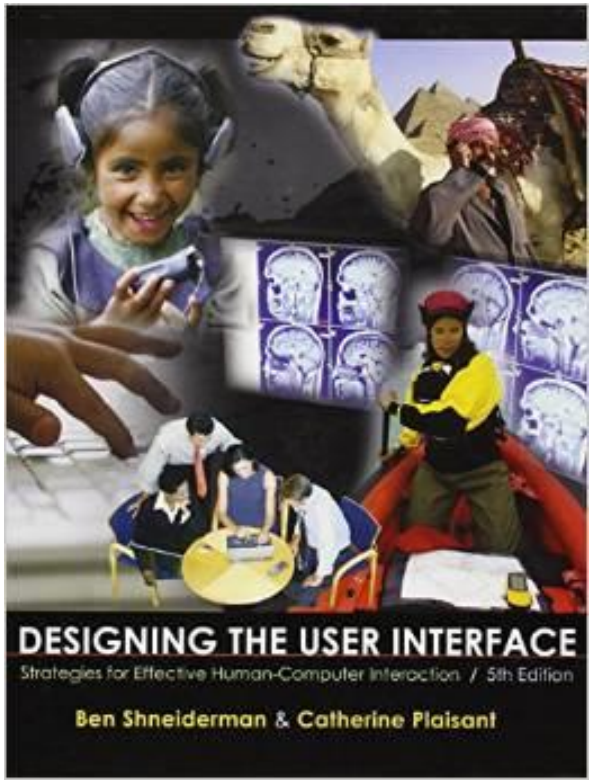
NANYANG TECHNOLOGICAL UNIVERSITY

Guidelines, Principles, and Theories

CZ2004 Human–Computer Interaction

"Guidelines, Principles, and Theories"

- Reading – **Designing the User Interface: Strategies for Effective Human-Computer Interaction** by Ben Shneiderman and Catherine Plaisant
  - Chapter 2.1, 2.2, 2.3, 2.4.2



"Guidelines, Principles, and Theories"

– Overview

- Guidelines – specific and practical

  » narrowly focused rules

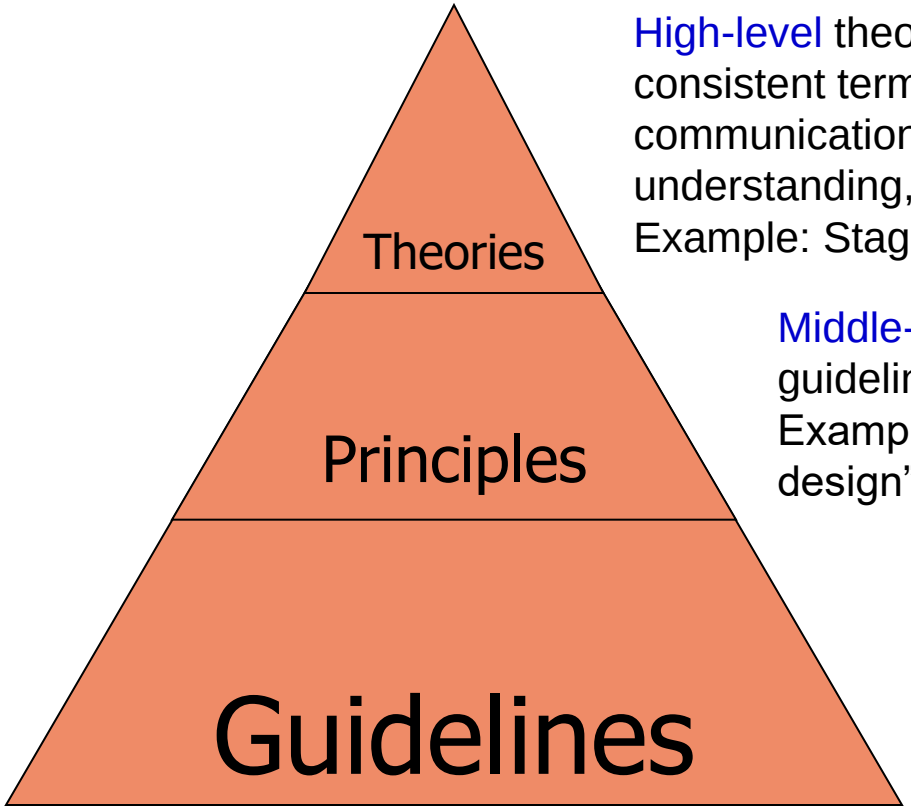
- Principles – mid-level

  » widely applicable and enduring

- Theories – high level (includes models)

  » tested, proven, broadly useful

Introduction



High-level theories that describes objects and actions with consistent terminology to support teaching, education, and communication. Can be used to ***predict*** performance, errors, understanding, satisfaction of user.
Example: Stages-of-action models

Middle-level practices that can be applied to different guidelines, analyzing and comparing design alternative.
Example: User classification, “8 golden rules of UI design”, etc.

Design-level practices and rules that make for good and consistent design (some based on theory).
Examples: Apples guidelines for UIs

Why guidelines, principles, and theories?

- **Why have guidelines, principles, and theories?**
  - Help keep our UI designs focused and consistent
  - Help avoid and remedy mistakes (e.g., cluttered display, tedious procedures, inadequate functionalities, etc.)
  - Provide theories and high-level description of interaction and design

- The role of *theory* in this course
  - We will *not* spend a lot of time on any specific theory
  - However, it is important to understand the role of theory, and its relationship between guidelines and principles
    - We will only carefully study one example of the theories – the *stage of actions*

NANYANG TECHNOLOGICAL UNIVERSITY

I. Guidelines

GUIDELINES

- Definition
- Components
- Important (example) guidelines
  - Navigation
  - Helping people with disability
  - Display organization
  - Data entry

What are “guidelines”?

- Guidelines were developed in the “early days”
- Best Practices
  - For example, Windows and Apple UI
- From experience
  - For example, of Microsoft or Apple interface designers
- Good starting point for all projects involving a UI
- Developed “Shared language”
  - Widget Names, Functionality name, etc.
  - Gives all developers involved a language to discuss the UI

Components that form guidelines

- **(1) Rules** (Specific and practical)
  - Provides cures for design problems
  - Provides cautions for potential danger
  - Reminders based on experience

Components that form guidelines (cont.)

- **(2) Examples**
  - Give details on how a design must be performed
  - Style, color usage, window appearance, etc.
  - Interaction usage (when to use check-boxes, when to user buttons, etc.)
    - These guidelines could be based on experience
    - Ex: developers found that users preferred a list+slider over a pull-down menu for a long list of choices
  - Require all developers to follow the guidelines

Components that form guidelines (cont.)

- **(3) Document**
  - Any serious large-scale UI design should have a “Guideline Document”
  - Provides a “Shared language” that developers and ***customers*** can use

    Similar to CSS (style sheet in HTML):

    http://www.w3.org/TR/html4/present/styles.html
  - Allows consistency within a design team
    - Especially a large-team working on a large project
  - Guidelines document is not trivial
    - Think of the effort needed to specify “everything” pertaining to the UI, but it is *necessary*

(Guideline) Document

- **Can be used to specify many aspects of an interface:**
  - Input and output formats
  - Action sequences
  - Terminology
  - Hardware devices/platforms
  - Provide Examples & counterexamples
- **Pros:**
  - Builds upon (good previous) experience
  - Continued improvements
- **Cons:**
  - Too specific
  - Hard to innovate
  - Not applicable/realistic to the situation
  - Hard to apply
- What do you do when having an exception?

Guideline Document

- Think about templates
  - Word
  - PowerPoint
  - LaTeX
- Any other from you?

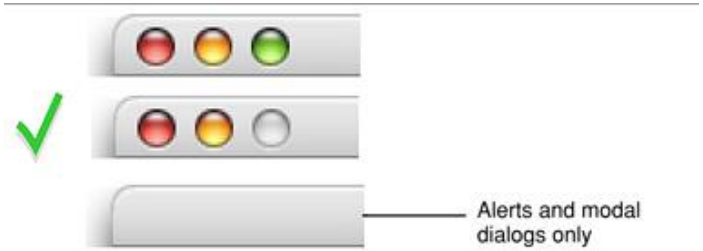
#1: A case study: iOS 7 guideline

Apple's "Design Principles"
http://developer.apple.com/library/ios/#documentation/UserExperience/Conceptual/MobileHIG/Principles/Principles.html#//apple_ref/doc/uid/TP40006556-CH5-SW1

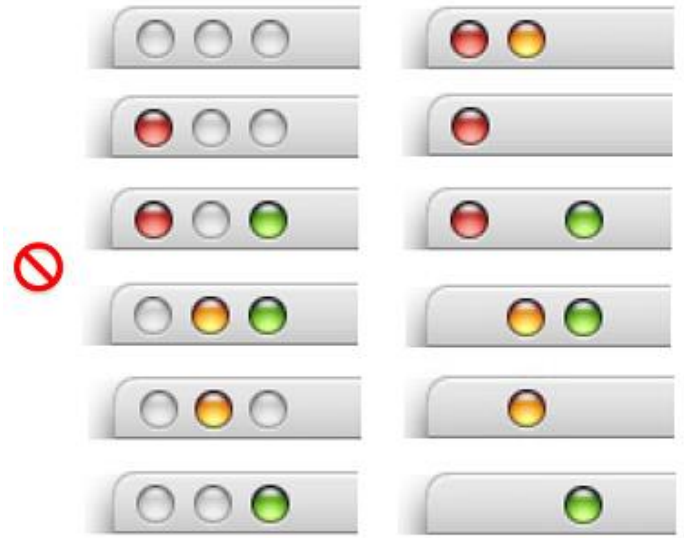
Apple's "Human Interface Guidleine for iOS 7"
https://developer.apple.com/library/ios/documentation/UserExperience/Conceptual/MobileHIG/index.html#//apple_ref/doc/uid/TP40006556

Guideline Document from Apple

Figure 13-27 Example of an About window



- Create icons that measure no more than 19x19 pixels.
- Make the outline sharp and clear.
- Use a straight-on perspective.
- Use black (add transparency only as necessary to suggest dimensior
- Use anti-aliasing.
- Use the PDF format.
- Make sure the image is visually centered in the control (note that vis same as mathematically centered).

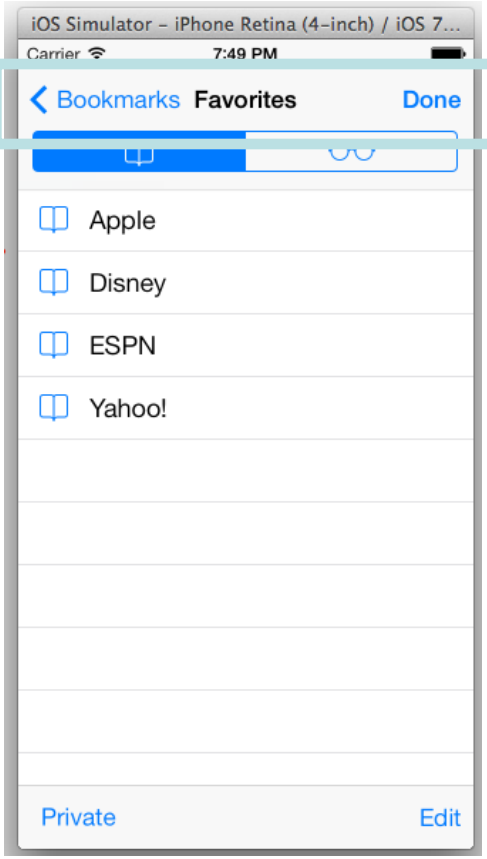


http://developer.apple.com/library/mac/#documentation/UserExperience/Conceptual/AppleHIGuidelines/index.html

iOS 7: Navigation Bar (from Apple library)

- Definition
  - A **navigation bar** enables navigation through an information hierarchy and, optionally, management of screen contents
- Example
  - 

- Rules
  - A navigation bar is translucent.
  - Generally appears at the top of an app screen, just below the status bar. On iPad, a navigation bar can also display within a view that doesn't extend across the screen, such as one pane of a split view controller.
  - Can automatically change its height when an iPhone changes orientation. Maintains the same height in all orientations on iPad

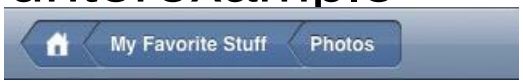


From: iOS UI Element Usage Guidelines
https://developer.apple.com/library/ios/documentation/UserExperience/Conceptual/MobileHIG/Bars.html#//apple_ref/doc/uid/TP40006556-CH12-SW1

iOS 7: Navigation Bar (cont.)

- Selected guidelines

  (Only portions of those listed by Apple)

  - When it adds value, use the title of the current view as the title of the navigation bar
  - Consider putting a segmented control in a navigation bar at the top level of an app
  - Avoid crowding a navigation bar with additional controls, even if it looks like there's enough space
  - Make sure text-titled buttons have enough space between them
  - Don't create a multi-segment back button
- Counterexample
  - 

  - Why is bad?

Guideline: Five Example Cases

1. Navigating the Interface
2. Guidelines for Disabled
3. Organizing the Display
4. Get the user's attention!!
5. Facilitate Data Entry

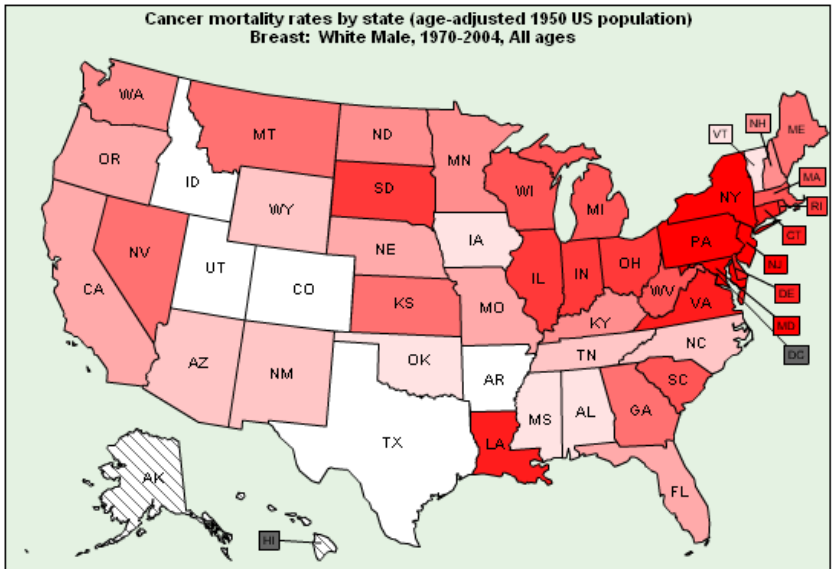
Navigating the Interface

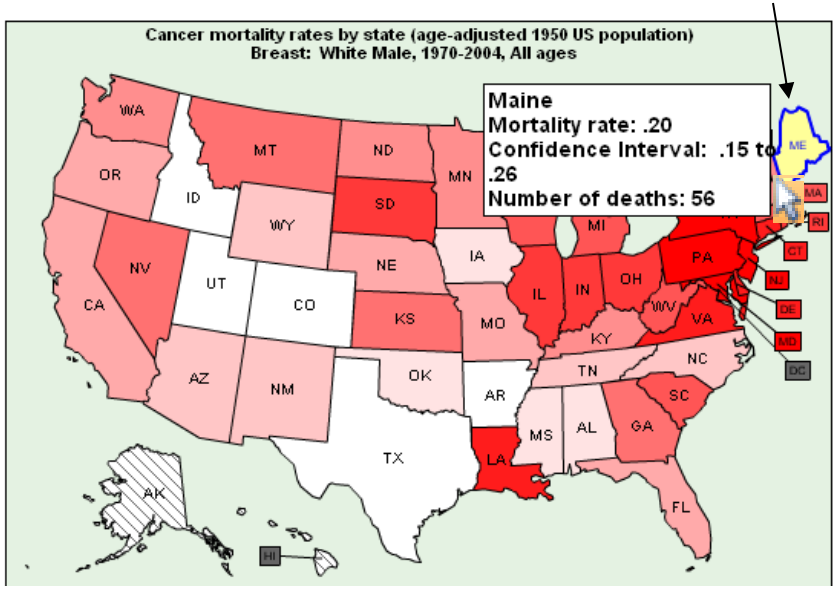
- Example from National Cancer Institute (NCI)
  - Developers developed 388 guidelines backed by research for designing their web-pages
- Some guidelines established by the NCI website developers
  - Standardize task sequences
  - Ensure that embedded links are descriptive
  - Use unique and descriptive headings (related to the content they describe)
  - Use *radio button* for mutually exclusive choice and *check boxes* for multi-answer choices
  - Develop pages that will print properly
    - All pages/information on the web should be printable
  - Use thumbnail images to preview larger images
- Go to their website, http://www.nci.nih.gov/ and evaluate:
  - Pretend to be different types of User: Novice, Intermediate, Expert
  - Test Different Tasks: Education, Search, Research
  - Are the pages consistent? Are the guidelines followed?

Navigating the Interface (cont.)

