

SWE3053

Human Computer Interaction

Lecture 27

User Evaluation

User Evaluation



Introduction

How do you test...

- a web site?
- an air traffic control system?

How much would you budget for testing?

Are you required to test? (e.g. military, government, safety)



Types of evaluation

1. Controlled settings involving users
 - Usability testing & experiments in laboratories and living labs.
2. Natural settings involving users
 - Field studies and in the wild studies to see how the product is used in the real world.
 - Lab studies to observe particular behavior
3. Expert Review, settings not involving users,
 - To predict, analyze & model aspects of the interface analytics.

Evaluation methods

Method	Controlled settings Empirical Methods	Natural settings	Expert Review Not involving users Analytical Methods
Observing	X	X	
Asking users	X	X	
Asking experts		X	X
Testing	X		
Modeling			X

Expert Review

- General Review
 - Ask Colleagues or Customers
 - Informal
 - Natural starting point
 - Ask for opinions
- Expert Review
 - Ask experts to evaluate the design
 - Formal
 - Considerations:
 - What is an expert? User or designer?
 - How long? Half day to week
 - Different review methods from which to choose

Expert Review

- Heuristic Evaluation
- Cognitive Walk-through
- GOMS





Heuristics Evaluation

- Developed by Jakob Nielsen in late 80's-early 90's
 - Focused on ROI and simplicity
 - Trying to convince world usability was worth paying attention to
- A simple structured process for finding usability problems in a UI
- Apply design heuristics to evaluate the interface
- Design Heuristics are general design principles and guidelines
- What is Design Heuristics???
-

Design Heuristics (General Design Principles)

- Refresh your memory
- In Lecture 11, we talked about General Design Principles

Some common interface design principles

- Nielson's 10 Heuristics (by Jakob Nielson)
- Shneiderman's 8 Golden Rules (by Ben Shneiderman)
- Norman's Design Principles (by Don Norman)
- NDA's 7 Principles of Universal Design -(National Disability Authority)

Design Heuristics

- Design Heuristics are useful in two stages of the process.
- In design, you can use the heuristics to guide you in choosing between design alternatives (and avoid making boneheaded mistakes).
- It turns out that heuristics are also effective for evaluation, identifying problems in an implemented interface.



Heuristic Evaluation

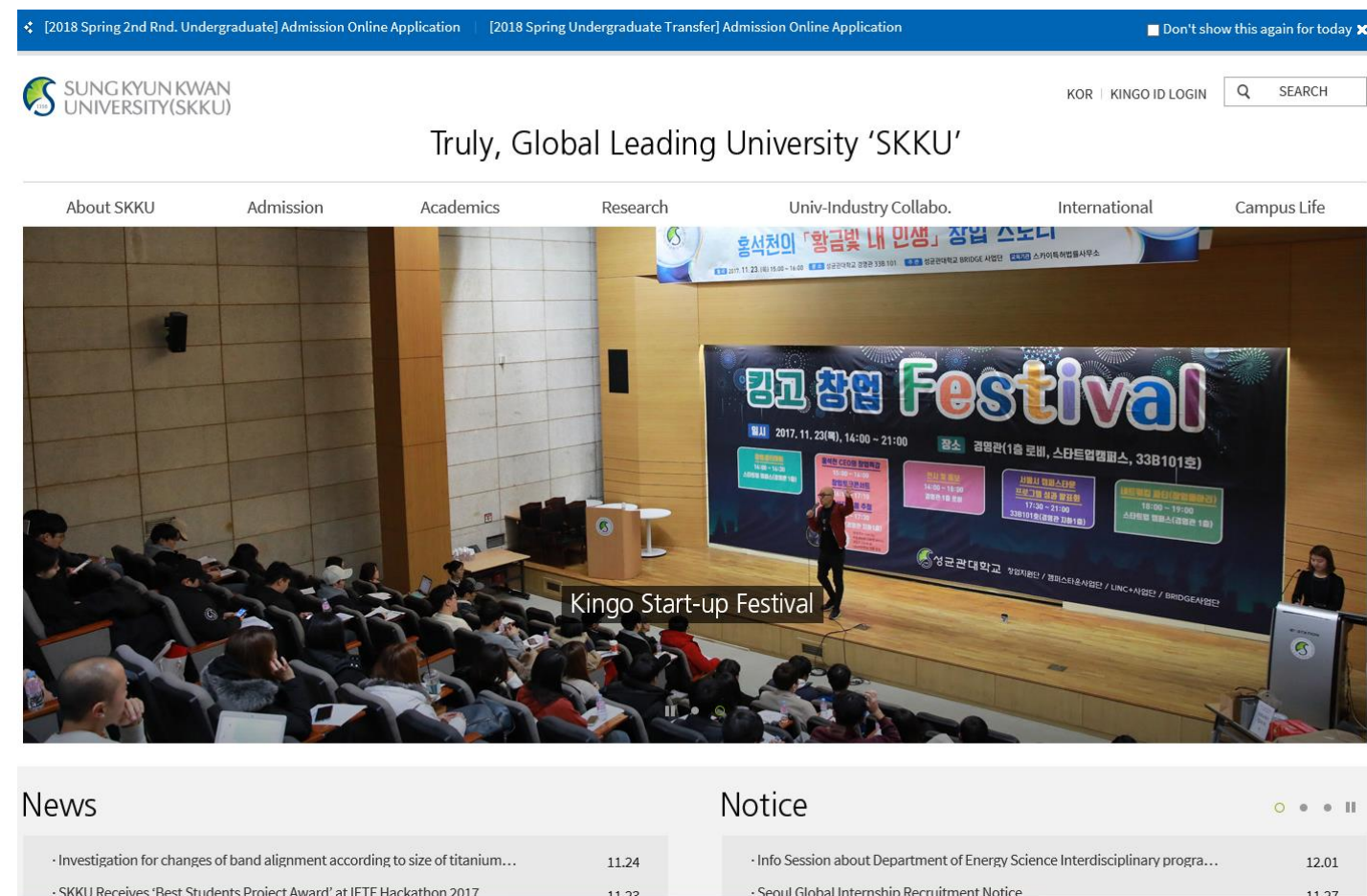
- Experts to evaluate interface on using design heuristics
- Based on existing design principles or guidelines
 - Design Heuristics Example:
 - Nielsen's 10 Heuristics
 - Shneiderman's Eight Golden Rules
 - Norman's Design Principles
 - Tognazzini's 16 Principles
 - TOG's first principles
 - Mac, Windows, Gnome, KDE, Android, iOS design guidelines
 - etc ...

