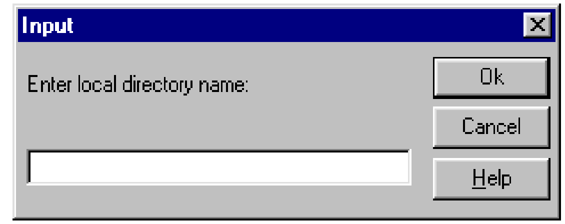
IFSM 303 Human Factors

Topics

Theories, Principles, and Guidelines

Design of Everyday Things

What's Wrong With This?



Application directory dialog

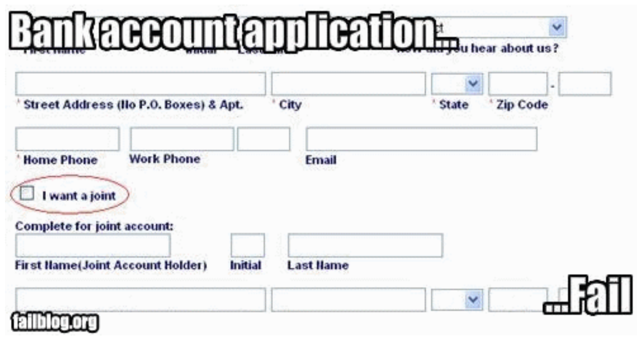
Requires typing a path name – no browse option

What if you have many directories?

Requires recall over recognition

Want *recognition over recall*

FAIL



HF Challenge

The National Building Museum
Washington, DC
No more than 1 page
What did you find?

Today's Experiment

What screen colors do you respond to best / worst?

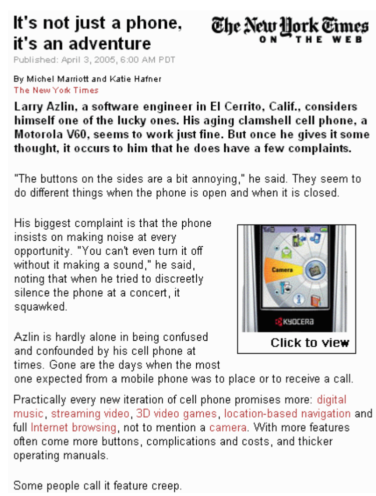
Procedure
- Type in your Age
- Press the letter on the screen
- Do not pause during test.
- Work as quickly as you can

HCI in the News

Feature Creep

Multifunction

Each function good but not excellent...



It's not just a phone, it's an adventure

The New York Times ON THE WEB

Published: April 3, 2005, 6:00 AM PDT

By Michel Marriott and Katie Hafner
The New York Times

Larry Azlin, a software engineer in El Cerrito, Calif., considers himself one of the lucky ones. His aging clamshell cell phone, a Motorola V60, seems to work just fine. But once he gives it some thought, it occurs to him that he does have a few complaints.

"The buttons on the sides are a bit annoying," he said. They seem to do different things when the phone is open and when it is closed.

His biggest complaint is that the phone insists on making noise at every opportunity. "You can't even turn it off without it making a sound," he said, noting that when he tried to discreetly silence the phone at a concert, it squawked.

Click to view

Azlin is hardly alone in being confused and confounded by his cell phone at times. Gone are the days when the most one expected from a mobile phone was to place or to receive a call.

Practically every new iteration of cell phone promises more: digital music, streaming video, 3D video games, location-based navigation and full Internet browsing, not to mention a camera. With more features often come more buttons, complications and costs, and thicker operating manuals.

Some people call it feature creep.

HCI in the News - WhiteHouse.gov 2001

And Today...

But Does it work?

- The site administrators posted an entry saying Obama "was sworn in" before that happened
- Another post titled "Read the Inaugural Address" was blank an hour after Obama finished giving it
- Some photo captions were incorrect the search option didn't work reliably.

Chapter 2

Guidelines, Principles, and Theories

Guidelines

- Shared language
- Best practices
- Critics
  - Too specific, incomplete, hard to apply, and sometimes wrong
- Proponents
  - Encapsulate experience

Navigating the interface

- Sample of the National Cancer Institutes guidelines:
  - Standardize task sequences
  - Ensure that embedded links are descriptive
  - Use unique and descriptive headings
  - Use check boxes for binary choices
  - Develop pages that will print properly
  - Use thumbnail images to preview larger images

Accessibility guidelines

- Provide a text equivalent for every nontext element
- For any time-based multimedia presentation synchronize equivalent alternatives
- Information conveyed with color should also be conveyed without it
- Title each frame to facilitate from identification and navigation