- Embedded links are descriptive:

Mouse over





Where are u studying?

e.g., NTU or NUS

Which canteen(s) you like?
e.g., Canteen A, Canteen B, Canteen 1, etc.

Guidelines for Disabled

- WWW Consortium adopted these guidelines for designing web pages for disabled : http://www.w3.org/TR/WCAG20/ (V2.0 2008)
  - Text equivalent for every non-text element (images, image map, animations, applets, ascii art, frames, scripts, bullets, sounds, audio, video, etc.)
  - Any time-based multimedia, provide equivalent synchronized alternatives (captions, descriptions)
  - All color info can be captured by users without color – from context or markup
  - Title each frame, facilitating frame identification and navigation
- Enables screen readers or other technologies to have multiple methods to obtain the webpage info
- How does this end up helping everyone?

Display organization guidelines

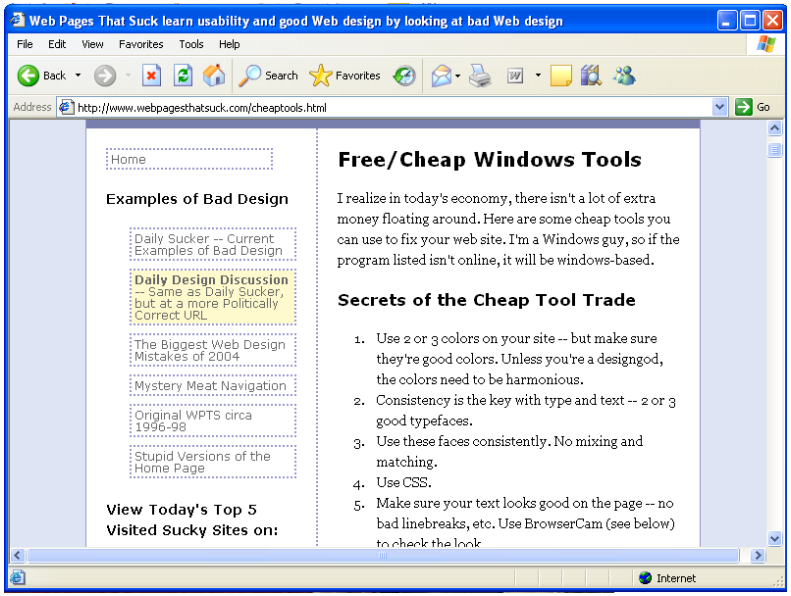
- Consistency of data display
  - Terminology, abbrev., formats, colors, grammar, capitalization should be consistent!
- Efficient information assimilation by the user
  - Familiar format
  - Related to tasks at hand
  - e.g. spacing, formatting, labels, units/measurements, numbers of decimal points
- Minimal memory load on the user
  - Minimal carry information over from on screen to another
  - Require fewer actions
    - TAB key to move to next entry field vs. having to use the mouse
  - Labels and common formats should be provided for novice (Ex. SSN/phone #)

Display organization guidelines (cont.)

- Compatibility of data display with data entry
  - Entering data should look similar to the eventual viewing of the data
- Flexibility for user control of data display
  - User control for information display (e.g., sorting, ordering of columns and rows)
- Only a starting point
  - Has many special cases
  - Application specific, hardware independent (e.g., ATMs)

Displays vs. User's attention!

- User sees lots of data in front of them
- Urgent, exceptional, and time-dependent conditions need to be brought forward
- Ex. games and damage (visual, audio)
- Intensity – two levels only, limited use of high intensity
- Marking – underlines, enclose it in a box, arrows, asterisk, bullet, dash
- Size – Up to 4 sizes, with larger sizes attracting more attention
- Fonts – three fonts



Displays vs. User's attention! (cont.)

- Inverse video – inverse coloring
- Blinking Colors
  - Should blink at 2-4 blinks per second (Hz), Color – *no more than 4 on a screen*
- Audio
  - soft tones – positive
  - harsh – emergency
  - multiple levels are difficult to distinguish, do we like human voices?
- Danger in overusing the above
  - Animation should provide needed information (e.g. progress indicator)
  - Similarly highlighted items imply relationships
  - Novices need simple, logically organize, well labeled displays
  - Experts want shorter labels, more flexibility, subtle highlight of changed values

Example of a Bad Webpage

This part blinks.

From: http://www.webpagesthatsuck.com

They changed later… but…

http://www.notrag.org.uk/ (this webpage updates later but now not longer available)

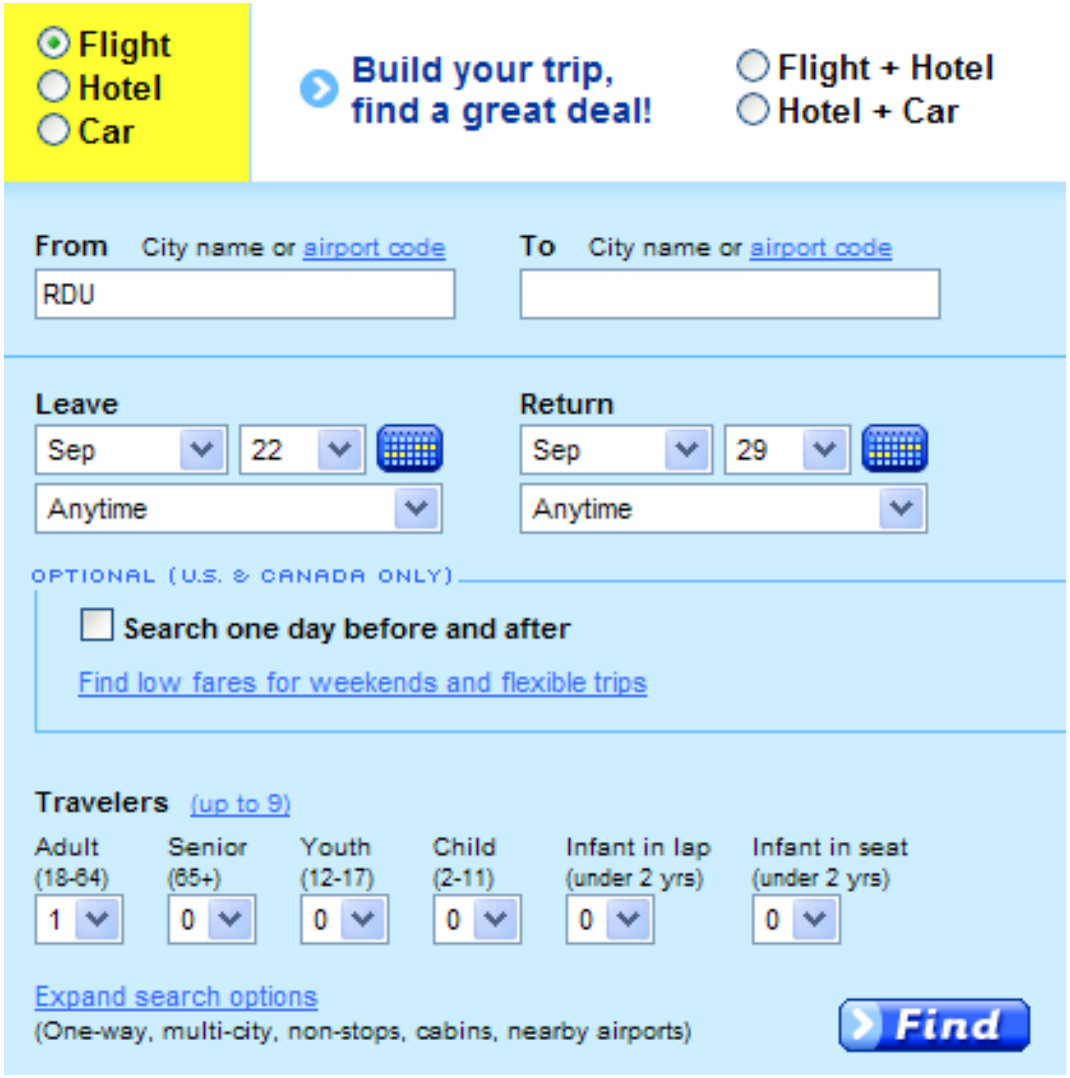
Data Entry guidelines

- Data entry can occupy a substantial portion of user's time and be the source of frustrating and potentially dangerous errors
- Consistency of data-entry transactions – similar sequence of actions, delimiters, abbrev.
- Minimal input actions by user
  - fewer actions = greater productivity and less error
  - E.g., single key-stroke vs. mouse selection, vs. typing is typically better
  - E.g., Command line vs. GUI
  - Too much hand movement is not good. Ex. Experts prefer to type 6-8 characters instead of moving a mouse, joystick, etc.
  - Avoid redundant data entry (waste of time, perceived effort, increased error). System should aid but allow overriding

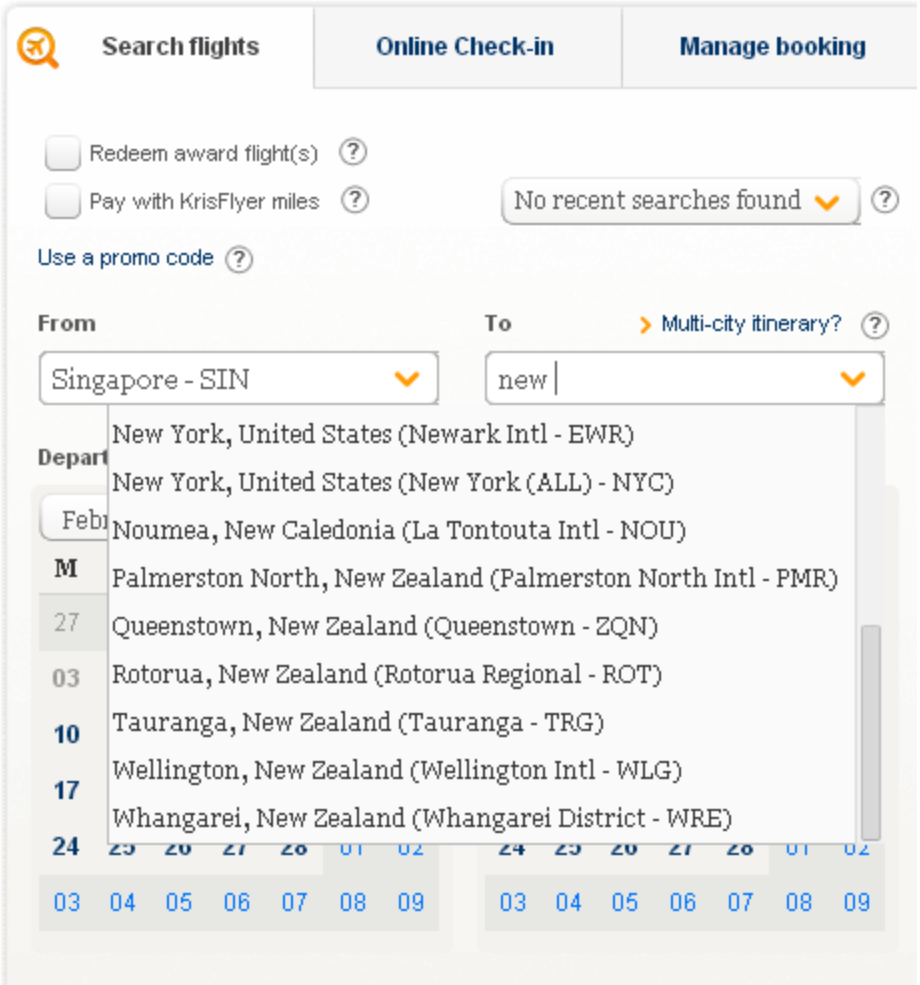
Data Entry guidelines (cont.)

- Minimal memory load
  - Don’t use codes, complex syntactic strings
    - E.g., Don’t user codes for a country on a web form
  - Provide “selection” from a list
    - don’t need to memorize choices
- Compatibility of data entry with data display
  - should matches display capability
- Flexibility for user control – Experienced vs. novice
    - Experienced may want “hot-keys”, novice doesn’t
    - All you Ctrl-F file people are happy!
    - Should be used cautiously, since it goes against consistency

A case study: booking flights



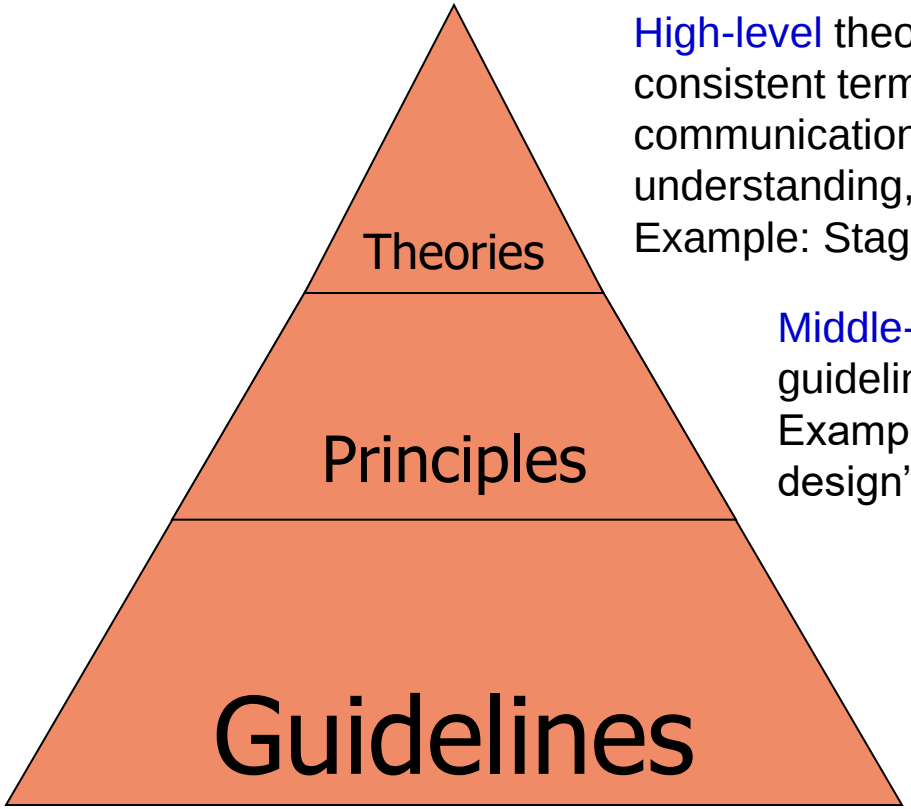
Entry Example



NANYANG TECHNOLOGICAL UNIVERSITY

II. Principles

Introduction



High-level theories that describes objects and actions with consistent terminology to support teaching, education, and communication. Can be used to ***predict*** performance, errors, understanding, satisfaction of user.
Example: Stages-of-action models

Middle-level practices that can be applied to different guidelines, analyzing and comparing design alternative.
Example: User classification, “8 golden rules of UI design”, etc.

Design-level practices and rules that make for good and consistent design (some based on theory).
Examples: Apples guidelines for UIs

PRINCIPLES

- More fundamental, widely applicable, and enduring than guidelines
- Fundamental principles for all UI
- Determine user's skill levels / Spiral design strategy
- Identify the tasks of the application
- Five primary interaction styles
- Eight golden rules of interface design
- Prevention of errors

Determine user's skill levels

- W. J. Hansen (1971) proposed the first (and perhaps the shortest) list of design principles
- Simple idea, but a difficult and unfortunately often undervalued goal.
- Hansen's principles:
  - Know the user
  - Minimize memorization
  - Optimize operations
  - Engineer for errors

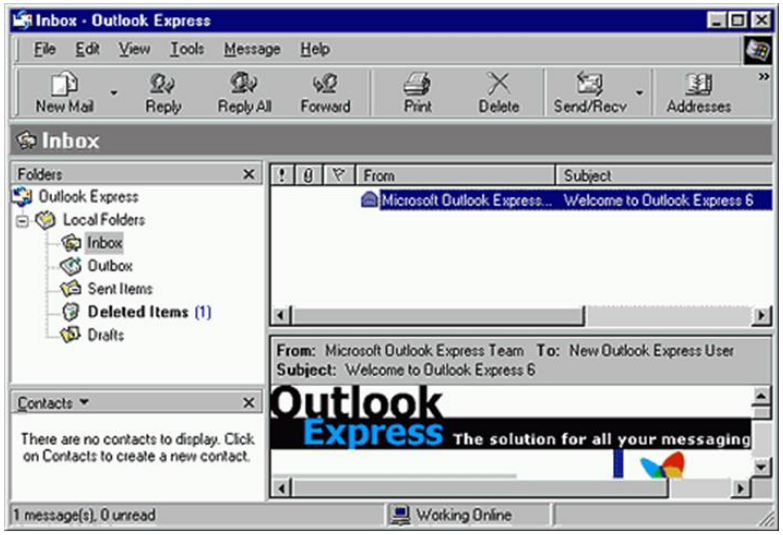
Wilfred J. Hansen. 1972. User engineering principles for interactive systems. In Proceedings of the November 16-18, 1971, fall joint computer conference (AFIPS '71 (Fall)). ACM, New York, NY, USA, 523-532.

Determine user's skill levels (Cont.)