Eight Golden Rules of Interface Design

1. Strive for consistency
2. Cater to universal usability
3. Offer informative feedback (e.g. button clicked)
4. Design dialogs to yield closure (e.g. confirmation page)
5. Prevent errors (e.g. gray out menu items)
6. Permit easy reversal of actions
7. Support internal locus of control
8. Reduce short-term memory load (e.g. 7 ± 2)



Evaluate this Design



The image shows a screenshot of the Sungkyunkwan University (SKKU) website and a photograph of a university event.

Website Screenshot:

- Top navigation bar: [2018 Spring 2nd Rnd. Undergraduate] Admission Online Application, [2018 Spring Undergraduate Transfer] Admission Online Application, Don't show this again for today.
- SKKU Logo: SUNG KYUN KWAN UNIVERSITY(SKKU)
- Language: KOR | KINGO ID LOGIN | SEARCH
- Header: Truly, Global Leading University 'SKKU'
- Menu: About SKKU, Admission, Academics, Research, Univ-Industry Collabo., International, Campus Life
- Main Content: A large banner for the 'Kingo Start-up Festival' with details about the event (2017. 11. 23(목), 14:00 ~ 21:00) and various booths.
- Footer: News and Notice sections with dates.

Event Photo:

- Event: Kingo Start-up Festival
- Date: 2017. 11. 23(목), 14:00 ~ 21:00
- Location: 경명관(1층 로비, 스타트업캠퍼스, 33B101호)
- Activities: Various booths and presentations are visible on the stage.

Example...

- Let's use Nielsen's 10 Heuristics for Heuristics Evaluation ...
- Review each single page and interaction in an interface design
- Review the Indiana University Website: <http://www.indiana.edu>
- By Ross Campbell, Kyle Frost, Matt Soave
- http://www.mattsoave.com/old/cogs187a/iu_site_eval/index.html
- Goal:
 - Generate a document listing all the issues in the design
-

Heuristics Evaluation

- Performed by an expert
- Steps
 - Inspect UI thoroughly
 - Compare UI against heuristics
 - List usability problems
- Explain & justify each problem with heuristics



1. Visibility

- The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.



The screenshot shows the Indiana University homepage. At the top is the 'INDIANA UNIVERSITY' logo in red. Below it is a navigation bar with links: Home, Prospective Students, Alumni & Donors, and Economic Development. A large red banner with the text 'We Are IU' is prominent. To the left of the banner is a photo of students. To the right is a callout box stating 'preservation of top navigation is good.' Below the banner, a callout box points to the 'We Are IU' title, stating 'title shows current location, but no highlighting of the navigation to indicate directory'. Below this, a list of bullet points describes IU's impact on Indiana. To the left of the main content is a sidebar with links under three categories: 'We are IU' (Campuses, Medical Centers, Research), 'About IU' (Admissions, Academics, Arts & Culture, Community Outreach, Emergency Preparedness, Employment, International Resources, Libraries, News & Information, Sports & Recreation, Technology), and 'Administration' (President, Board of Trustees). At the bottom, a footer contains the IU logo, address, phone number, and copyright information.

INDIANA UNIVERSITY

Home | Prospective Students | Alumni & Donors | Economic Development

We Are IU

preservation of top navigation is good.

title shows current location, but no highlighting of the navigation to indicate directory

- Nearly 258,000 IU alumni work in Indiana. More than 50 percent of Indiana's physicians, 40 percent of nurses, 64 percent of dentists are IU graduates.
- As part of the Indiana Life Sciences Initiative, IU is developing a business incubator and biomedical research center to take advantage of the state's growing life sciences industry.
- IU has recognized the central role of information technology in the 21st-century economy by creating the new School of Informatics.
- As part of Clarian Health Partners (University Hospital, Riley Hospital for Children, and Methodist hospital) and in collaboration with the Indiana State Department of Health, IU provides care for thousands of patients each year. In addition, many Hoosier citizens are treated at IU's eye care centers, dental clinics, and other health services.
- Through the Indiana Genomics Initiative (INGEN), IU scientists are using the genetic map published by the Human Genome Project to identify genes that may be linked to disease.
- IU campuses across the state enrich the lives of Indiana residents with cultural offerings ranging from art exhibits, theater, and music to lectures and performances.
- IU not only trains future teachers for Indiana's schools but also forms partnerships with schools and communities to improve education.

You can explore this Web site to find many more ways in which Indiana University benefits Hoosiers every day.

We are IU
Campuses
Medical Centers
Research

About IU
Admissions
Academics
Arts & Culture
Community Outreach
Emergency Preparedness
Employment
International Resources
Libraries
News & Information
Sports & Recreation
Technology

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1. Visibility

- The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.



The screenshot shows the 'Emergency Preparedness' page of the Indiana University website. A callout box points to the top navigation area, stating: 'The navigation is lost completely on this page. Even though this page was accessed from the main page, we lose the main navigation bar, so there's no way to get back to where we came from.'

Emergency Preparedness

EXPLOSION
TORNADO
FIRE
TERRORIST ATTACK
BIOHAZARD

BE READY BE READY BE READY BE READY
FOR ANYTHING FOR ANYTHING FOR ANYTHING FOR ANYTHING

Indiana University wants you to be ready for anything. In the event of a disaster or emergency, this Web site will contain regularly updated news, instructions, and information.

You will need to know what to do and what actions the university is taking in the following types of situations:

- Explosion
- Severe Weather
- Fire
- Shooter
- Terrorist Attack
- Biohazard

During critical situations, IU faculty, staff, and students will receive information and instructions directly through IU-Notify, an integrated e-mail.

1 Influenza Information

[Learn more about Human Influenza A >>](#)

IU-Notify

Stay informed by managing your contact information through OneStart >>

[Check out the IU-Notify FAQ to learn more about how IU-Notify works >>](#)

Alert Status by Campus

- IU Bloomington: Normal
- IUPUI: NORMAL
- IPFW: Normal
- IUPUC: Normal
- IU East: Normal
- IU Kokomo: Normal

2. Match the Real World

- Don't use technical jargon
- Use common words
- Especially in error messages

Prospective Students

Each year, Indiana University welcomes thousands of new students to our eight campuses. Most are first-year college students, but the quality of life is enhanced by transfer students, international students, and returning students who also join our ranks every year. Discover all that IU offers for undergraduate and international students.