Organizing the display

- Smith and Mosier (1986) offer five high-level goals
  - Consistency of data display
  - Efficient information assimilation by the user
  - Minimal memory load on the user
  - Compatibility of data display with data entry
  - Flexibility for user control of data display

Getting the user's attention

Inte**nsity**	(2)
Marking	
SIZE	(4)
Fonts	(3)
Inverse Video	
Blinking	(2 to 4 Hz)
Colors	(4)
Audio	

Facilitating data entry

- Smith and Mosier (1986) offer five high-level objectives as part of their guidelines for data entry
  - Consistency of data-entry transactions
  - Minimal input actions by user
  - Minimal memory load on users
  - Compatibility of data entry with data display
  - Flexibility for user control of data entry

Principles

- More fundamental, widely applicable, and enduring than guidelines
- Need more clarification
- Fundamental principles
  - Determine user's skill levels
  - Identify the tasks
- Five primary interaction styles
- Eight golden rules of interface design
- Prevent errors
- Automation and human control

Determine user's skill levels

- "Know thy user" Hansen (1971)
- 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
- Multi-layer designs

Identify the tasks

- Task Analysis usually involve long hours observing and interviewing users
- Decomposition of high level tasks
- Relative task frequencies

	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

- Direct Manipulation
- Menu selection
- Form fillin
- Command language
- 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 fillin	
Simplifies data entry	Consumes screen space
Requires modest training	
Gives convenient assistance	
Permits use of form-management tools	
Command language	
Is flexible	Has 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
	Is unpredictable

8 golden rules of interface design

- Strive for consistency
- Cater to universal usability
- Offer informative feedback
- Design dialogs to yield closure
- Prevent errors
- Permit easy reversal of actions
- Support internal locus of control
- Reduce short term memory

Prevent errors

- Make error messages specific, positive in tone, and constructive
- Mistakes and slips (Norman, 1983)
- Correct actions
  - Gray out inappropriate actions
  - Selection rather than freestyle typing
  - Automatic completion
- Complete sequences
  - Single abstract commands
  - Macros and subroutines

Automation and human control

Humans Generally Better	Machines Generally Better
Sense low-level stimuli	Sense stimuli outside human's range
Detect stimuli in noisy background	Count or measure physical quantities
Recognize constant patterns in varying situations	Store quantities of coded information accurately
Sense unusual and unexpected events	Monitor prespecified events, especially infrequent ones
Remember principles and strategies	Make rapid and consistent responses to input signals
Retrieve pertinent details without a priori connection	Recall quantities of detailed information accurately
Draw on experience and adapt decisions to situation	Process quantitative data in prespecified ways
Select alternatives if original approach fails	Reason deductively: infer from a general principle
Reason inductively: generalize from observations	Perform repetitive preprogrammed actions reliably
Act in unanticipated emergencies and novel situations	Exert great, highly controlled physical force
Apply principles to solve varied problems	Perform several activities simultaneously
Make subjective evaluations	Maintain operations under heavy information load
Develop new solutions	Maintain performance over extended periods of time
Concentrate on important tasks when overload occurs	
Adapt physical response to changes in situation	

Automation and human control

- Successful integration:
  - Users can avoid:
    - Routine, tedious, and error prone tasks
  - Users can concentrate on:
    - Making critical decisions, coping with unexpected situations, and planning future actions

Automation and human control

- Supervisory control needed to deal with real world open systems
  - E.g. air-traffic controllers with low frequency, but high consequences of failure
  - FAA: design should place the user in control and automate only to improve system performance, without reducing human involvement

Automation and human control

- Goals for autonomous agents
  - knows user's likes and dislikes
  - makes proper inferences
  - responds to novel situations
  - performs competently with little guidance
- Tool like interfaces versus autonomous agents
- Aviators representing human users, not computers, more successful

Automation and human control

- User modeling for adaptive interfaces
  - keeps track of user performance
  - adapts behavior to suit user's needs
  - allows for automatically adapting system
    - response time, length of messages, density of feedback, content of menus, order of menu items, type of feedback, content of help screens
  - can be problematic
    - system may make surprising changes
    - user must pause to see what has happened
    - user may not be able to
      - predict next change
      - interpret what has happened
      - restore system to previous state

Automation and human control

- Alternative to agents:
  - user control, responsibility, accomplishment
  - expand use of control panels
    - style sheets for word processors
    - specification boxes of query facilities
    - information-visualization tools

Theories

- Beyond the specifics of guidelines
- Principles are used to develop theories
- Descriptions/explanatory or predictive
- Motor task, perceptual, or cognitive

Explanatory and predictive theories

- **Explanatory theories:**
  - Observing behavior
  - Describing activity
  - Conceiving of designs
  - Comparing high-level concepts of two designs
  - Training
- **Predictive theories:**
  - Enable designers to compare proposed designs for execution time or error rates

Perceptual, Cognitive, & Motor

- **Perceptual or Cognitive subtasks theories**
  - Predicting reading times for free text, lists, or formatted displays
- **Motor-task performance times theories:**
  - Predicting keystroking or pointing times

Taxonomy (explanatory theory)

- Order on a complex set of phenomena
- Facilitate useful comparisons
- Organize a topic for newcomers
- Guide designers
- Indicate opportunities for novel products.