- Start with population profile:
  - Age
  - Gender
  - Physical and cognitive abilities
  - Education
  - Cultural or ethnic background
  - Training
  - Motivation
  - Goals and personality
- Design goals based on skill level
  - Novice or first-time users
  - Knowledgeable intermittent users
  - Expert frequent users

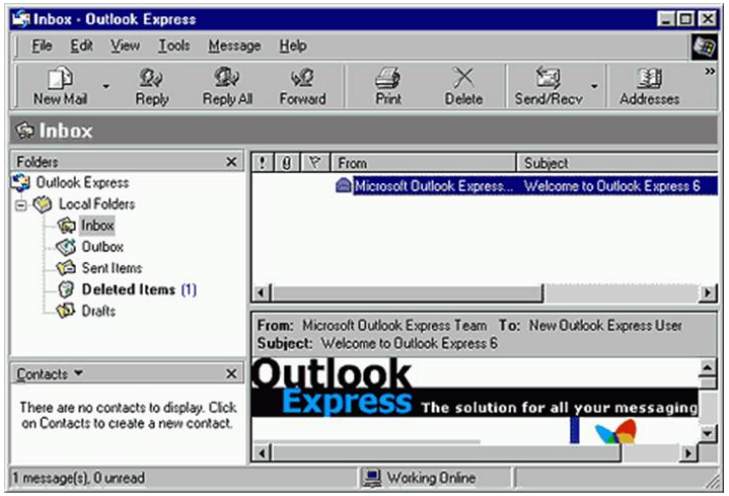
Novice/First-Time Users

- What would you need to consider for:
  - Grand-parents sending first email
  - Airport check-in kiosks
- Inexperience with interface (e.g., first time professionals)
- Anxiety
- Solutions
  - Restrict vocabulary
  - Providing help: Instructions, dialog boxes, know who to turn to for help, multiple languages, consistent terms
  - Small number of actions
  - Feedback
    - Good Error messages
  - Documents: Video demonstrations, online tutorials, good manuals



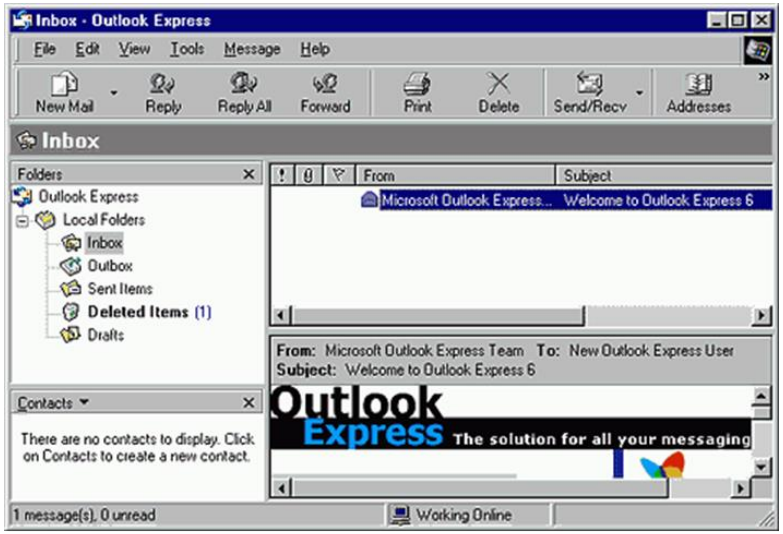
Knowledge-able Intermittent Users

- E.g., Frequent travelers, managers and code/word processors.
- These users understand task concepts, and interface basics
- May have difficulty retaining the structure of menus, or the location of features
- Solutions:
  - Consistent sequences of actions
  - Meaningful feedback
  - Guides to frequent patterns of usage
  - Protection from danger (encourage exploration), e.g., undo
  - Context dependent help



Expert/Frequent Users

- Thoroughly familiar with task and interface
- Goal is efficiency (high speed, low error)
- Solutions:
  - Rapid response time
  - Brief feedback
  - Shortcuts
  - Macros, abbreviations, and other accelerator

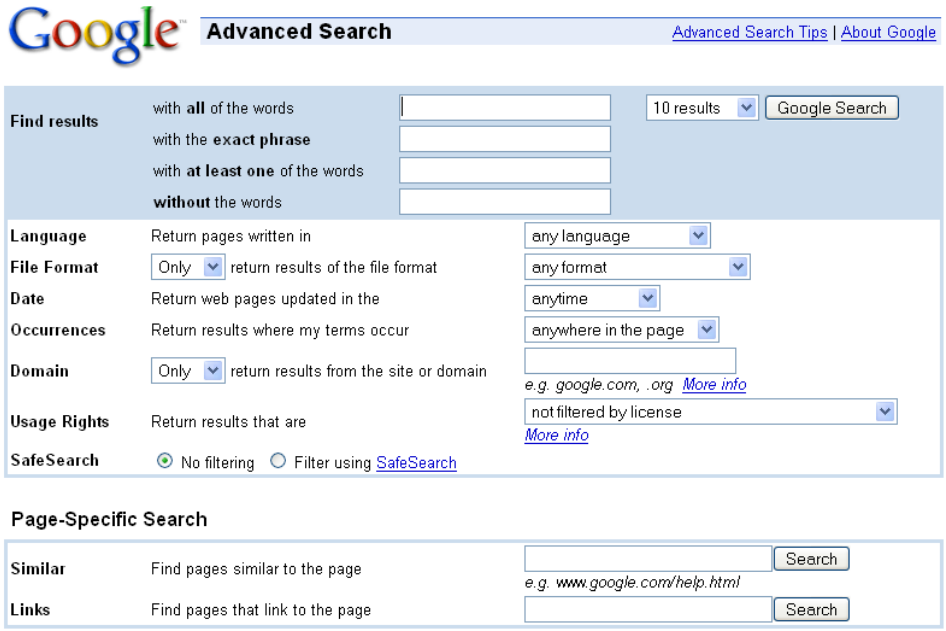


Multi-layer strategy

- You might be designing for more than one of these classes
- Approach is typically a *multi-layer* (a.k.a. *level-structured* or *spiral*)
  - Novices use a subset of commands, actions, and objects
  - Can move up when they feel comfortable
- Ex. Cellphones
  - Novices: phone calls easy to make
  - Experts: store #s, web, game, address book
- Also involves manuals, help screens, errors messages, tutorials, feedback
  - Different for multi-layer users

A case study: Google search & options

- Expand control to accommodate different users



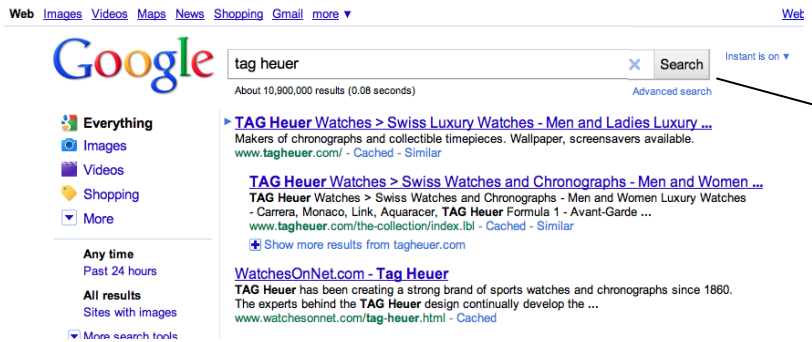
Easy control

Advance control

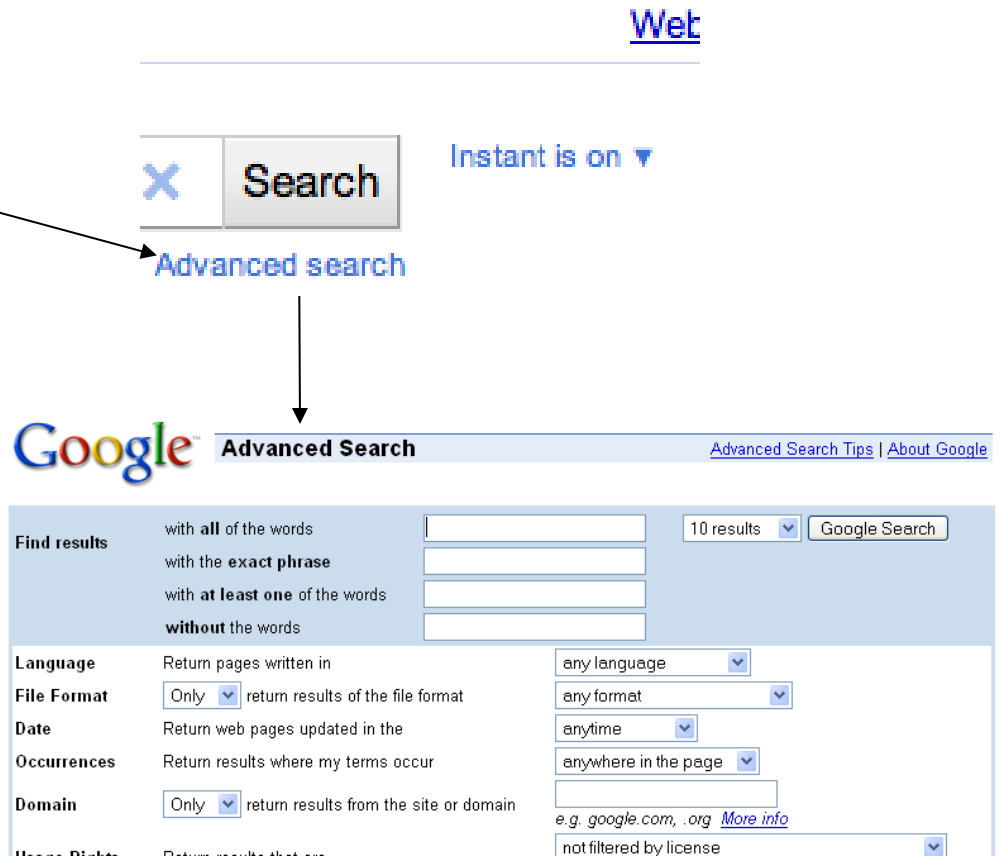
Example: Google 2010

- Users can choose!

  Expand controls to accommodate different users



Easy control: Just search!!

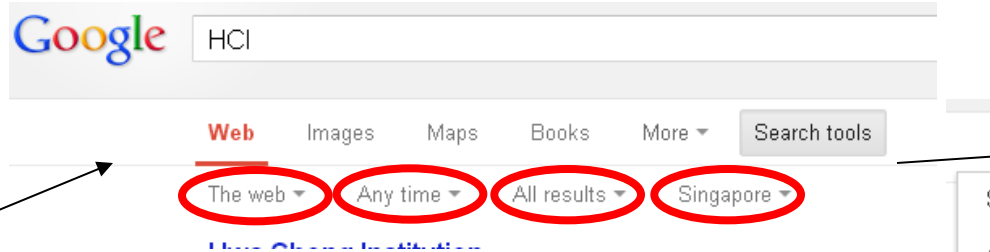


More Advance control

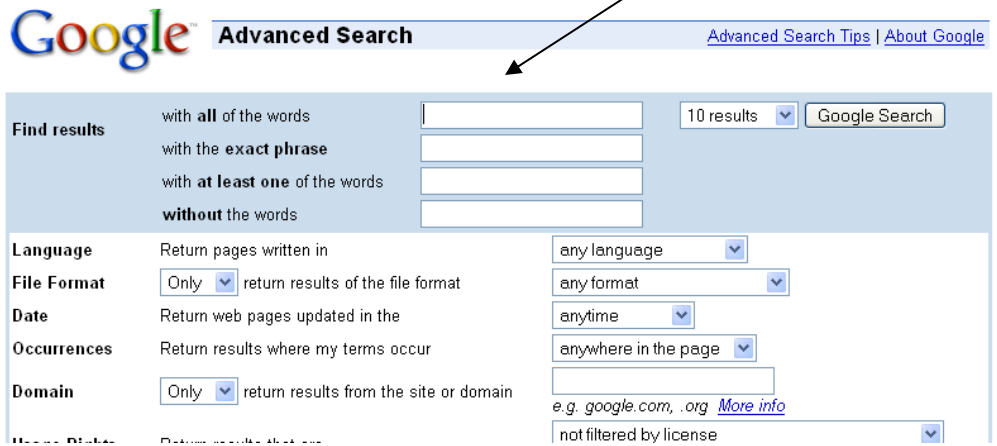
Example: Google 2012

- User Interface can evolve with users!!!
  Now… we have an intermediate level.

Easy control: Just search!!