IU Bloomington

Office of Admissions
300 North Jordan Ave.
Bloomington, IN 47405-1106
(812) 855-0661
E-mail: iuadmit@indiana.edu

IUPUI Indianapolis

Enrollment Services
425 University Blvd.
Cavanaugh Hall 129
Indianapolis, IN 46202-5143
(317) 274-4591
E-mail: apply@iupui.edu

IU East

Office of Admissions
2225 Chester Blvd

- Campus Profile
- Bursar (fees/costs)
- Student Financial Assistance
- Campus Map and Building List

why use the word "bursar" when you need to clarify with (fees/costs)?

- Photo Tour
- Registrar

- Campus Profile
- Bursar (fees/costs)
- Campus Maps and Directions
- Orientation
- Photo Tour
- Registrar
- Student Financial Aid Services

- Campus Profile
- Academic Advising
- Bursar (fees/costs)
- Campus Maps and Directions

2. Match the Real World

- Don't use technical jargon
- Use common words
- Especially in error messages

The screenshot shows the Indiana University website with a highly complex and overlapping navigation menu. The menu items are listed in a vertical column on the left, with multiple overlapping boxes containing different sets of links. A callout box asks "what is IUPUI?".

Navigation Menu Items (Left Column):

- Campuses
- Medical Centers
- Research
- About IU
- Admissions
- Academics
- Arts & Culture
- Community Outreach
- Emergency Preparedness
- Academics
- Arts & Culture
- Community Outreach
- Emergency Preparedness
- Diversity Resources
- International Resources
- Libraries
- News & Information
- Sports & Recreation
- Technology
- Administration
- President
- Board of Trustees

Overlapping Boxes (Left):

- Bloomington Research
- IUPUI Research
- Research Administration
- Research News
- IU Bloomington Admissions
- IUPUI Indianapolis Admissions
- IU East Admissions
- IPFW Fort Wayne Admissions
- IU Kokomo Admissions
- IU Northwest Admissions
- IU South Bend Admissions
- IU Southeast Admissions

Overlapping Boxes (Right):

- We are IU
- Campuses
- Medical Centers
- Research
- About IU
- Admissions
- Academics
- Arts & Culture
- Community Outreach
- Emergency Preparedness
- Diversity Resources
- International Resources
- Libraries
- News & Information
- Sports & Recreation
- Technology
- Bloomington
- Indianapolis
- East
- Fort Wayne
- Kokomo
- Northwest
- South Bend
- Southeast

Callout Box: what is IUPUI?

Text at Bottom: extreme variation of language used to describe the different campuses may confuse users

3. User Control and Freedom

Comments

Your information needs and comments about this site are important to us. If you have a question is directed to the appropriate office or department.

Select a topic:

--- Choose an option ---
--- Choose an option ---
Give us feedback on the search function
Question / Comment about the IU Gateway
Add your site to the IU Gateway or update your existing information
Question about admissions, scholarships, or how to apply
Comment about Indiana University
Question / comment about a news item

restrictive use of topics on the comments page.

404 error if you make an error in your first submission

Your name:

Your e-mail address

Submit

Error

Error 404 - Page not found

Sorry for the inconvenience, the page you requested could not be found.

If the site you are in offers a site map or 'A-Z Big List' try those first. Otherwise, try conducting

4. Consistency and Standards

INDIANA UNIVERSITY

Search: **GO!**
Find People

Prospective Students | Alumni & Donors | Economic Development | K-12 Education | Faculty & Staff

We are IU
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Medical Centers
Research

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Spotlight
Captain Kidd's pirate cannon arrives at IU. [More >>](#)

IU Headlines 
• IU Bloomington libraries named top in the country
• Captain Kidd's pirate cannon from the Caribbean comes to Indiana

Top Sites
Updated Info
 **H1N1 Influenza Information**
Haiti Earthquake Relief


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INDIANA UNIVERSITY

Search: **GO!**
Find People

Prospective Students | Alumni & Donors | Economic Development | K-12 Education | Faculty & Staff

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• [Museum for Higher Education](#)

Top Sites
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 **H1N1 Influenza Information**
Haiti Earthquake Relief

Follow the Funding
 **Economic Stimulus**
IU Awards to Date
Advocate for IU
 **HHE Statehouse Visit**
February 2

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5. Error Prevention

Comments

Error

You have not filled in all the required fields. Please use the form below to finish submitting a question. All of the fields are required

Select a topic:

Type your question or comment in the box below:

Required!

Submitting the form without populating the fields results in "Required!" error messages

Your name:

Your e-mail address


Submit

Despite the fact that the form still isn't filled in properly, hitting the submit button still submits the form

6. Recognition rather than Record

INDIANA UNIVERSITY

[Home](#) | [Prospective Students](#) | [Alumni & Donors](#) | [Economic Development](#)



We Are

A lack of breadcrumbs make current position within the site difficult to discover

Today, more than ever before, universities hold the key to ensuring our economic prosperity and quality of life. With more than 1 million Hoosiers in thousands of ways.

We are IU

- [Campuses](#)
- [Medical Centers](#)
- [Research](#)

About IU

- [Admissions](#)
- [Academics](#)
- [Arts & Culture](#)
- [Community Outreach](#)
- [Emergency Preparedness](#)
- [Employment](#)
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- IU not only trains future teachers for Indiana's schools but also forms partnerships with schools and communities to improve the quality of education for all Hoosiers.