Models

- Foley and van Dam four-level approach
  - *Conceptual level:*
    - User's mental model of the interactive system
  - *Semantic level:*
    - Describes the meanings conveyed by the user's command input and by the computer's output display
  - *Syntactic level:*
    - Defines how the units (words) that convey semantics are assembled into a complete sentence that instructs the computer to perform a certain task
  - *Lexical level:*
    - Deals with device dependencies and with the precise mechanisms by which a user specifies the syntax
- Approach is convenient for designers
  - Top-down nature is easy to explain
  - Matches the software architecture
  - Allows for useful modularity during design

Stages of action models

- Norman's seven stages of action
  - Forming the goal
  - Forming the intention
  - Specifying the action
  - Executing the action
  - Perceiving the system state
  - Interpreting the system state
  - 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

Stages of action models (cont.)

- Four principles of good design
  - State and the action alternatives should be visible
  - Should be a good conceptual model with a consistent system image
  - Interface should include good mappings that reveal the relationships between stages
  - User should receive continuous feedback
- Four critical points where user failures can occur
  - Users can form an inadequate goal
  - Might not find the correct interface object because of an incomprehensible label or icon
  - May not know how to specify or execute a desired action
  - May receive inappropriate or misleading feedback

GOMS

- Goals, operators, methods, and selection rules (GOMS) model
  - Keystroke-level model: Predict performance times for error-free expert performance of tasks
  - Transition diagrams
  - Natural GOMS Language (NGOMSL)
  - Several alternative methods to delete fields, e.g.
    - Method 1 to accomplish the goal of deleting the field:
      - Decide: If necessary, then accomplish the goal of selecting the field
      - Accomplish the goal of using a specific field delete method
      - Report goal accomplished

GOMS

- Method 2 to accomplish the goal of deleting the field:
  - Decide: If necessary, then use the Browse tool to go to the card with the field
  - Choose the field tool in the Tools menu
  - Note that the fields on the card background are displayed
  - Click on the field to be selected
  - Report goal accomplished
- Selection rule set for goal of using a specific field-delete method:
  - If you want to past the field somewhere else, then choose "Cut Field" from the Edit menu.
  - If you want to delete the field permanently, then choose "Clear Field" from the Edit menu.
  - Report goal accomplished.

Consistency through grammars

- **Consistent user interface goal**
  - Definition is elusive - multiple levels sometimes in conflict
  - Sometimes advantageous to be inconsistent.

Consistent	**Inconsistent A**	**Inconsistent B**
delete/insert character	delete/insert character	delete/insert character
delete/insert word	remove/bring word	remove/insert word
delete/insert line	destroy/create line	delete/insert line
delete/insert paragraph	kill/birth paragraph	delete/insert paragraph

Consistency through grammars

- **Inconsistent action verbs**
  - Take longer to learn
  - Cause more errors
  - Slow down users
  - Harder for users to remember

Consistency through grammars

- Task-action grammars (TAGs) try to characterize a complete set of tasks.
- Example: TAG definition of cursor control

Dictionary of tasks:

move-cursor-one-character-forward	[Direction=forward,Unit=char]
move-cursor-one-character-backward	[Direction=backward,Unit=char]
move-cursor-one-word-forward	[Direction=forward,Unit=word]
move-cursor-one-word-backward	[Direction=backward,Unit=word]

Consistency through grammars

High-level rule schemas describing command syntax:

- task [Direction, Unit] -> symbol [Direction] + letter [Unit]
- symbol [Direction=forward] -> "CTRL"
- symbol [Direction=backward] -> "ESC"
- letter [Unit=word] -> "W"
- letter [Unit=char] -> "C"

Generates a consistent grammar:

move cursor one character forward	CTRL-C
move cursor one character backward	ESC-C
move cursor one word forward	CTRL-W
move cursor one word backward	ESC-W

Widget-level theories

- Follow simplifications made in higher-level, user-interface building tools.
  - Potential benefits:
  - Possible automatic generation of performance prediction
  - A measure of layout appropriateness available as development guide
  - Estimates generated automatically and amortized over many designers and projects
    - perceptual complexity
    - cognitive complexity
    - motor load
  - Higher-level patterns of usage appear

Object/Action Interface model

- **Syntactic-semantic model of human behavior**
- used to describe
  - programming
  - database-manipulation facilities
  - direct manipulation
- Distinction made between meaningfully-acquired semantic concepts and rote-memorized syntactic details
- Semantic concepts of user's tasks well-organized and stable in memory
- Syntactic details of command languages arbitrary and required frequent rehearsal

Object/Action Interface model

With introduction of GUIs, emphasis shifted to simple direct manipulations applied to visual representations of objects and actions.