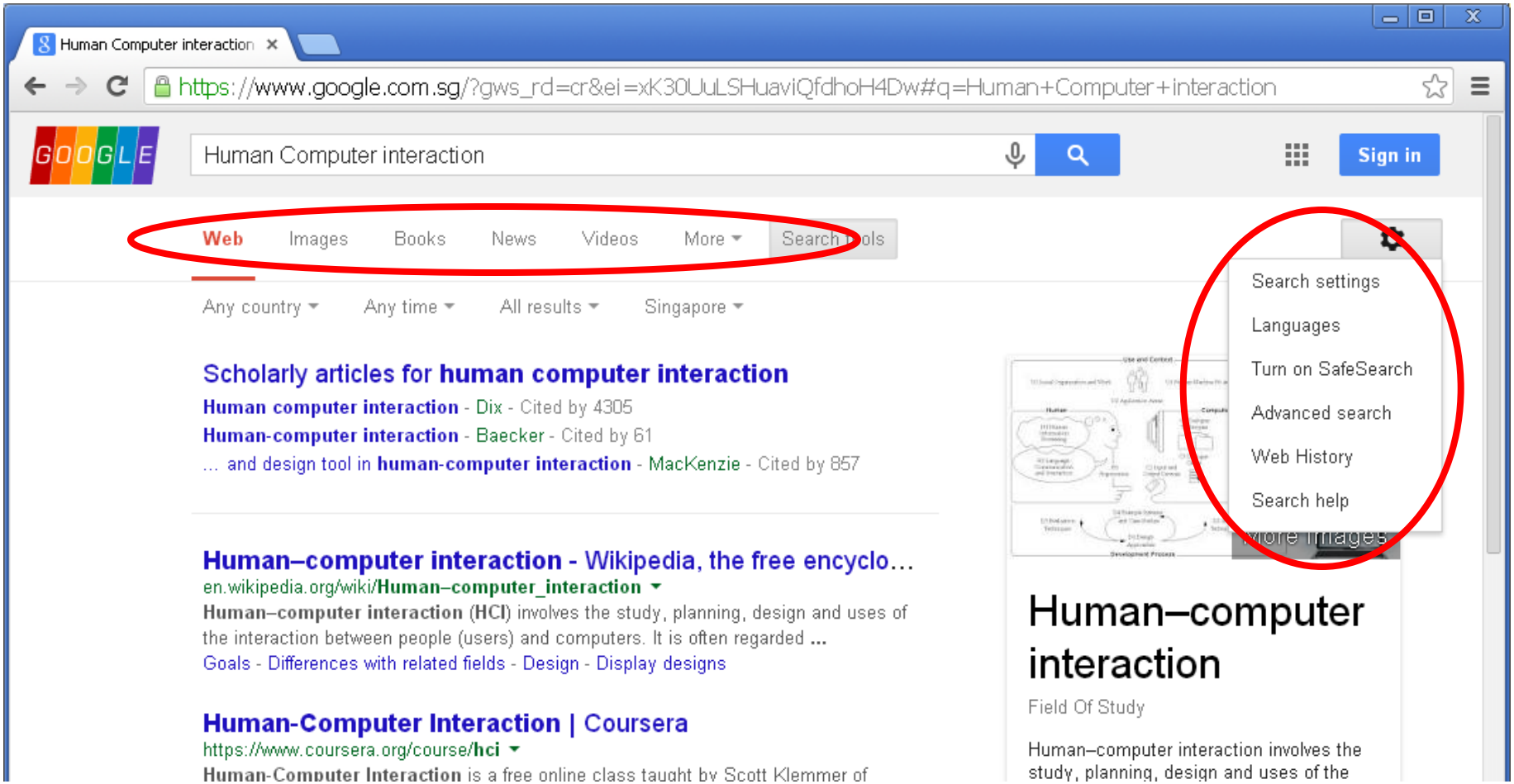
Intermediate: more tools



More Advance controls

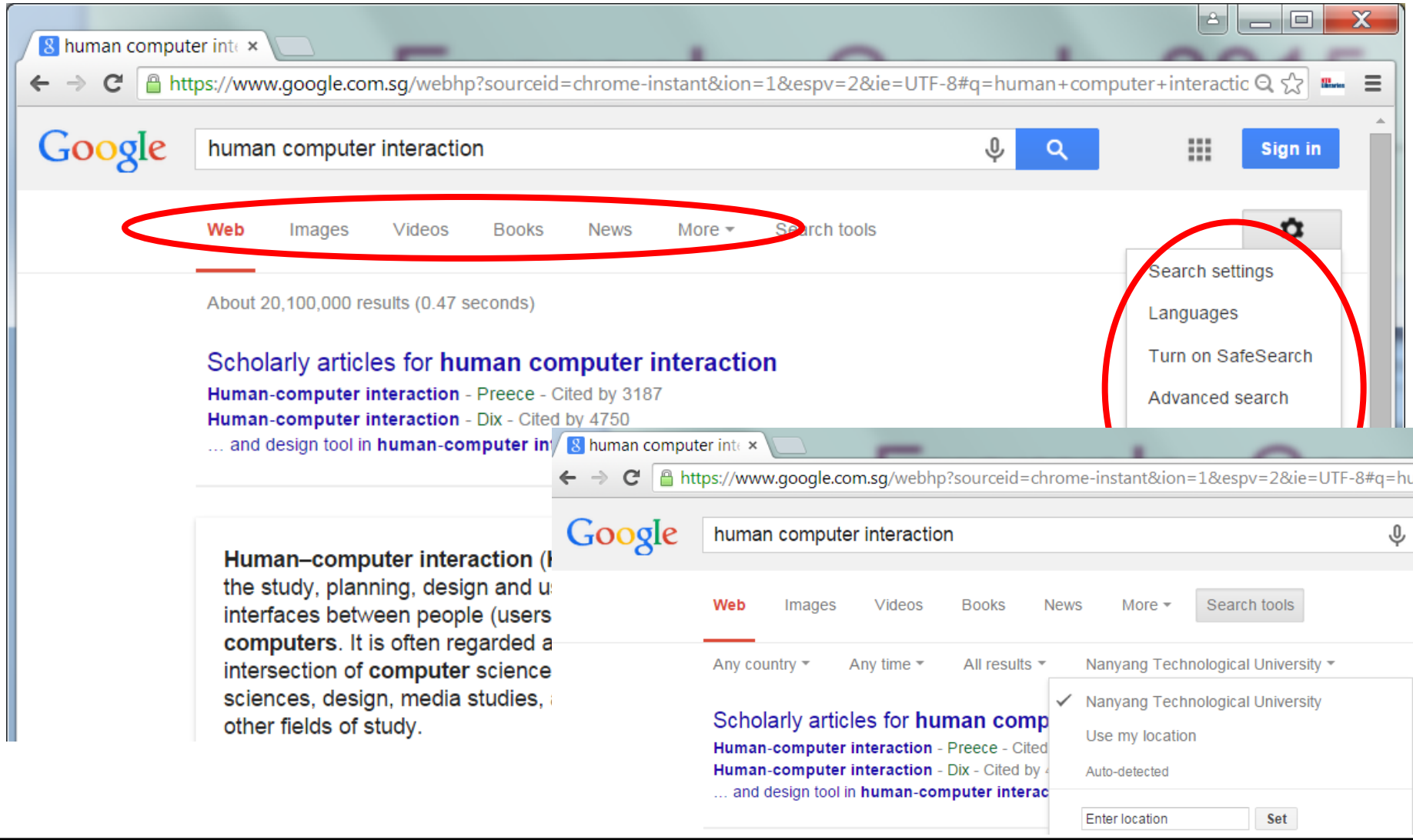
Example: Google 2014

How about 2014?



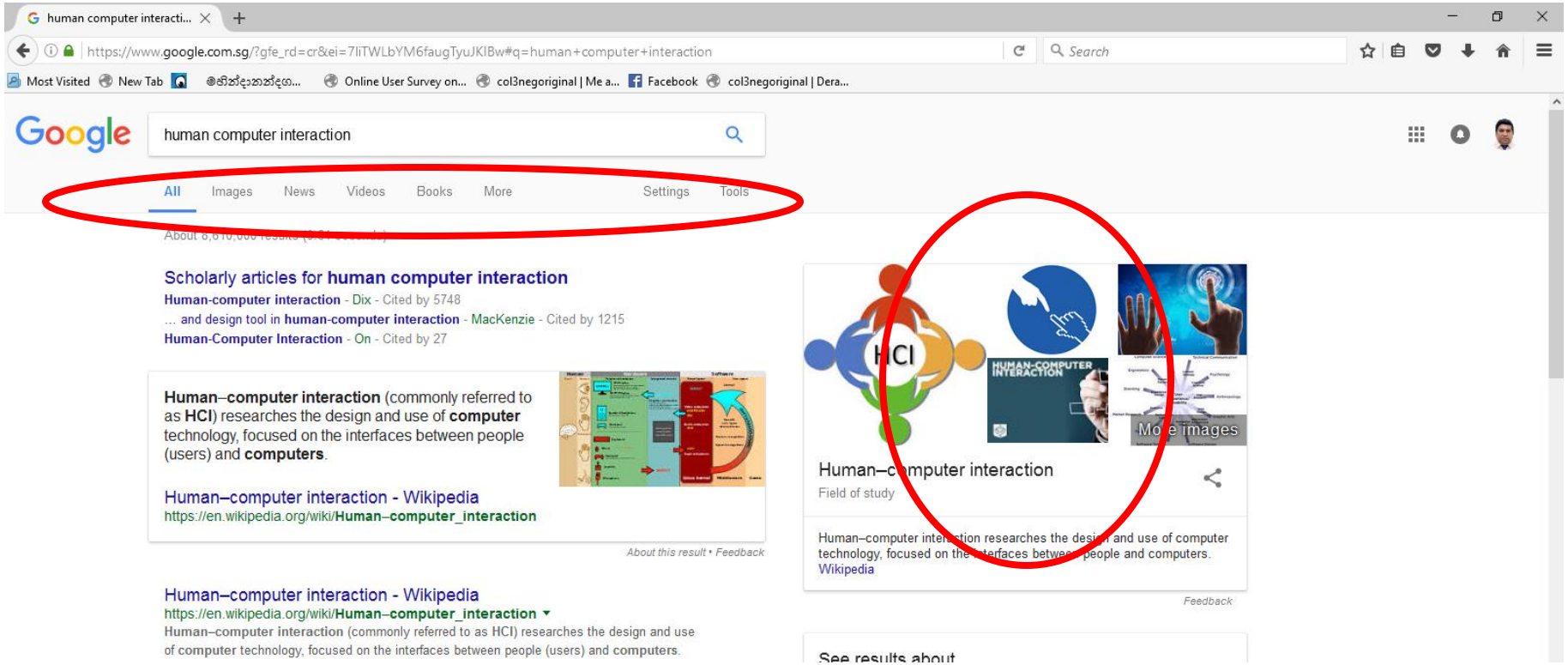
Example: Google 2015

Spot the difference! Any recent changes you found?



Example: Google 2017

Spot the difference! Any recent changes you found?



Identify the tasks

- After carefully drawing the user profile, the developers must identify the tasks to be carried out.
  - Every designer would agree that the set of tasks must be determined before design can proceed, but too often the task analysis is done informally or implicitly.
- Task Analysis(***Bailey, 1996, Hackos and Redish, 1998***) usually involve long hours observing and interviewing users
- Decomposition of high level task
  - Task sequences
- Relative task frequencies

- Robert W. Bailey. 1996. Human Performance Engineering (3rd Ed.): Designing High Quality Professional User Interfaces for Computer Products, Applications and Systems. Prentice-Hall, Inc., Upper Saddle River, NJ, USA.
- JoAnn T. Hackos and Janice C. Redish. 1998. User and Task Analysis for Interface Design. John Wiley & Sons, Inc., New York, NY, USA.

Identify the Tasks

- How?
  - Brainstorm
  - Observe and interview users (esp. newer versions)
- Example: *Palm Pilot*
  - Limited functionality = universal usability
  - Successful because of ruthlessly limiting functionality (calendar, to-do list, contacts and notes) to guarantee simplicity
- "Atomicity" of tasks is important to consider
  - Too small = too many steps (inefficient, frustrating)
  - Too many = need special cases, inflexible, frustrating
- Task frequency
  - High frequency = simple, quick, even if it slows other tasks down
- Task vs. Job Frequency Matrix (see next slide)
- Task analysis and task objects and objects defined

A case study: Hospital information system

- User-needs assessment clarifies what tasks are essential for the design and which ones could be left out to preserve system simplicity and ease of learning
- Should be starting point for any good UI designer

	TASK				
Job title	Query by Patient	Update Data	Query across Patients	Add Relations	Evaluate System
Nurse	0.14	0.11			
Physician	0.06	0.04			
Supervisor	0.01	0.01	0.04		
Appointment personnel	0.26				
Medical-record maintainer	0.07	0.04	0.04	0.01	
Clinical researcher			0.08		
Database programmer			0.02	0.02	0.05

Choose an Interaction Style

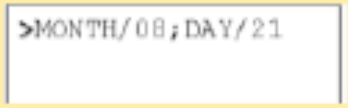
Five types of interaction style

1. Direct Manipulation
2. Menu Selection
3. Form-fill in
4. Command Language
5. Natural Language

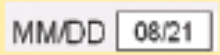
Advantages	Disadvantages
Direct manipulation	
Visually presents task concepts	May be hard to program
Allows easy learning	May require graphics display and pointing devices
Allows easy retention	
Allows errors to be avoided	
Encourages exploration	
Affords high subjective satisfaction	
Menu selection	
Shortens learning	Presents danger of many menus
Reduces keystrokes	May slow frequent users
Structures decision making	Consumes screen space
Permits use of dialog-management tools	Requires rapid display rate
Allows easy support of error handling	
Form fill-in	
Simplifies data entry	Consumes screen space
Requires modest training	
Gives convenient assistance	
Permits use of form-management tools	
Command language	
Flexible	Poor error handling
Appeals to "power" users	Requires substantial training and memorization
Supports user initiative	
Allows convenient creation of user-defined macros	
Natural language	
Relieves burden of learning syntax	Requires clarification dialog
	May not show context
	May require more keystrokes
	Unpredictable

Spectrum of Directness

An example of progression towards more direct manipulation: less recall/more recognition, fewer keystrokes/fewer clicks, less capability to make errors, and more visible context.

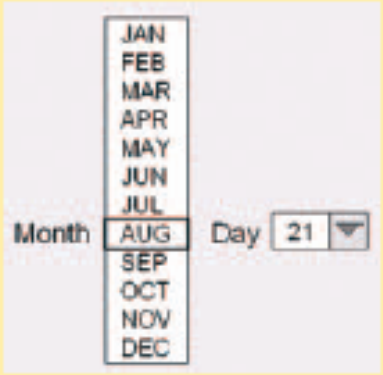


a. Command line



b. Form fill-in to reduce typing

c. Improved form fill-in to clarify and reduce errors



d. Pull-down menus offer meaningful names and eliminate invalid values

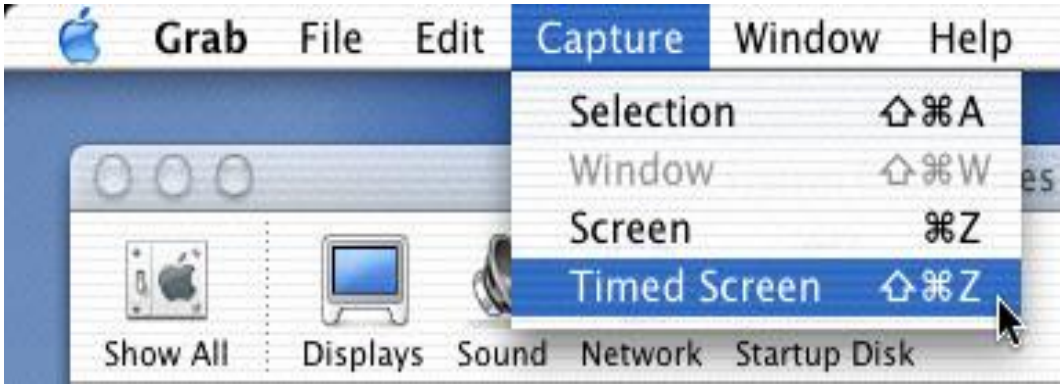
e. 2-D menus to provide context, show valid dates, and enable rapid single selection

1. Direct manipulation

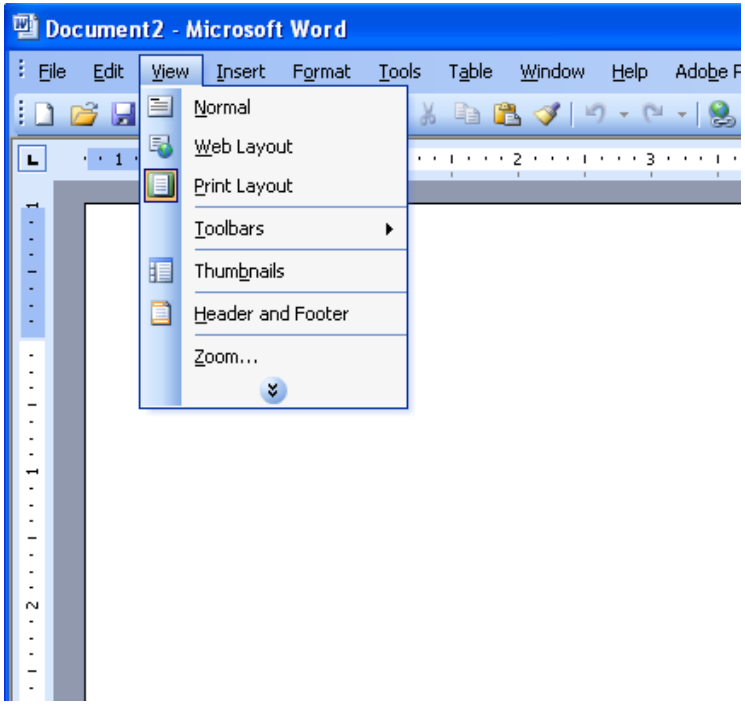
- Manipulate visual representations, e.g. Desktop metaphor, CAD, games
- Appealing to novices and easy to remember for intermittent users.
- **Pros**:
  - fast
  - feedback
  - easy to understand and retain (ex. icons on your desktop)
  - exploration encouraged
  - good for novices
  - can be good for other classes, visual data
- **Cons**:
  - hard to program
  - interaction devices are harder to design or modify

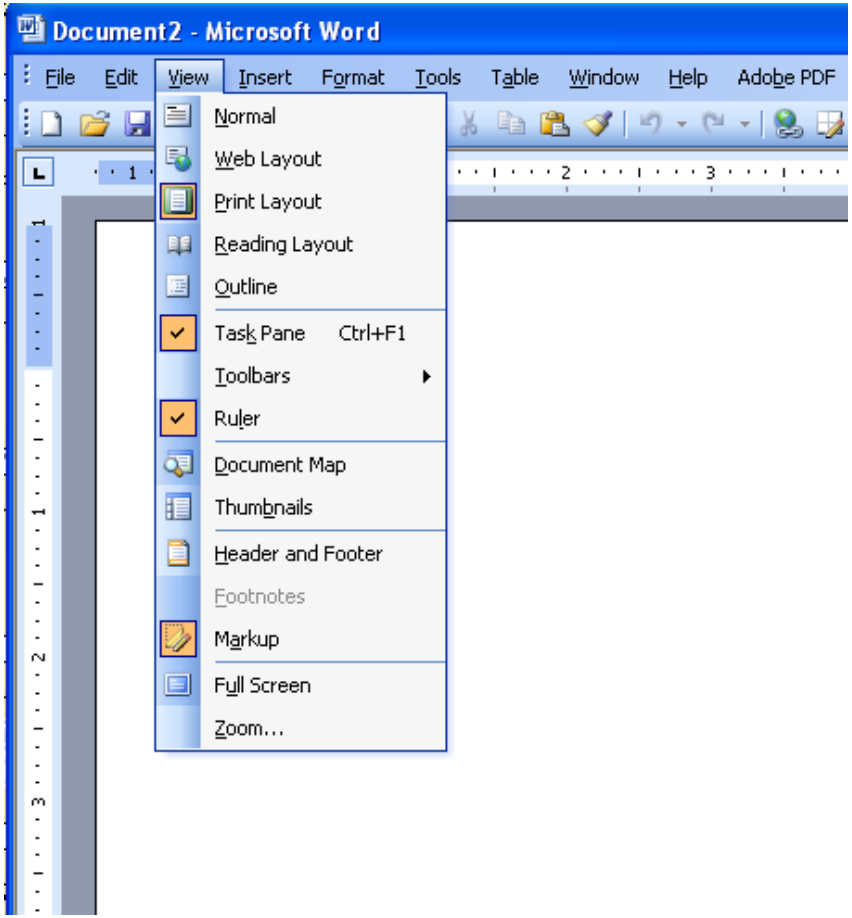
2. (Menu) Selection

- User reads a list of items, and selects one
- Appropriate for novice and intermittent users and can be appealing to frequent users if the display and selection mechanisms are rapid.
- **Pros:** no memorization, few actions, clear structure, tools for validity and consistency exist
- **Cons:** Make actions understandable not easy, careful task analysis