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The red links are clearly recognizable





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Heuristic Evaluation

- This process is to be completed for every page and every interaction for the design
- At the end, you will have a list of issues identified.
-



How To Do Heuristic Evaluation Right

- Justify every problem with a heuristic
 - “Too many choices on the home page – Aesthetic & Minimalist Design”
 - Can’t just say “I don’t like the colors”
- List every problem
 - Even if an interface element has multiple problems
- Go through the interface at least twice
 - Once to get the feel of the system
 - Again to focus on particular interface elements
- Don’t limit yourself to the 10 heuristics
 - We’ve seen others: affordances, constraints, visibility of parts, Fitts’s Law, perceptual fusion, color principles
 - But the 10 heuristics are easier to compare against

Heuristic Evaluation Is Not User Testing

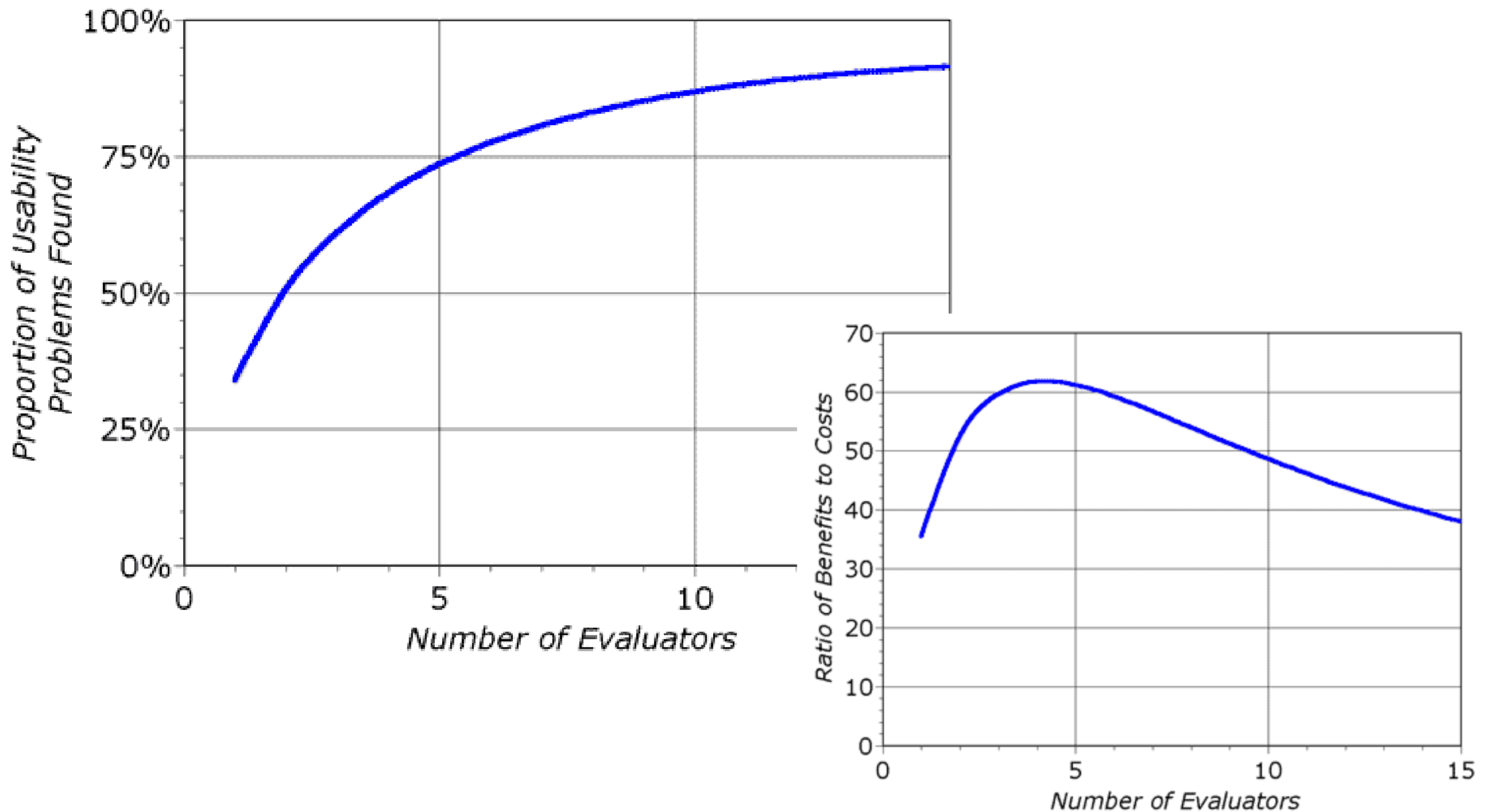
- Evaluator is not the user either
 - Maybe closer to being a typical user than you are, though
- Analogy: code inspection vs. testing
- Heuristic Evaluation finds problems that User Testing often misses
 - Inconsistent fonts
 - Fitts's Law problems
- But User Testing is the gold standard for usability



Hints for Better Heuristic Evaluation

- Use multiple evaluators
 - Different evaluators find different problems
 - The more the better, but diminishing returns
 - Nielsen recommends 3-5 evaluators
 - Evaluators must work independently
- Alternate heuristic evaluation with user testing
 - Each method finds different problems
 - Heuristic evaluation is cheaper

How many evaluators?



Empirical evidence suggests that five evaluators usually identify around 75% of total usability problems.

Formal Heuristic Evaluation Process

1. Training

- Meeting for design team & evaluators
- Introduce application
- Explain user population, domain, scenarios

2. Evaluation

- Evaluators work separately
- Generate written report, or oral comments recorded by an observer
- Focus on generating problems, not on ranking their severity yet
- 1-2 hours per evaluator


3. Severity Rating

- Evaluators prioritize all problems found (not just their own)
- Take the mean of the evaluators' ratings

4. Debriefing

- Evaluators & design team discuss results, brainstorm solutions

Severity Ratings

- Contributing factors
 - Frequency: how common?
 - Impact: how hard to overcome?
 - Persistence: how often to overcome?
 - Severity scale
 1. Aesthetic: need not be fixed
 2. Minor: needs fixing but low priority
 3. Major: needs fixing and high priority
 4. Catastrophic: imperative to fix
- 

Evaluating Prototypes

- Heuristic evaluation works on:
 - Sketches
 - Paper prototypes
 - Unstable prototypes
- “Missing-element” problems are harder to find on sketches
 - Because you’re not actually using the interface, you aren’t blocked by feature’s absence
 - Look harder for them

Heuristic Evaluation – Pros and Cons

- Pros

- Very fast and cost effective
- Easy, comparing with running user study
- Identifies many usability issues
- no user involves, no cost for test subjects
-

