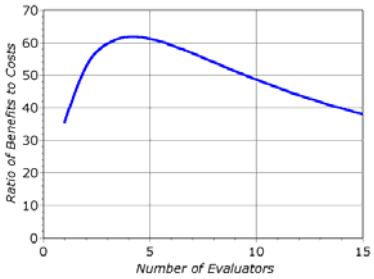
- popular products → high support cost for small bugs

Decreasing Returns

Problems Found



Benefits / Cost



Benefits of Using HE

Discount: benefit-cost ratio of 48 [Nielsen94]

- Cost was $10,500 for benefit of $500,000
- Value of each problem ~15K (Nielsen & Landauer)
- how might we calculate this value?
  - In-house → productivity
  - Open market → sales
  - Customer calls to your customer service center

Tends to find more of the high-severity problems

Summary

- Heuristic evaluation is a discount method
- Have evaluators go through the UI twice
  - Ask them to see if it complies with heuristics
    - Note where it doesn't and say why
- Have evaluators independently rate severity
- Combine the findings from 3 to 5 evaluators
- Discuss problems with design team

- Cheaper alternative to user testing
  - Finds different problems, so good to alternate

Next Time

Quantitative Evaluation

- How To Do Experiments. *Doing Psychology Experiments.* Chap 2. Marin.
- How to Decide Which Variables To Manipulate and Measure. *Doing Psychology Experiments.* Chap 7. Marin.