Example: Adaptive Menu

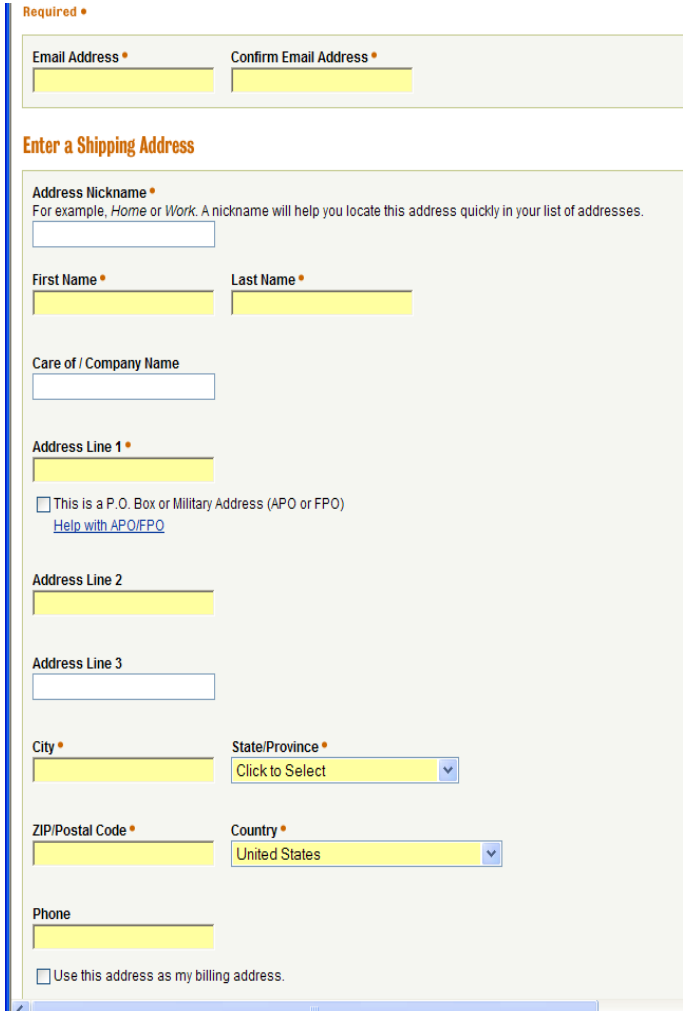




Windows adapt menu choices to usage pattern. This is to prevent “clutter”

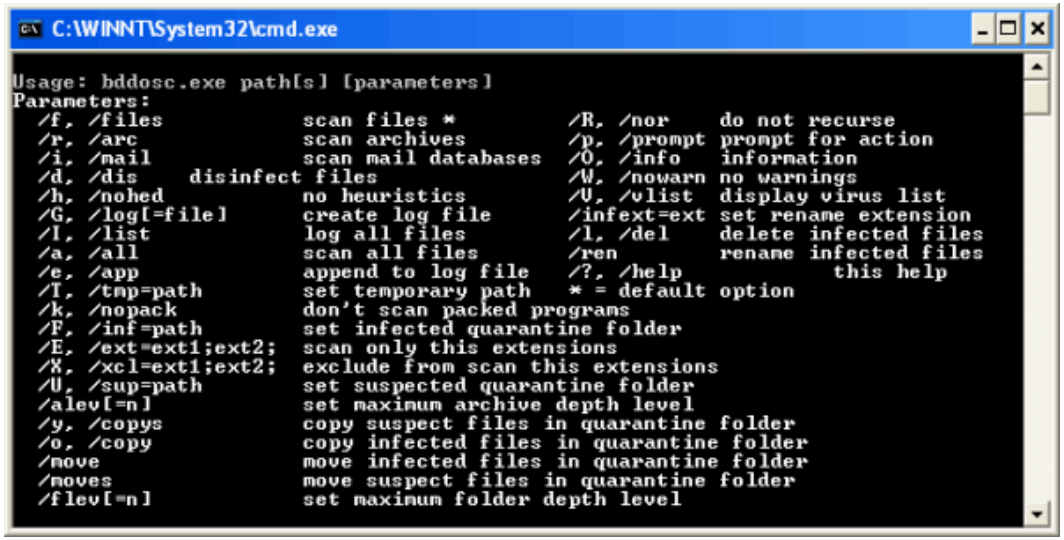
3. Form fill-in

- Data entry into fields
- Most appropriate for knowledgeable intermittent users or frequent users.
- **Pros:**
  - rapid,
  - for more advanced users
  - tools available for forms
- **Cons:**
  - must understand labels and request format
  - be able to respond to errors
  - training required



4. Command language

- Suitable for expert frequent users who derive great satisfaction from mastering a complex set of semantics and syntax.
- **Pros:** feeling of control, most advanced users like it, rapid, histories and macros are easy, flexibility
- **Cons:** high error rates, training required, poor retention rate, hard to create error messages

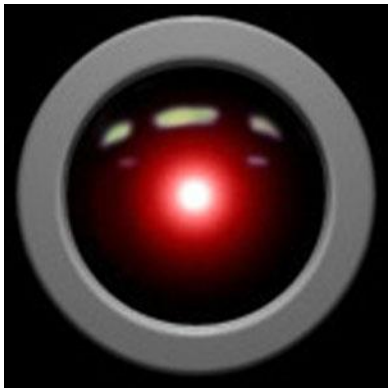


5. Natural language

- Computers will respond properly to arbitrary natural language sentences or phrases.
- **Pros:** easy to learn
- **Cons:** unpredictable, requires clarification dialog, technology is not fully developed . . Still in research stage.

- *NL is the Ultimate Goal*
  - Was “science fiction”, Example: HAL9000
  - Is Siri or other similar natural language service ready now?

    http://www.kubrick2001.com/



HAL9000 Computer (From 2001)

Ben Shneiderman: 8 golden rules

- Ph.D. from Stony Brook University Computer Science Dept. in 1973.
- CS Professor at the HCI Lab at Univ. of Maryland, College Park.
- Introduced the term “Direct Manipulation Interface” in 1983.
- Developed Eight Golden Rules of Interface Design.
- Recipient of the ACM CHI Lifetime Achievement Award 2001.

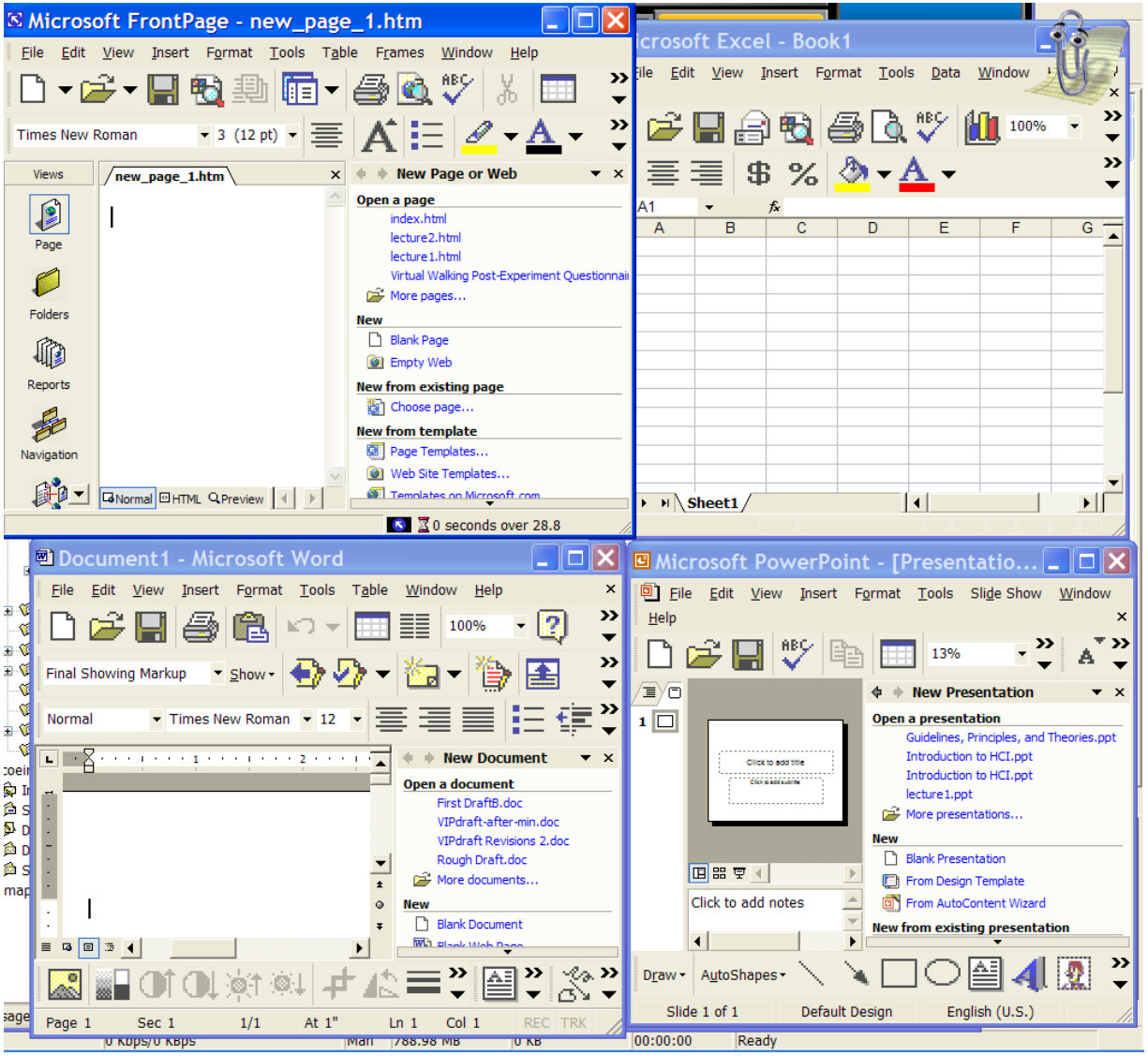
Ben Shneiderman: 8 golden rules

1. Strive for consistency
2. Cater to universal usability
3. Offer informative feedback
4. Design dialogs to yield closure
5. Permit easy reversal of actions
6. Support internal locus of control
7. Reduce short term memory
8. Prevent errors

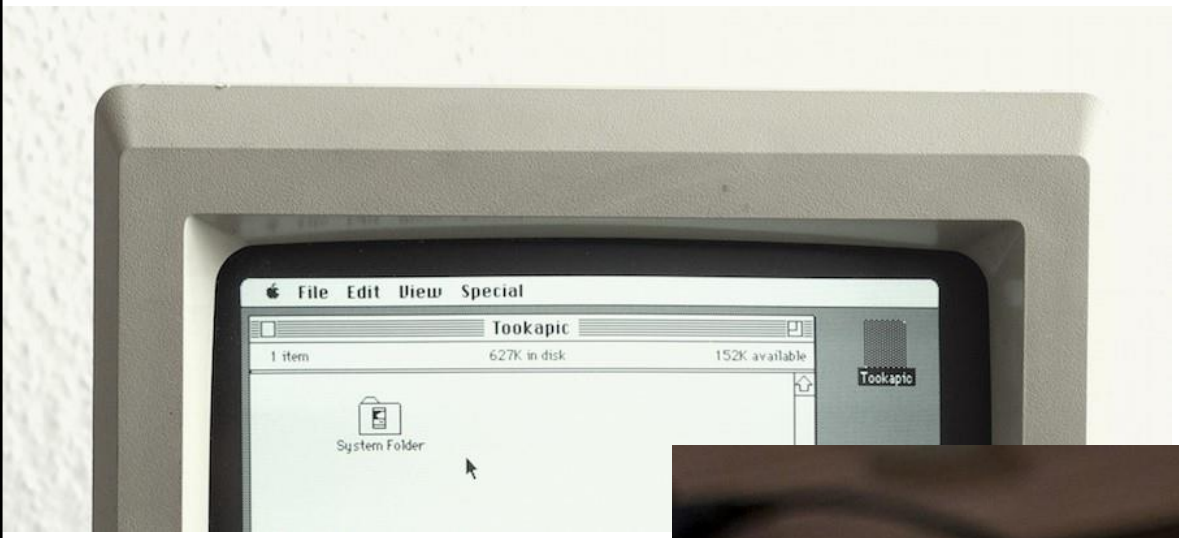
1. Strive for Consistency

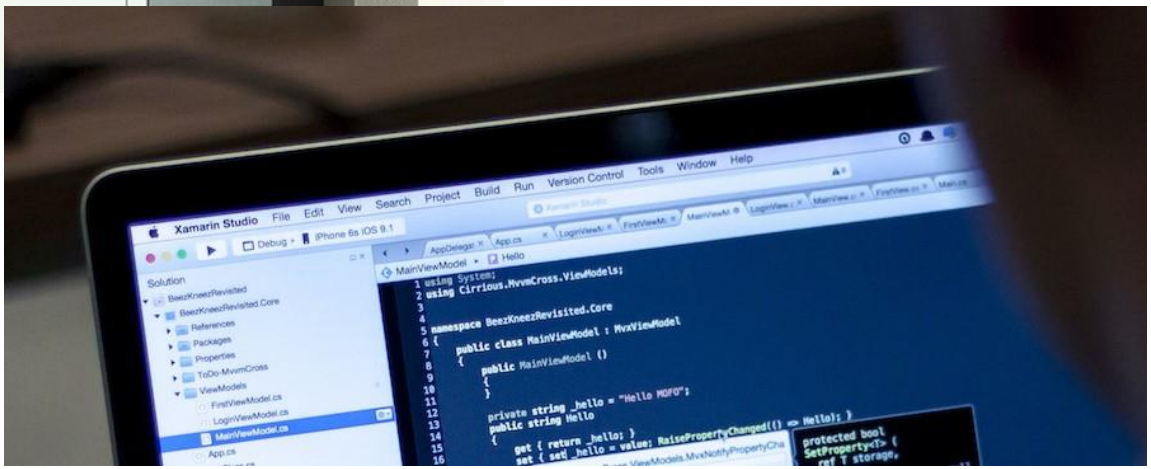
- Consistent sequence of actions for similar situations
- Identical terminology should be used in prompts, menus, and help screens
- Consistent visual layout (fonts, color, etc.)
- Exceptions:
  - Confirmation of deletion
  - No password echoing

1. Strive for Consistency (cont.)



1. Strive for Consistency (cont.)





The look of Mac OS over time. Mac OS Menu Bar stays consistent.

2. Cater to Universal Usability

- Recognize the needs of a diverse user group
- Design for *plasticity* (transformation of content)
  - Plasticity means content can be used on any type of display
- Interface supports Novice -> Expert
  - "You're only a beginner once"
- Usable by Disabled

2. Cater to Universal Usability (cont.)

Image from: http://johnpolacek.github.io/scrolldeck.js/decks/responsive/

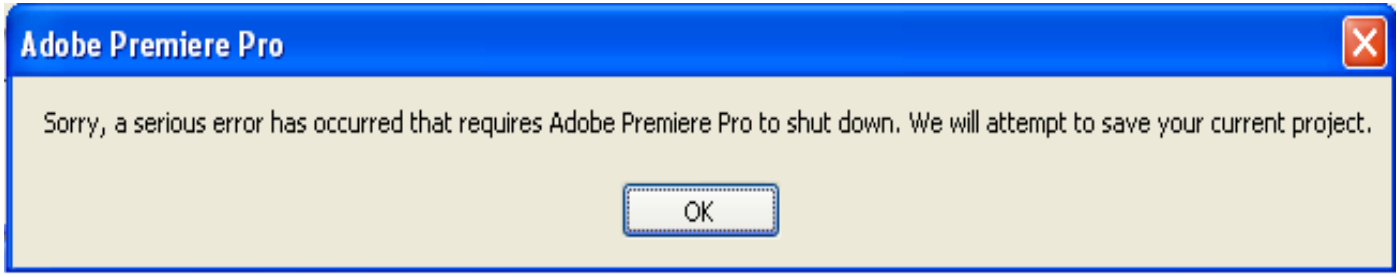
2. Cater to Universal Usability (cont.)

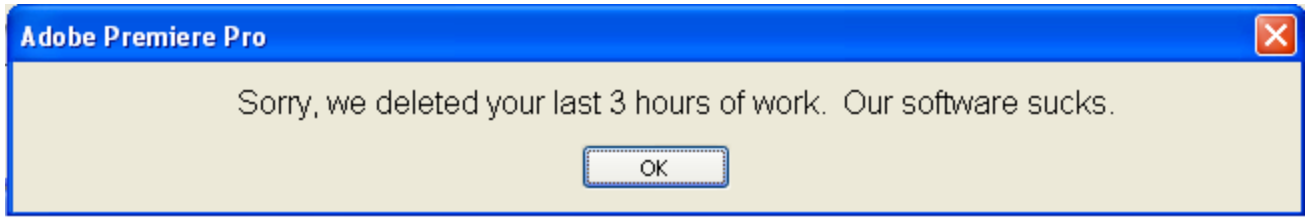
Mac allow users to forgo mouse-clicks by providing them with keyboard shortcuts.