- Cons

- relies on interpretation of guidelines
- guidelines may be too generic
- needs more than one evaluator to be effective
- no user involves, doesn't reflect actual usage

-



Walkthrough Basics

- Related to Heuristic Evaluation, but focus on tasks and users
- Imagine how well a user could perform tasks with your low-fidelity prototype (base on a persona, if you created one)
- Like role-playing: imagine yourself as the user, then perform the task
-
- Manipulate prototype as you go
 - evaluate choice-points in the interface
 - evaluate labels or options
 - evaluate likely user navigation errors
 -
- Revise prototype and perform again

Cognitive Walk-through

- Like role-playing, imagine yourself as the user
- Mentally walk-through the task
- Task specific approach
- Procedure
 - Specify a task
 - Imagine you are the user and list the step by step procedure of performing the task
 - e.g. Softdrink machine –procedure to make a purchase
 - At each step, ask: Will the user make the right choice?
 - Think as if you are the target user: make use of the persona

Example

- Will the user try to achieve the right effect?
(assumption and expectation)
- Will the user notice that the correct action is available?
(visibility and understandability of UI elements)
- Will the user associate the correct action with the effect
to be achieved?
- If the correct action is performed, will the user see the
progress is being made? (feedback)



Example:

How about this one...

- Will the user try to achieve the right effect? (assumption and expectation)
- Will the user notice that the correct action is available? (visibility and understandability of UI elements)
- Will the user associate the correct action with the effect to be achieved?
- If the correct action is performed, will the user see the progress is being made? (feedback)



Actual remote may vary by service area.
* Feature not available in some areas.

Why we use it

- Cognitive walkthrough enables a designer to evaluate an interface *without* users
- a designer attempts to see the interface from the perspective of a user
 -
- Low-investment technique to identify task-related usability issues early on
 - no implementation or users required
 - can be performed on existing interfaces
- Identify task-related problems before implementation
- invest a little now, save a lot later
 -
- Enables rapid iteration early in design
- can do several evaluations of trouble points
 -
-

When to do the Cognitive Walkthrough

- Have a low-fidelity prototype of the interface
- Know who the users are
- Have task descriptions
- Have scenarios designed to complete the task
 - you have a “functional” paper prototype
-
- Viable once the scenario and paper prototype are complete



GOMS

- GOMS stands for Goals, Operators, Methods, Selection Rules
- GOMS is a UI modeling technique
 - Develop a representational model for a task
- GOMS attempts to establish a model to achieve three goals
 - Predict
 - Predict the time required for the user to complete a task
 - Describe
 - Describe how the user perform a task
 - Prescribe
 - Develop training program and help system for a task

GOMS

- Goals
 - What the user wants to do
- Operators
 - Specific steps a user is able to take, and assign an estimated execution time for each step
- Methods
 - A sequence of operators to accomplish the goal
- Selection Rules
 - Guidelines for deciding between multiple methods
-

Different Variant of GOMS

- Keystroke-Level Model (KLM)
- Card, Moran, and Newell (CMN-GOMS)
- Natural GOMS Language (NGOMSL)
- Cognitive-Perceptual-Motor GOMS (CPM-GOMS)
- We will discuss the simplest variant, the KLM model only in this class

•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

•Real-world GOMS Applications

- KLM

- Mouse-based text editor

- Mechanical CAD system

- NGOMSL

- TV control system

- Nuclear power plant operator's associate

- CPM-GOMS

- Telephone operator workstation

Real-world GOMS Applications

- ❑ Simulations of airplanes and helicopters in simulated theatres of war (STOWs) with SOARS
- ❑ Sun's webpage, CAD, word processors, mobile phone input methods, etc.
- ❑ Project Ernestine: Adding new, "improved" workstations for Telephone Operators
 - CPM-GOMS revealed that the new workstations would have cost an additional \$2 million a year to operate!



GOMS: Keystroke-Level Model (KLM)

- Simplest GOMS technique
 - The basis for all other GOMS techniques
 - Predicts execution time
 - How long does it take on average for a user to complete a task on the interface?
-
- Assumes that routine cognitive skills can be decomposed into a serial sequence of **basic cognitive operations and motor activities**, which are:
 - **K**: A keystroke (280 msec)
 - **M**: A single mental operator (1350 msec)
 - **P**: Pointing to a target on a small display (1100 msec)
 - **H**: Moving hands from the keyboard to a mouse (400 msec)

Motor: Key Input

- Parameters of keyboard input based on
 - Skill of the typist
 - Best Typist (120 wpm): 80 msec
 - Worst Typist: 1200 msec
 - Predictability & continuity of the text to be typed
 - Typing random letters: 500 msec



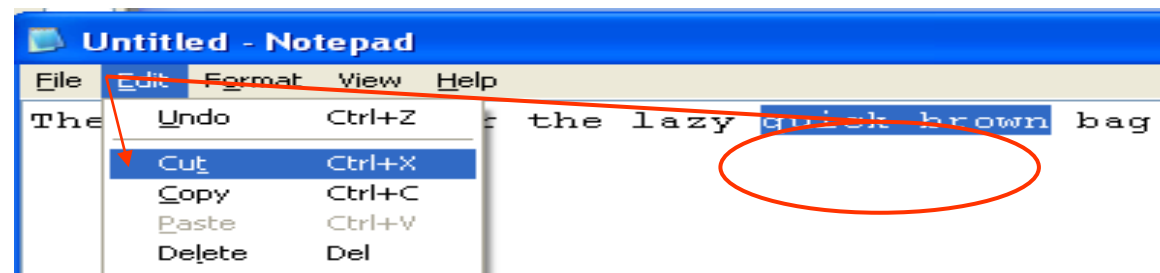
Summary of Cognitive Parameters

Retrieve from memory	1200 msec
Execute a mental step	70 msec
Choose among methods	1250 msec
Enter a keystroke	230 msec
Point with a mouse	1500 msec
Move hands to mouse	360 msec
Perceive	100 msec
Make a saccade	230 msec

•Keystroke-Level Model

- How to make a KLM
 - List specific actions user does to perform task
 - Keystrokes and button presses
 - Mouse movements
 - Hand movements between keyboard & mouse
 - System response time (if it makes user wait)
 - Add Mental operators
 - Assign execution times to steps
 - Sum execution times
- Only provides execution time and operator sequence