Syntactic aspects not eliminated, but minimized.

Object/Action Interface model

Object-action design:

- understand the task.
  - real-world objects
  - actions applied to those object
- create metaphoric representations of interface objects and actions
- designer makes interface actions visible to users

Task hierarchies

Decomposition of real-world complex systems natural

- human body
- buildings
- cities
- symphonies
- baseball game

Task hierarchies

Computer system designers must generate a hierarchy of objects and actions to model users' tasks:

- Representations in pixels on a screen
- Representations in physical devices
- Representations in voice or other audio cue

Interface hierarchies

Interface includes hierarchies of objects and actions at high and low levels. E.g. A computer system:

- Interface Objects
  - rectory
    - name
    - length
    - date of creation
    - owner
    - access control
  - files of information
    - lines
    - difields
    - characters
    - fonts
    - pointers
    - binary numbers

Interface hierarchies

- Interface Actions
  - load a text data file
  - insert into the data file
  - save the data file
    - save the file
    - save a backup of the file
    - apply access-control rights
    - overwrite previous version
    - assign a name

Interface hierarchies

Interface objects and actions based on familiar examples.

Users learn interface objects and actions by:

- seeing a demonstration
- hearing an explanation of features
- conducting trial-and-error sessions

The disappearance of syntax

- Users must maintain a profusion of device-dependent details in their human memory.
  - Which action erases a character
  - Which action inserts a new line after the third line of a text file
  - Which abbreviations are permissible
  - Which of the numbered function keys produces the previous screen.

The disappearance of syntax

- Learning, use, and retention of this knowledge is hampered by two problems
  - Details vary across systems in an unpredictable manner
  - Greatly reduces the effectiveness of paired-associate learning
- Syntactic knowledge conveyed by example and repeated usage
- Syntactic knowledge is system dependent

The disappearance of syntax

- Minimizing these burdens is the goal of most interface designers
  - Modern direct-manipulation systems
  - Familiar objects and actions representing their task objects and actions.
  - Modern user interface building tools
  - Standard widgets

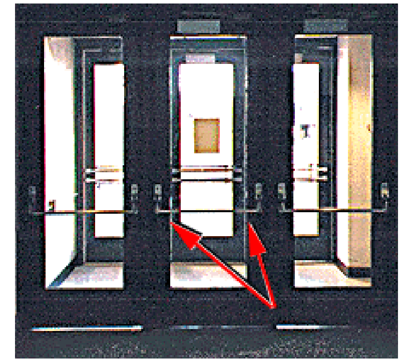
VCR Clocks

Doors

Phones

Doors

Which Side to Push On?



Sidewalks

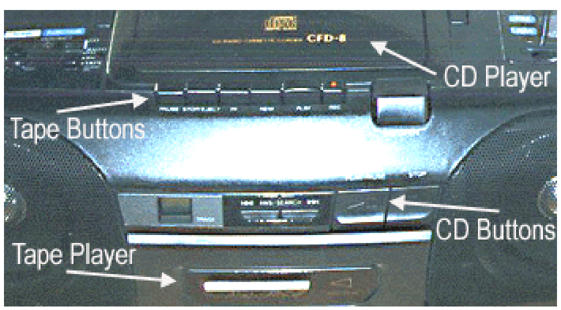
Figure out where people want to go first

What Side is the Gas Tank On?

Conceptual Models

- Confusions Arise When
  - Conceptual
    - Conflicts with
  - Reality

Conceptual Models



Conceptual Models

Power Window Buttons

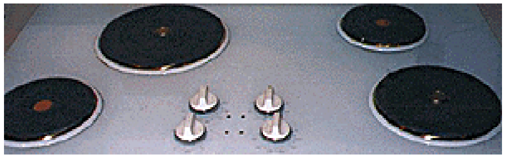
Mapping

- Action = Reaction
- Relationship between Control and Result
- Feedback
- Design

The Stove Top

Bad Design

Good Design



Homework

Myers-Briggs Type Indicator
Download and unzip MBTI.zip
Answer the questions
Save the file as *lastname.fi.*mbt
Email it to
submit.homework@gmail.com
Subject line: MBTI *name*
Email it Sunday 6pm
Only send it once!

End of This Lesson