3. Offer Informative Feedback (cont.)

- For every user action, system should provide feedback
- Frequency of task affects feedback type
  - Common tasks – modest feedback
  - Errors/uncommon tasks – substantial feedback
- Visual approaches make feedback easy

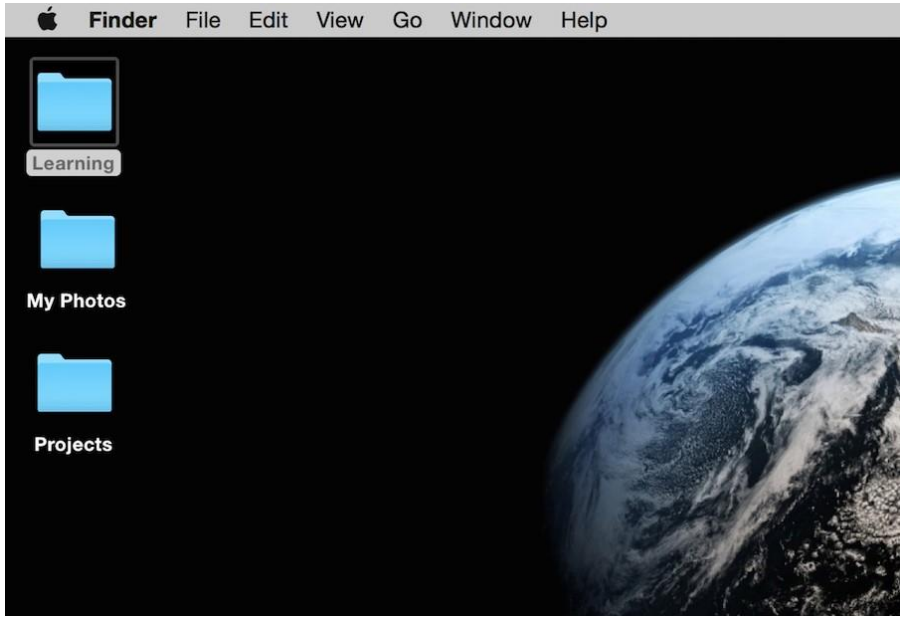
Adobe Premiere Pro 1.5 (USD$500-700)



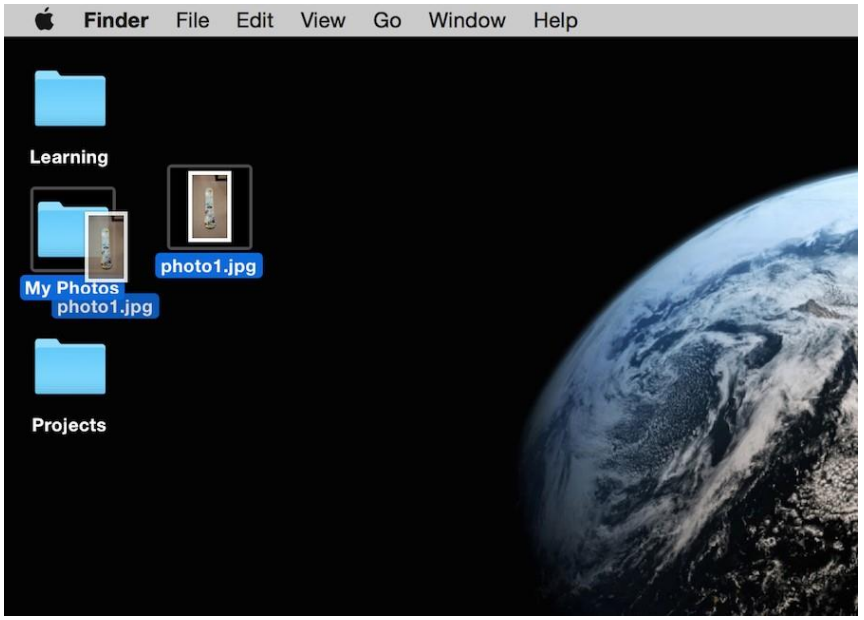


(not more useful, but more honest)

3. Offer Informative Feedback (cont.)



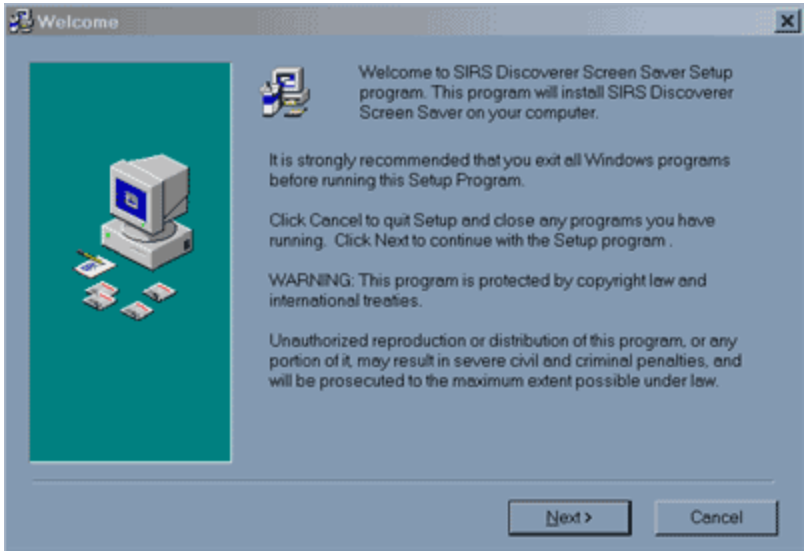
The ‘Learning’ folder becomes highlighted as the user clicks on a folder on a Mac desktop.



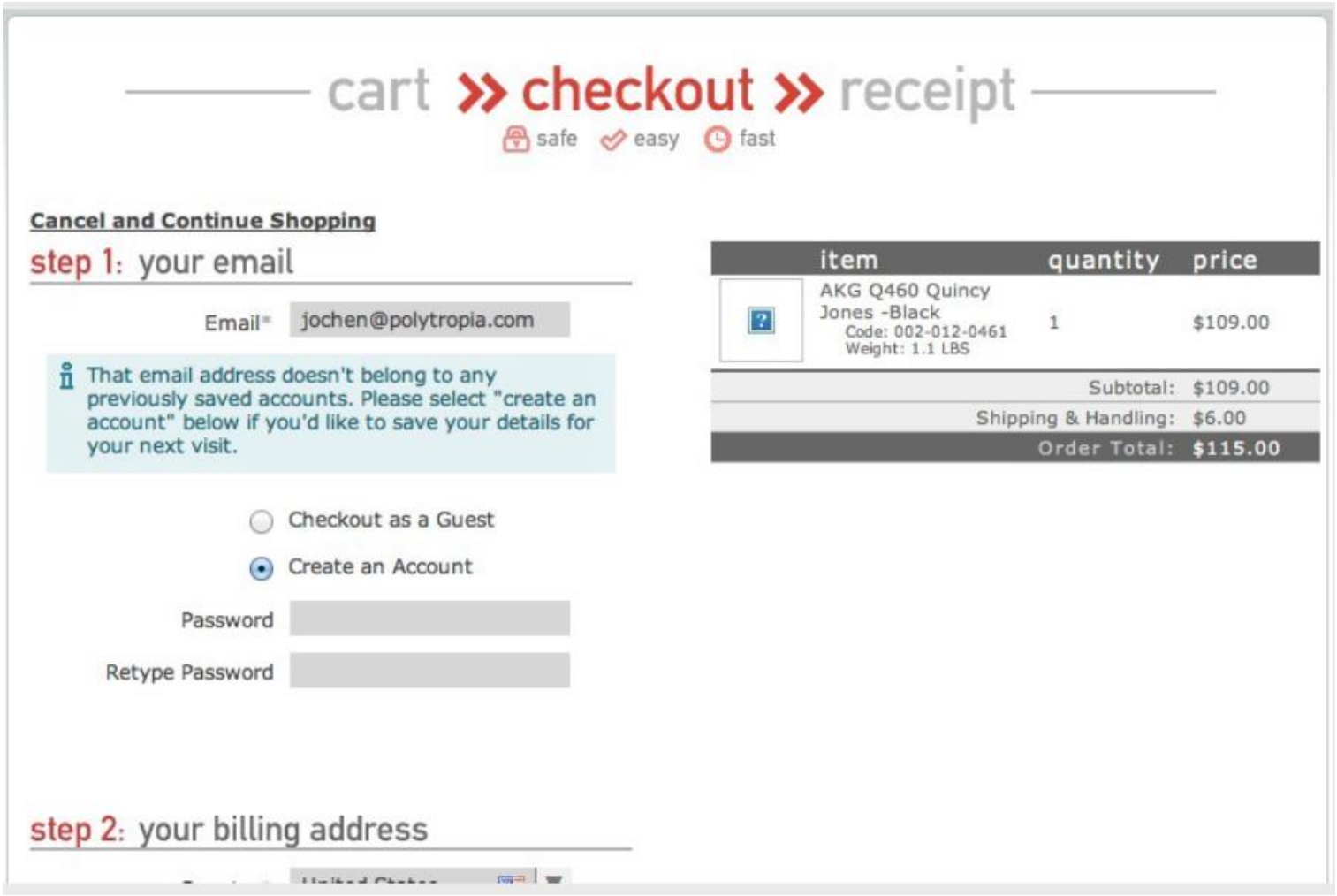
The folder is represented as physically being moved as the user holds down the mouse and drags a folder across the desktop.

4. Design Dialogs to Yield Closure

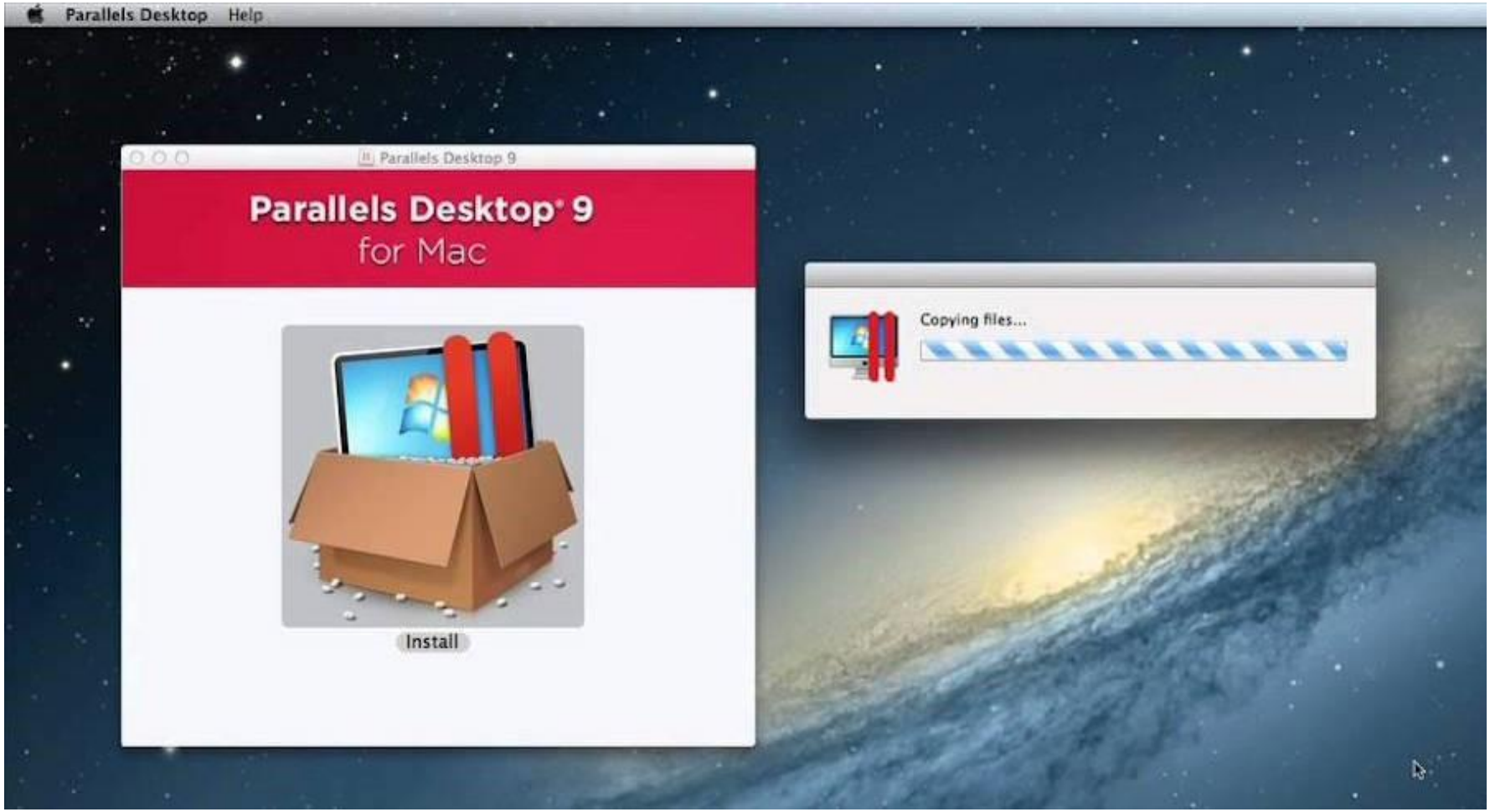
- Sequences of actions should be organized into groups with a beginning, middle, and end.
- Feedback provides sense of accomplishment
- E.g., Purchasing items via internet has a clearly defined step-by-step process



4. Design Dialogs to Yield Closure (cont.)

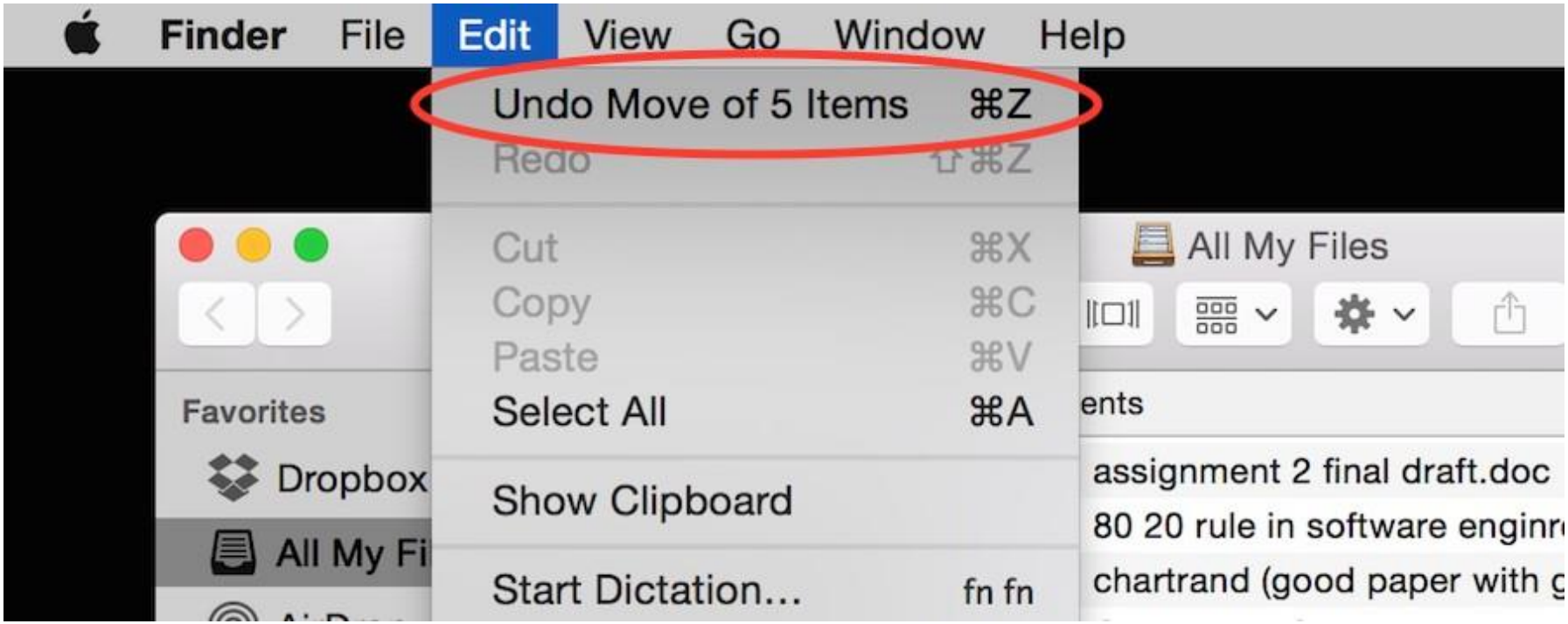


4. Design Dialogs to Yield Closure (cont.)



As the user installs the program “Parallels Desktop 9”, it shows that it is currently “copying files”.

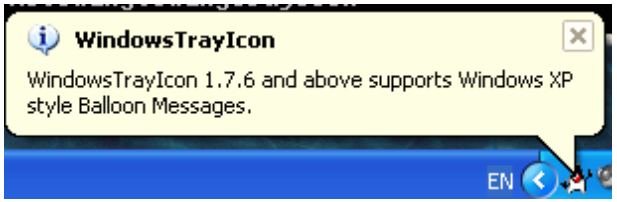
5. Permit easy reversal of actions (cont.)