KLM Example



Top-level Goal:

- Edit Manuscript (move "quick brown" to before "fox")

Subgoal:

- Highlight text

Operators:

Move-mouse

Click mouse-button

Type characters (keyboard shortcuts)

Methods:

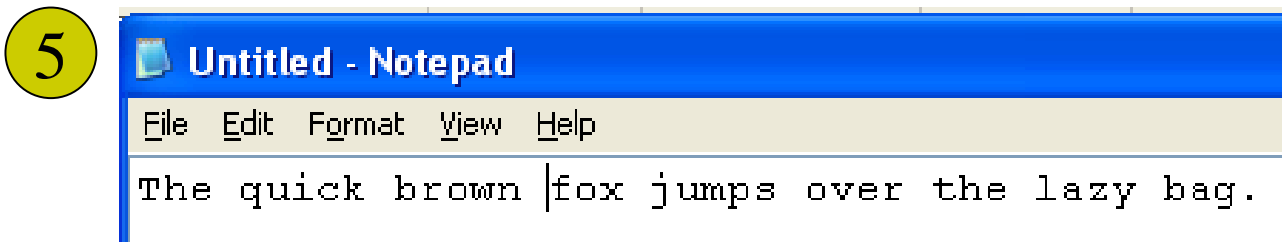
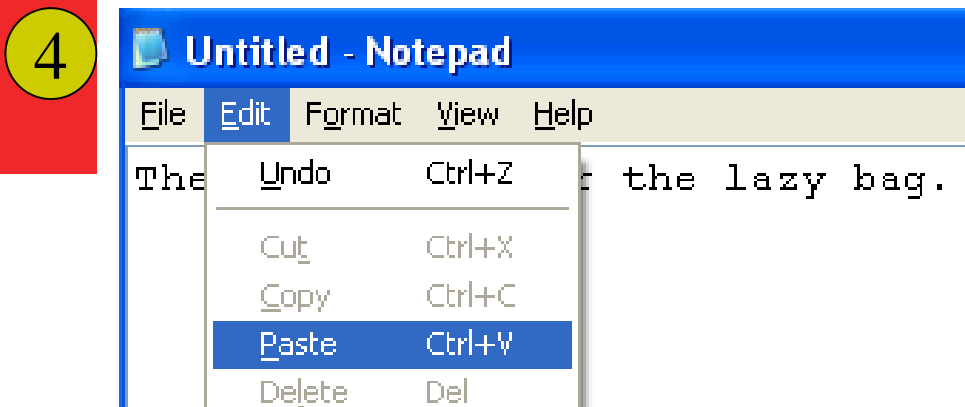
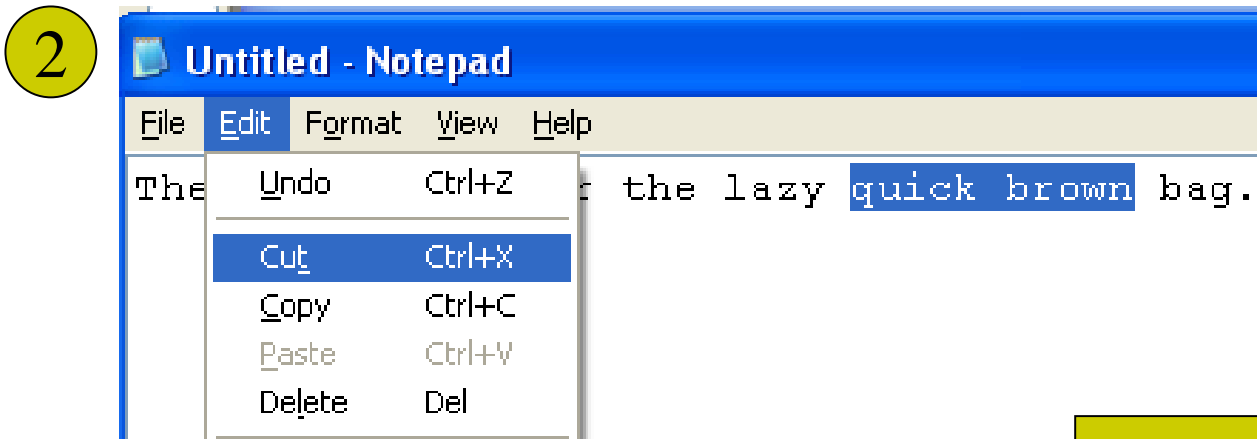
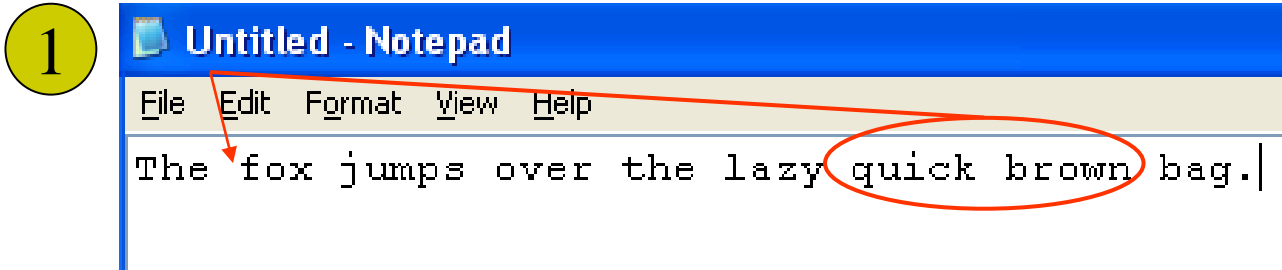
1. Delete-word-and-retype (retype method)
2. Cut-and-paste-using-keyboard-shortcuts (shortcuts method)
3. Cut-and-paste-using menus (menus method)

Selection Rules:

- **If** the text to be moved is one or two characters long, use retype method
- **Else**, if remember shortcuts, use shortcuts method
- **Else**, use the menus method

Method Used

Cut-and-paste-using-menus



M=1.35
P=1.10
K=0.20

Description	Operator	Duration (sec)
Mentally Prepare	M	1.35
Move cursor to "quick"	P	1.10
Double-click mouse button	K	0.40
Move cursor to "brown"	P	1.10
Shift-click mouse button	K	0.40
Mentally Prepare	M	1.35
Move cursor to Edit Menu	P	1.10
Click mouse button	K	0.20
Move cursor to Cut menu item	P	1.10
Click mouse button	K	0.20
Mentally Prepare	M	1.35
Move cursor to before "fox"	P	1.10
Click mouse button	K	0.20
Mentally Prepare	M	1.35
Move cursor to Edit menu	P	1.10
Click mouse button	K	0.20
Move cursor to Paste menu item	P	1.10
Click mouse button	K	0.20
TOTAL PREDICTED TIME		14.90

•Comparative Example - DOS

- Goal: Delete a File
- Method for accomplishing goal of deleting file
 - retrieve from Long term memory that command verb is “del”
 - 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 - Mac

- 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 - DOS

- 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 - Mac

- 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 Mac! This makes it much easier.

What GOMS can model

- Task must be goal-directed
- Task must be a routine cognitive skill
 - as opposed to problem solving as in Cognitive Walkthrough
- GOMS-KLM predicts execution time
 - Assume task performed by expert
 - Very good rank ordering
 - Absolute accuracy ~10-20%

•Applications of GOMS analysis

- Compare UI designs
- Profiling
- Ensure frequent goals achieved quickly
- Sensitivity and parametric analysis
- Building a help system
 - GOMS modeling makes user tasks and goals explicit
 - Can suggest questions users will ask and the answers

•Pros of GOMS

- Model explains **why** the results are what they are
- Less work than user study
- Easy to modify when interface is revised
-

•Cons of GOMS

- Not as easy as heuristic analysis, guidelines, or cognitive walkthrough
- Only works for goal-directed tasks
- Assumes tasks are performed by expert users
- Evaluator must pick users' tasks/goals
- Does not address several important UI issues, such as
 - readability of text
 - memorability of icons, commands
- Does not address error and fatigue issues
- Does not address social or organizational impact



Usability Testing

<https://www.youtube.com/watch?v=3Qg80qTfzqU>

Major Types of Evaluation

- Formative evaluation

Done at different stages of development to check that the product meets users' needs

- Summative evaluation

Assesses the quality of a finished product

Usability testing: involves recording typical users' performance on typical tasks in controlled settings

Field studies: done in natural settings, the aim is to understand what users do naturally and how technology impacts them

Expert Review (Analytical Review): inspections, theoretically based models

No hypothesis

Loose
methodology

Subjective,
qualitative
results

Fixed hypothesis

Rigidly defined
methodology

Objective,
quantitative
results



**Field
study**

**User
observation**

**Usability
testing**

Usability Testing and Labs

- 1980s, testing was luxury (but deadlines crept up)
- Usability testing was incentive for deadlines
 - Speed up projects*
 - Cost savings*
- Labs are different than academia
 - Less general theory
 - More practical studies

Usability Labs

- IBM early leader
- Microsoft next (>25 labs)
- Now hundreds of companies



Staff

- Expertise in testing (Psych, HCI, CS)
- 10 to 15 projects per year
- Meet with UI architect to plan testing
- Participate in early task analysis and design reviews
- Participants – number, types and sources (current customers, company staff, temp agencies, advertisements)



Participants

- Labs categorize users based on:
 - Computing background
 - Experience with task
 - Motivation
 - Education
 - Ability with the language used in the interface
- Controls for
 - Physical concerns (e.g. eyesight, handedness, age)
 - Experimental conditions (e.g. time of day, physical surroundings, noise, temperature, distractions)

Recording Participants

- Logging is important, yet tedious
 - Software to help (Live Logger, [Mora](#), Spectator)
- New approaches: eye tracking
 - Tobii (infrared to generate reflection patterns on corneas)
 - Mobile eye tracker:
<https://www.youtube.com/watch?v=2NcUkvIX6no>



Major Types of Evaluation

- Usability testing: involves recording typical users' performance on typical tasks in controlled settings
 - Different type of Usability Testing
 - Discount Usability Testing
 - Technique: Think Aloud Technique
 - Technique: Post-test Walkthrough

Methodology

Measurement

- Post-test questionnaires
- How many subjects?
- Assessment Testing
 - most typical, either early or midway in the product development
- Validation Testing
 - verification of product's usability
- Comparison Testing
 - compare two or more designs; can be used with other three types of tests

Discount Usability Testing

- Usually conducted early in the project stage
- Early:
 - Most design is not fixed
 - Prototype is low fidelity
 - Measurement and analysis is crude
 - Collect qualitative data
 - “Just get the feeling”
 - Few participants
 - Convenient sample (but still, need to match with user profile)
 -

Example

<https://www.youtube.com/watch?v=9wQkLthhHKA>



Think aloud technique

User should think aloud

- What they think is happening
- What they're trying to do
- Why they took an action
- Problems
 - Feels weird
 - Thinking aloud may alter behavior
 - Disrupts concentration

Facilitator should moderate: keep asking subject questions

Think aloud technique

- Other approach: pairs of users
 - Two users working together are more likely to converse naturally
 - Also called co-discovery, constructive interaction
- Retrospective think aloud
 - Asks people afterwards what they were thinking
 - Issues with accuracy (remembering)
 - Does not interrupt users (timings are more accurate)

–

Example

<https://www.youtube.com/watch?v=IHmaS0hXx4w>



How many subjects???

Landauer-Nielsen model

- Every tested user finds a fraction L of usability problems
- Typical $L = 31\%$ (based on empirical data)
- If user tests are independent
 - then n users will find a fraction $1-(1-L)^n$
- So 5 users will find 85% of the problems
- Which is better:
 - Using 15 users to find 99% of problems with one design iteration
 - Using 5 users to find 85% problems with each of three design iterations
- For multiple user classes, get 3-5 users from each class

Flaws in Landauer-Nielsen Model

L may be much smaller than 31%

– Spool & Schroeder study of a CD-purchasing web site found $L=8\%$, so 5 users only find 35% of problems

- L may vary from problem to problem

– Different problems have different probabilities of being found, caused by:

- Individual differences

- Interface diversity

- Task complexity

- Take-home lesson: you can't predict with confidence how many users may be needed

Post-test Walkthrough

- Transcript played back to participant for comment
 - Immediately → fresh in mind
 - Delayed → evaluator has time to identify questions

Useful to identify reasons for actions and alternatives considered

Necessary in cases where think aloud is not possible



Usability Testing: Methodology

1. Develop problem statements, objectives, and/or hypotheses
2. Design test materials
3. Identify and select participants who represent target population
4. Select administrators
5. Conduct the test
6. Analyze and interpret the data



1. Develop problem statements, objectives, and/or hypotheses

- What is the questions you're trying to ask through the usability study?
 - Comparison of alternatives?
 - Exploration of idea?
 - Evaluation of effectiveness and/or efficiency?
 - Effectiveness: if the expected goals have been achieved?
 - Efficiency: What is the effort required to achieve the goals?
 - Measure user's satisfaction?
 - Design specific questions?