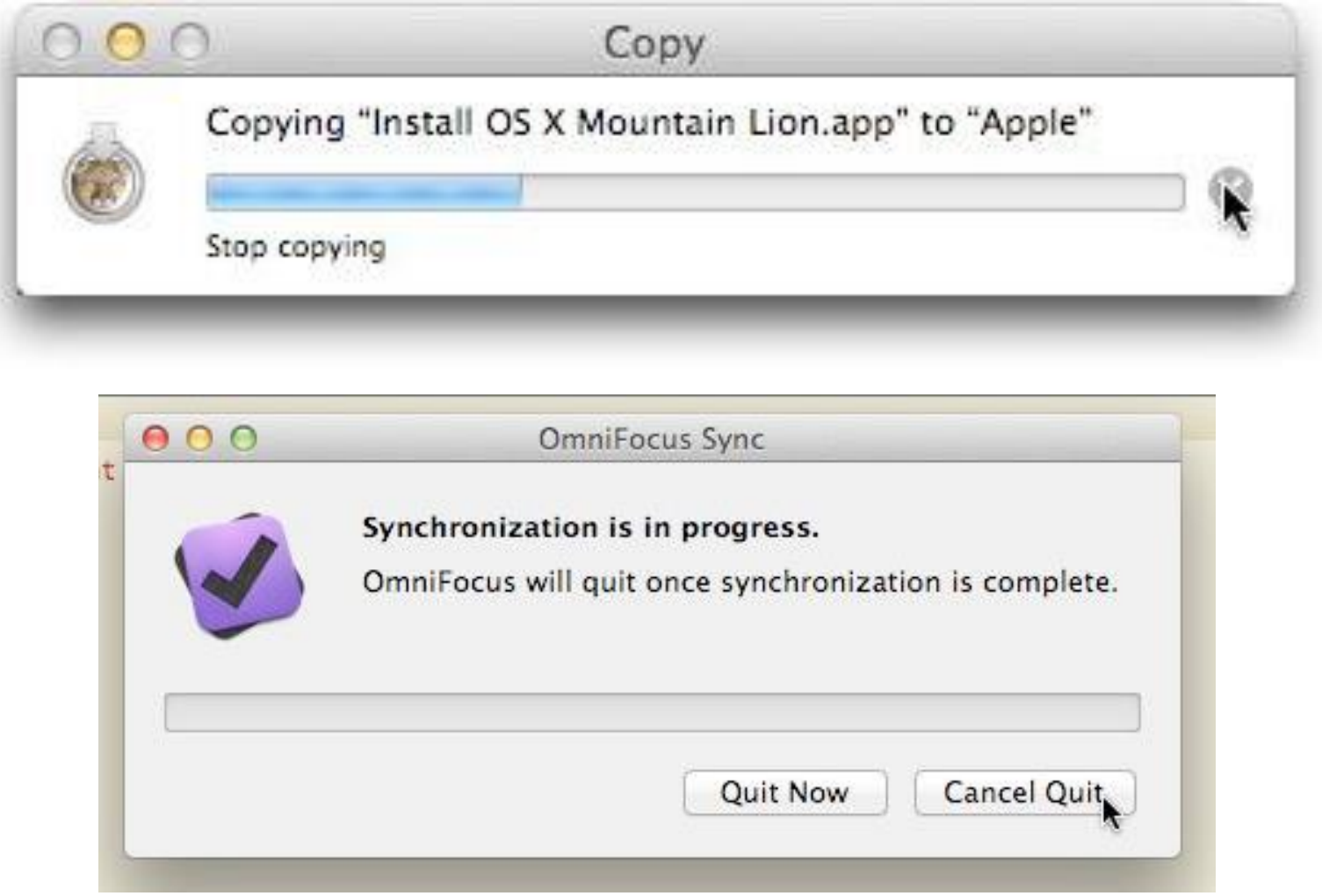
The user can undo a previous action quickly and easily.

6. Support Internal Locus of Control

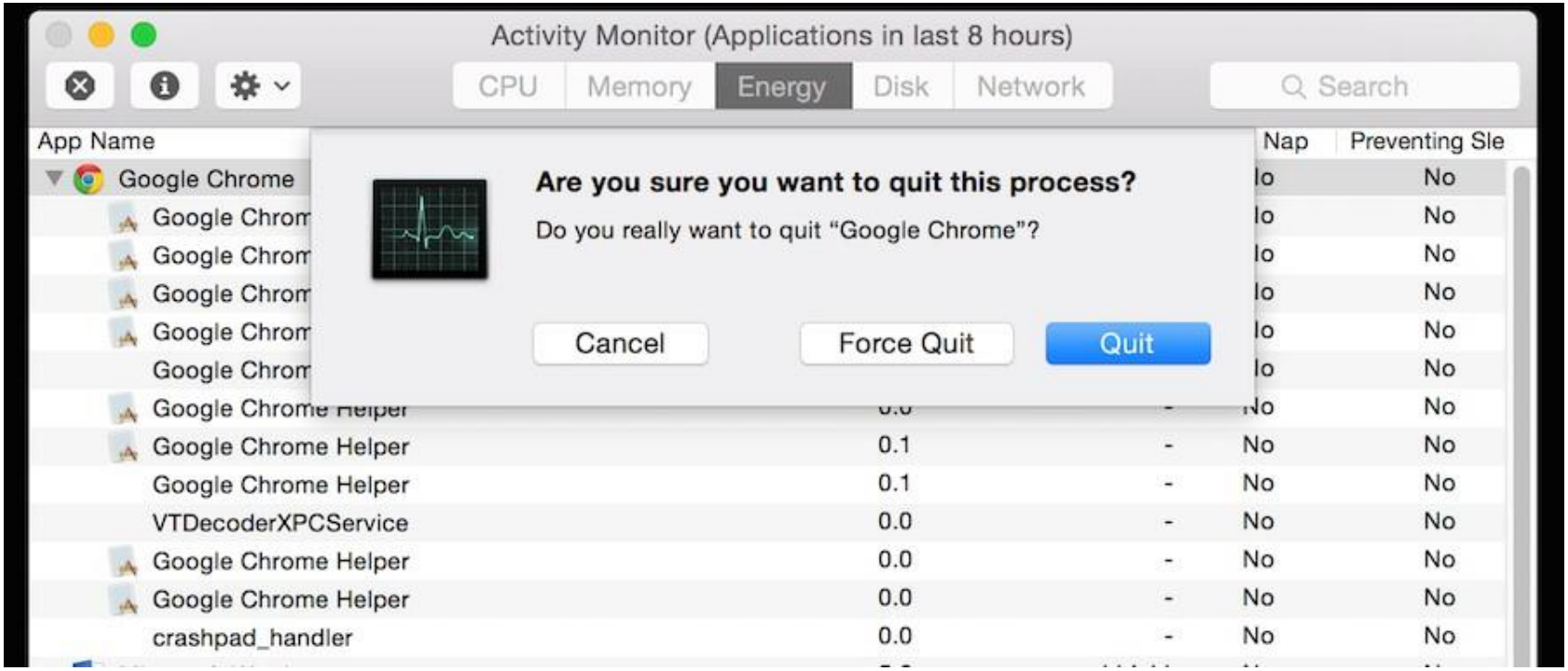
- Experiences operators want to feel in control
  - User is in charge of the interface
  - Interface rapidly responds to the user
- Builds anxiety and dissatisfaction
  - Surprising interface actions
  - Tedious actions
  - Difficulty in obtaining necessary ability
  - Difficulty in producing action
  - Ex. Long lag when using UI
- **Good rules:** Avoid *acausality*, make users initiators rather than responders
  - Acausality (BAD)
    - Ex. some sound happens to get your attention (user not involved), little paper-clip appears when not expected
  - Causality (user in control) (GOOD)
    - Ex. Sound when clicking on a link



6. Support Internal Locus of Control (cont.)



6. Support Internal Locus of Control (cont.)



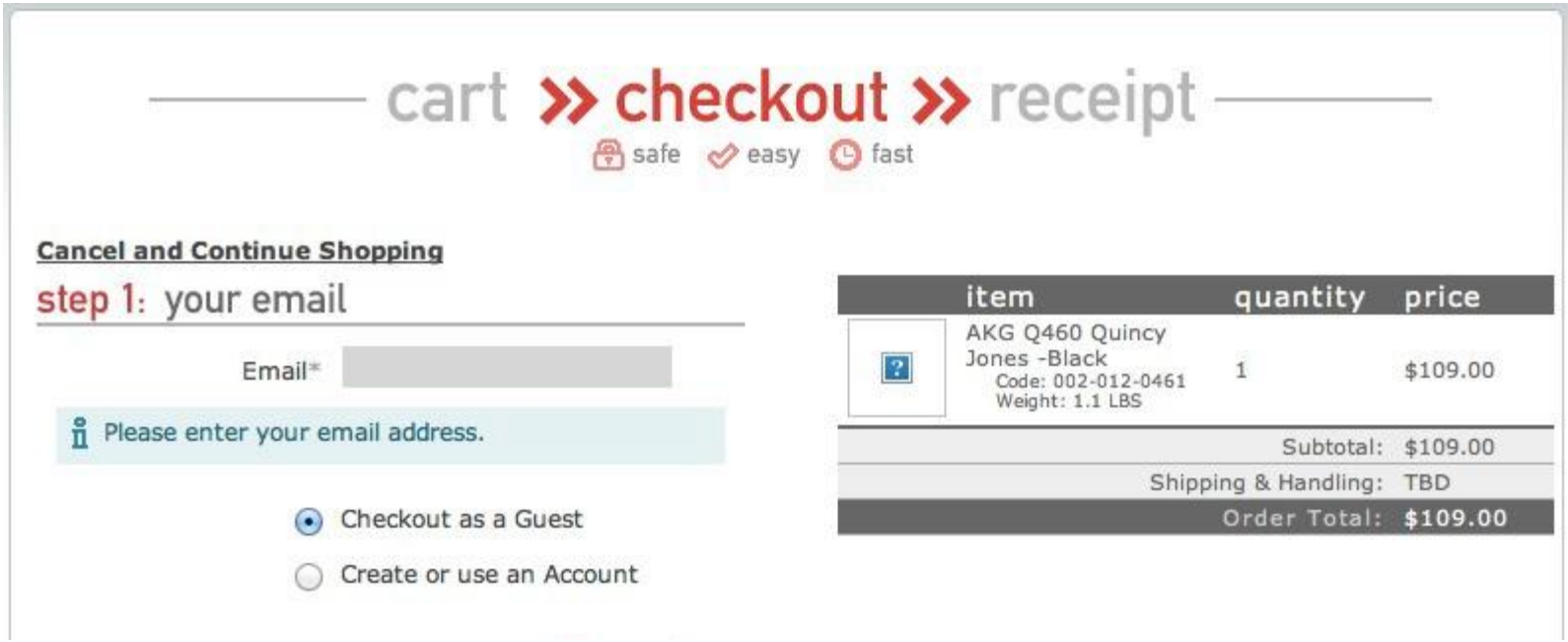
The user is able to Quit or Force Quit a program if it crashes

7. Reduce Short-term Memory Load

- Rule of thumb: Humans can remember 7 +/- 2 chunks of information
- Keep display simple
- Multiple page displays should be consolidated
- Training will be required if using codes, mnemonics, long sequence of actions
- You should provide online access to command-syntax, abbreviations, codes, etc. (i.e., provide help)

Miller, G. A. (1956). "The magical number seven, plus or minus two: Some limits on our capacity for processing information". Psychological Review 63 (2): 81–97. doi:10.1037/h0043158. PMID 13310704

7. Reduce Short-term Memory Load (cont.)

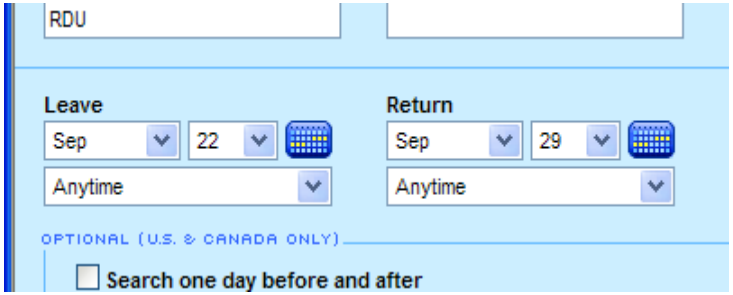


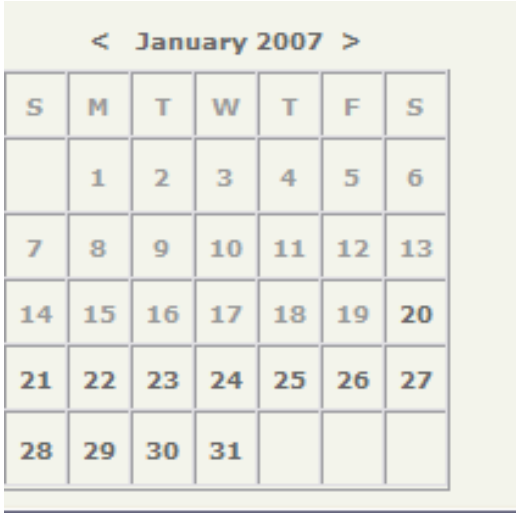
7. Reduce Short-term Memory Load (cont.)

Great examples of how Apple implements the rules of consistency (1st rule) by displaying the same bottom menu across different versions of the iOS. This is also a great example of how Apple reduces short-term memory load (7th rule). As humans are only capable of retaining 5 items in our short term memory at one time, the Apple iPhone has stuck with allowing only 4 app icons to sit in the main menu area at the bottom of the screen, regardless of whether it's the iOS 4 or the iOS 7.

8. Prevent Errors

- Limit errors a user can make
  - Gray out menu items that don't apply
  - No characters in a numeric field
- In case of errors
  - Detect error
  - Simple, constructive, and specific instructions
  - Do not change system state





8. Prevent Errors (cont.)

- Error rate is typically higher than expected
  - What are common errors for us?
    - Coding, typing, dialing, grammar
- How can we design software to reduce them?
  - Better error messages
    - Helps fix current error
    - Helps reduce similar errors
    - Increases satisfaction
    - Specific, positive, and constructive
      - "Printer is off, please turn on" instead of "Illegal Operation"
  - Reduce chance for error
    - Organizing info, screens, menus
    - Commands and menu choices should be distinctive
    - State of the interface should be known (change cursor when busy)
    - Consistency of actions (Yes/No order of buttons)

8. Prevent Errors (cont.)

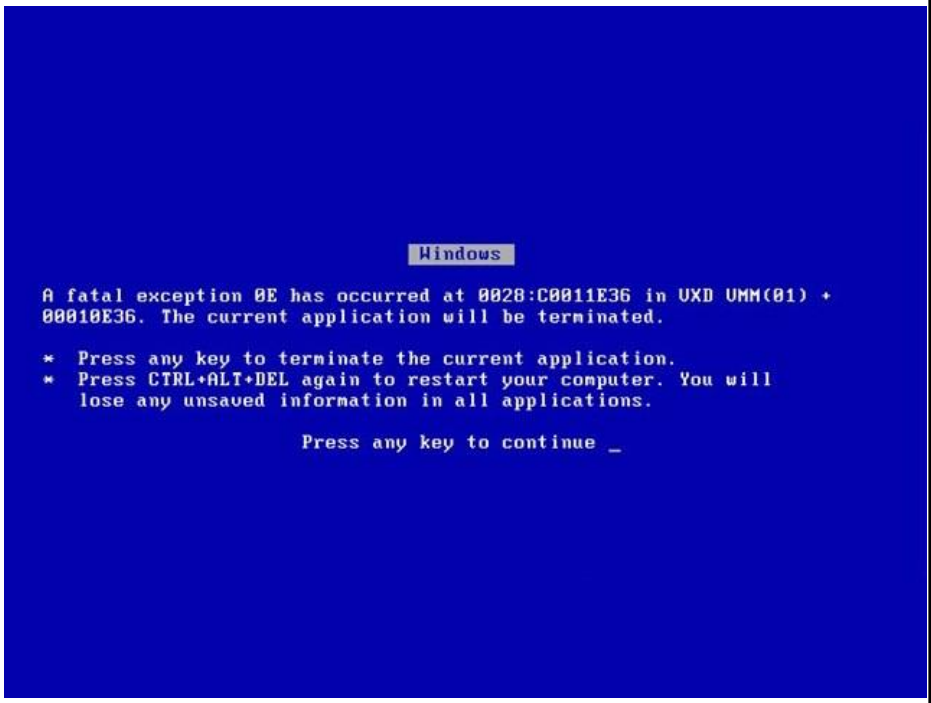
- Correct actions
  - Elevator – can't open doors until not moving
  - Aircraft engines – can't go in reverse unless landing gear is down
  - Choose a date from a visual calendar instead of having them type it in
  - Cell phones let you choose from recently dialed #s or received calls
  - Automatic command completion
  - Spell checker

8. Prevent Errors (cont.)

- Complete Sequences
  - One action can perform a sequence of events
    - E.g., Left turn signal (front and rear light flashing)
  - Study usage, error patterns, and user preferences via user groups, studies
  - Log errors
- Universal Usability can help lower errors
  - Large buttons helps with readability, and reduce

8. Prevent Errors (cont.)

A gentle error message is shown explaining to the user what was happening and why it was happening. It even goes further to reassure the user, telling them that they are in control



A bad example by Windows displays an error message that uses the words "fatal" and "terminated". Such negative, unfriendly words are sure to scare away most users!