2. Design test materials

- Develop testing prototype
- Measurements
- Task list
 - List of actions participants will execute
 - Desired end results
 - Motives for performing task
- Prepare test materials
 - Orientation script
 - Consent form
 - Data logging/recording equipment/materials

Measurements (Usability metrics)

- ❑ Metrics: A system/standard for measurement
- ❑ Usability metrics should be observable
- ❑ Simple Quantitative Measurements:
 - Time of completion
 - Task success
 - ❑ Binary success vs. Level of success
 - Number of errors
 - Number of key press
- ❑ Simple Qualitative Measurements:
 - User satisfaction
 - User enjoyment
- ❑ Usability metrics show if you're improving user's performance and/or experience (comparison between versions and alternatives)
- ❑ You may compare with your competitors

Usability Testing: Typical Objectives

- Usable Web site: (Rubin, 1994)
 - *Usefulness*
 - Establish whether it does what the user needs it to do
 - *Effectiveness*
 - Ease of use to achieve the desired task
 - *Learnability*
 - Ease of learning application and moving from being a novice to a skilled user
 - *User satisfaction*
 - User's attitude about the site—how enjoyable it is to use

Usability Testing: Benchmarking Usability

- - Five factors for benchmarking the usability of an interface (Shneiderman and Plaisant, 2004)
 - Time to learn
 - Speed of performance
 - Rate of errors
 - Retention over time
 - Subjective satisfaction

Usability Testing: Issue based metrics



- Issue based metrics relate to usability issues that has been identified
 - Frequency of issues
 - Frequency of issues per participant
 - Issues by category
 - Issues by task

Target Measurements (Benchmark)

- Don't simply report average value
 - e.g. Average time of completion is meaningless
 - A more meaningful report:
 - Percentage of users managed to complete a task within a time period

•Usability Specification Table

Scenario task	Worst case	Planned Target	Best case (expert)	Observed
Find most expensive house for sale?	1 min.	10 sec.	3 sec.	??? sec
...				



Typical Usability Studies

- 1) Complete a list of tasks with the interface
- 2) Measure performance during the tasks
- 3) Fill out post-test questionnaires



Most used Likert scales

- Questionnaire for User Interaction Satisfaction
- System Usability Scale (SUS) – Brooke 1996
 - 10 questions: 5 pos worded, 5 neg worded (reverse coding)
- Post-Study System Usability Questionnaire
- Computer System Usability Questionnaire
- Software usability Measurement Inventory
- Website Analysis and Measurement Inventory
- Mobile Phone Usability Questionnaire
- Questionnaire websites
 - Gary Perlman's website
 - <http://garyperlman.com/quest/>

Example 1: Prioritizing Web Usability

- ❑ Nielsen and Loranger, 2006
- ❑ Use Think Aloud Method
- ❑ 69 users, all with at least 1 year web browsing experience
- ❑ Test 25 web sites, with specific tasks
- ❑ Windows desktop, 1024x768
- ❑ Record monitor and video of user's upper body

Example 1: Prioritizing Web Usability

□ Some sample tasks:

- Go to ups.com and find out the cost to ship a postcard to China
- Go to getty.edu and find the opening time and ticket price for Getty Museum
- Go to bankone.com and find the best savings account for \$1,000

Example 1: Prioritizing Web Usability

□ Some findings:

- Task successful rate is 66% for single site activities; Task successful rate is 60% for multiple site activities
- Users spend about 25 seconds on a homepage; 45 seconds on interior pages
- 23% users scroll on their first visit of a homepage
- 88% of users go to search engines to find information

Example 2: OpenSmsDroid Evaluation

- ❑ Experimental Evaluation of Techniques for Usability Testing of Mobile Systems in a Laboratory Setting. (Beck, Christiansen, Kjeldskov, Kolbe and Stage, 2003)
- ❑ Evaluation of an Android messaging application – OpenSMSDroid
- ❑ Use Think Aloud Method

Example 2: OpenSmsDroid Evaluation

- Testing Environment:
 - Sitting on a chair
 - Walking on a treadmill at constant speed
 - Walking on treadmill at varying speed
 - Walking on an 8-shaped course at constant speed
 - Walking on an 8-shaped course at varying speed
 - Walking in Westfield Stratford at 16:00 on Saturday

Example 2: OpenSmsDroid Evaluation

- Testing Environment:
 - Sitting on a chair
 - Walking on a treadmill at constant speed
 - ~~■ Walking on treadmill at varying speed~~
 - ~~■ Walking on an 8-shaped course at constant speed~~
 - ~~■ Walking on an 8-shaped course at varying speed~~
 - Walking in Westfield Stratford at 16:00 on Saturday

Example 2: OpenSmsDroid Evaluation

□ Task:

- Writing the same SMS message 2 times to an existing contact: “The quick brown fox jumps over the lazy dog”
- Writing the same SMS message 2 times using predictive text features to an existing contact: “The quick brown fox jumps over the lazy dog”
- Take a picture and send to an existing contact
- Take a 1 minute video and send to an existing contact

Example 2: OpenSmsDroid Evaluation

- Measurement:
 - Quantitative:
 - Time of completion
 - Task success
 - Qualitative:
 - Think aloud technique

Limitations for Usability Testing

- Focuses on first-time users
- Limited coverage of interface features
 - Testing only 1-3 hours – can't know performance after week or month
 - Rarely used features
- Difficult to simulate realistic conditions
 - Ex: Military, first response
 - Stress in real usage situation can lead to inability to process info (Rahman 2007)
- Yet formal studies on usability testing have identified
 - Cost savings
 - Return on investment (Sherman 2006; Bias & Mayhew 2005)