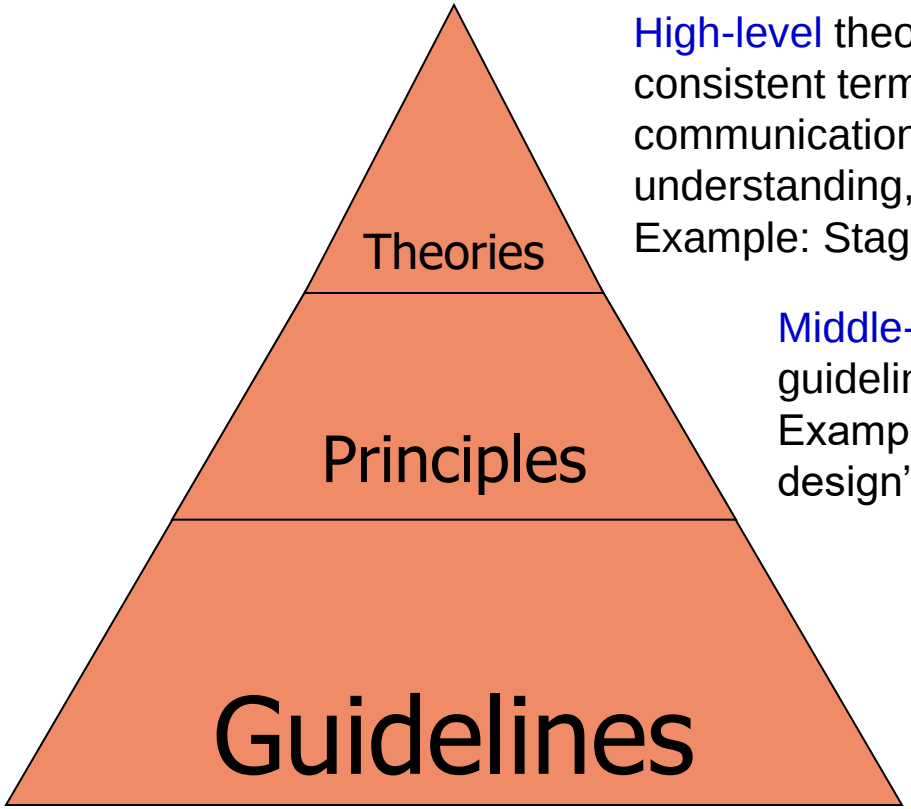
Golden rules of interface design

1. Strive for consistency
2. Enable frequent users to use shortcuts (Cater to universal usability)
3. Offer informative feedback
4. Design dialogs to yield closure
5. Permit easy reversal of actions
6. Support internal locus of control
7. Reduce short term memory load
8. Offer simple error handling (Prevent errors)

NANYANG TECHNOLOGICAL UNIVERSITY

II. THEORIES

Introduction



High-level theories that describes objects and actions with consistent terminology to support teaching, education, and communication. Can be used to ***predict*** performance, errors, understanding, satisfaction of user.
Example: Stages-of-action models

Middle-level practices that can be applied to different guidelines, analyzing and comparing design alternative.
Example: User classification, “8 golden rules of UI design”, etc.

Design-level practices and rules that make for good and consistent design (some based on theory).
Examples: Apples guidelines for UIs

THEORIES

- Beyond the specifics of guidelines
- Principles are used to develop theories
- A case study: Stages of Action

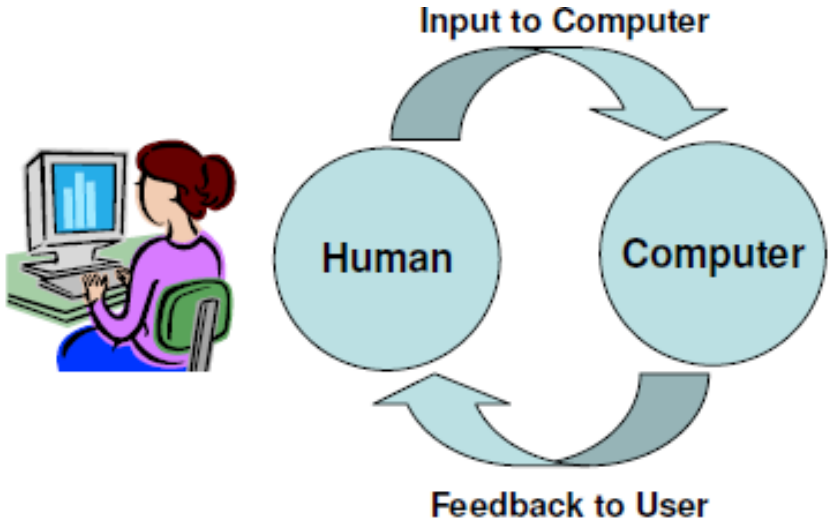
Donald Norman : Stages of action models

- Ph.D. from University of Pennsylvania.
- He has served as a faculty member at Harvard, University of California, San Diego, Northwestern, and KAIST (South Korea)..
- He is widely regarded for his expertise in the fields of design, usability engineering, and cognitive science.
- Seven stages of action is a term coined by the usability consultant Donald Norman.

https://www.jnd.org/

Stages of action models (Donald Norman)

- Seven stages of action theory by Donald Norman:
  1. Forming the goal
  2. Forming the intention
  3. Specifying the action
  4. Executing the action
  5. Perceiving the system state
  6. Interpreting the system state
  7. Evaluating the outcome



- Norman's contributions
  - Context of cycles of action and evaluation.
  - *Gulf of execution:* Mismatch between the user's intentions and the allowable actions
  - *Gulf of evaluation:* Mismatch between the system's representation and the users' expectations

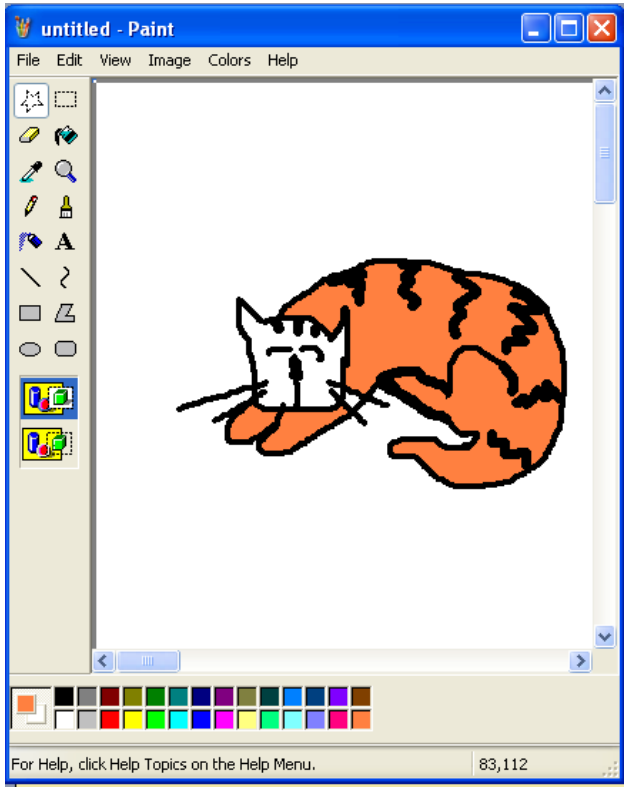
How people do things (Donald Norman)

1. To get something done, you start with some notion of what is wanted – the goal to be achieved
2. Then you do something to the world – take action to move yourself or manipulate someone or something
3. Finally, you check to see that your goal was made

- Human action has two primary aspects
  - Execution: doing something
  - Evaluation: comparison of what happened to what was desired (to our goal)

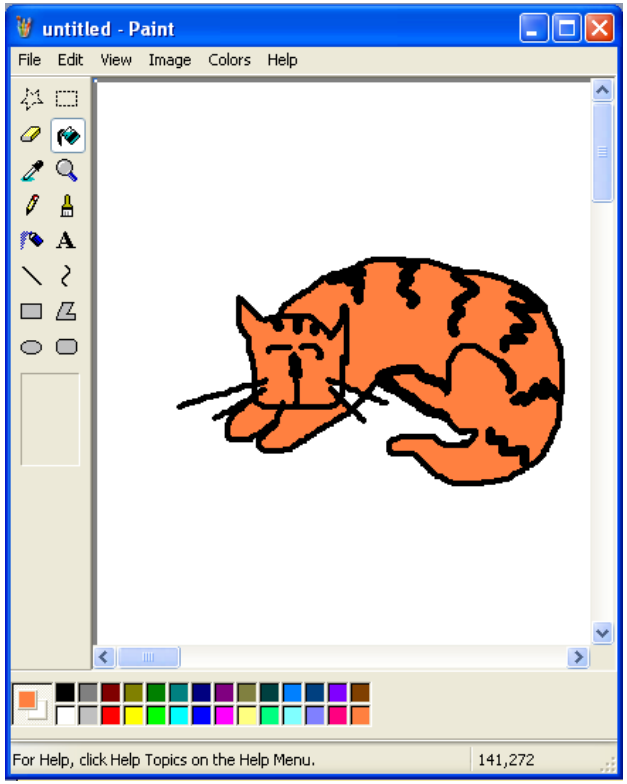
Norman's Example

1. Forming the goal
   * I want to paint the cat's head
2. Forming the intention
   * I will use the paintbucket (instead of brush)
3. Specifying the action
   * To do this, I need to click on the paint-bucket icon then the cat's head region
4. Executing the action
   * Physically doing the action with mouse and clicks.



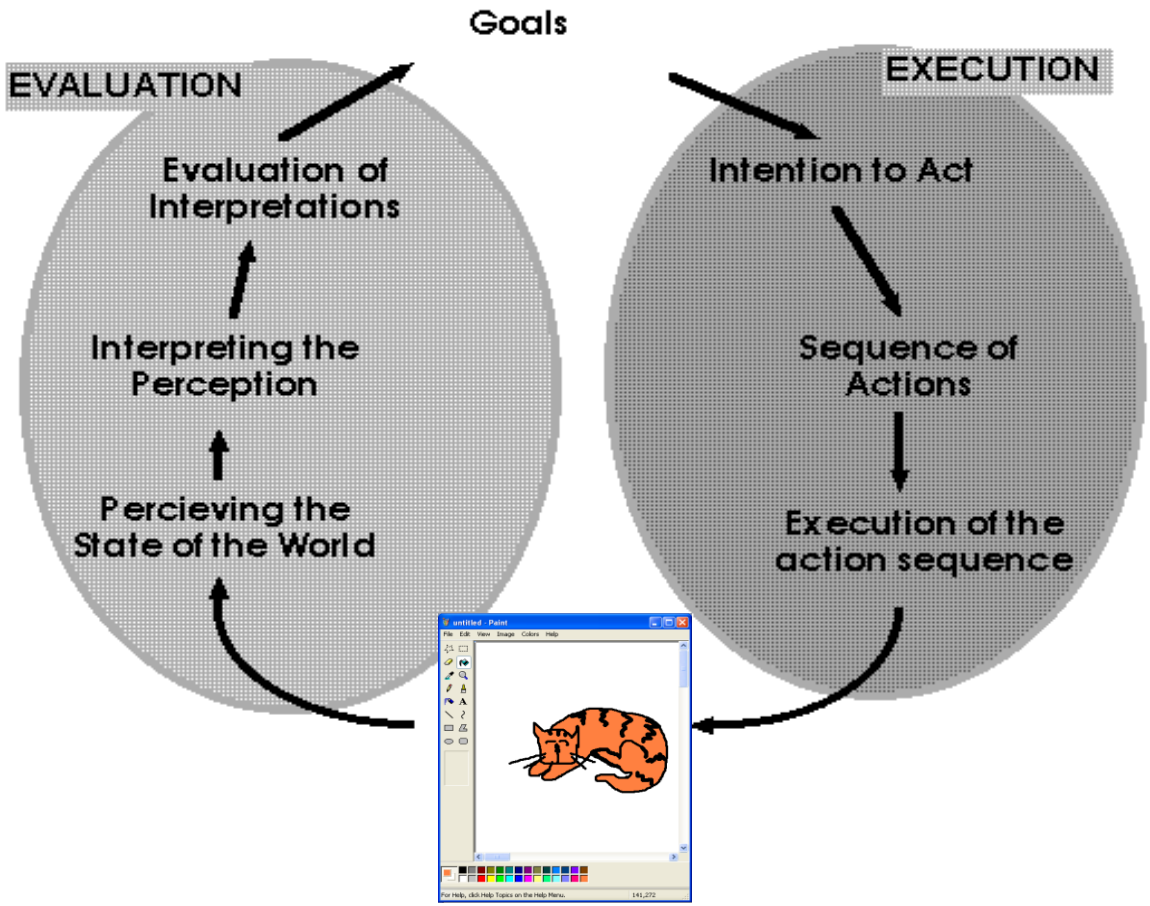
Norman's Example

5. Perceiving the system state
   * Display has changed
6. Interpreting the system state
   * Cat head is orange
7. Evaluating the outcome
   * Outcome is good, I'm a happy user.



Norman's Example

- Provides a "cycle" theory of usage



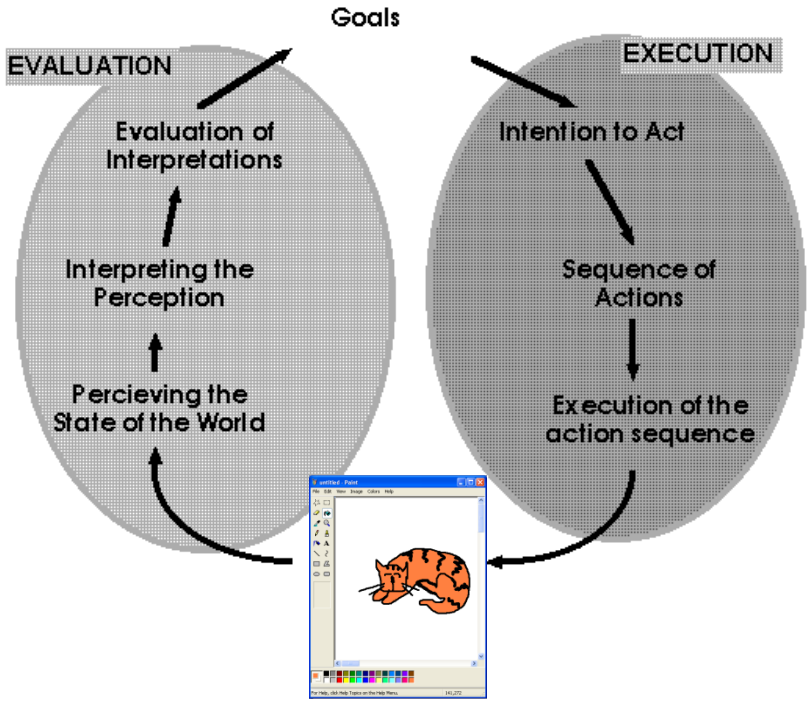
Issues in Execution and evaluation

- Gulf of execution
  - **Mismatch between the user's intentions and the allowable actions**
- Gulf of evaluation
  - **Mismatch between the system's representation and the users' expectations**

Gulf of evaluation error happens here.

Could be a real error in the system, or mismatch between what the user expected.

For example, imagine you want to paint the cat's head orange, but the program paints the entire image orange!



Gulf of execution error happens on this side.

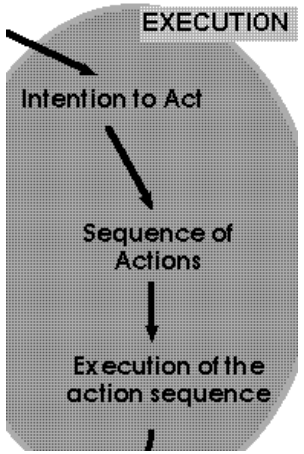
User wants to paint the cat's head stripped.

There is no corresponding action to perform this.

The user is lost, confused, and makes errors.

Suggestions from the Theory

- Four critical points where user failures can occur
  - Users can form an inadequate goal
  - Might not find the correct interface object because of ar incomprehensible label or icon
  - May not know how to specify or execute a desired action
  - May receive inappropriate or misleading feedback



- To avoid “gulf” errors, the following is proposed: Four principles of good design
  - Have a good conceptual model with a consistent system image
  - State and the action alternatives should be visible
  - Interface should include good mappings that reveal the relationships between stages
  - User should receive continuous feedback

Seven stages of action - Example

- "I am reading a book and decide to need more light"

1. My goal: get more light
2. Intention: push the switch button on the lamp
3. Action sequence (still a mental event) to satisfy intention: move my body, streach to reach the switch extend my finger
4. Physical execution: action sequence executed
5. Perceive whether there is more light in room
6. Decide whether the lamp turned on
7. Decide whether the resulting amount of light is sufficient

Gulf of Execution and evaluation

Summary

- Guidelines
  - Narrow rules established to guide basic UI design
- Principles
  - Widely accepted procedures and rules for UI design
- Theories
  - High-level analysis of users to help explain reasons for designs and predict usability