

CHAPTER 2:

Guidelines, Principles, and Theories

*Designing the User Interface:
Strategies for Effective Human-Computer Interaction*

Fifth Edition

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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 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

- Intensity
- Marking
- Size
- Choice of fonts
- Inverse video
- Blinking
- Color
- Audio

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”**
- **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 Allows easy learning Allows easy retention Allows errors to be avoided Encourages exploration Affords high subjective satisfaction	May be hard to program May require graphics display and pointing devices
Menu selection Shortens learning Reduces keystrokes Structures decision making Permits use of dialog-management tools Allows easy support of error handling	Presents danger of many menus May slow frequent users Consumes screen space Requires rapid display rate
Form fill-in Simplifies data entry Requires modest training Gives convenient assistance Permits use of form-management tools	Consumes screen space
Command language Flexible Appeals to "power" users Supports user initiative Allows convenient creation of user-defined macros	Poor error handling Requires substantial training and memorization
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.

>MONTH/08;DAY/21

a. Command line

MM/DD 08/21

b. Form fill-in to reduce typing

MM 08 DD 21

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

Month

JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

 Day 21

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

August						
S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

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

The 8 golden rules of interface design

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

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

- Sense low-level stimuli
- Detect stimuli in noisy background
- Recognize constant patterns in varying situations
- Sense unusual and unexpected events
- Remember principles and strategies
- Retrieve pertinent details without *a priori* connection
- Draw on experience and adapt decisions to situation
- Select alternatives if original approach fails
- Reason inductively: generalize from observations
- Act in unanticipated emergencies and novel situations
- Apply principles to solve varied problems
- Make subjective evaluations
- Develop new solutions
- Concentrate on important tasks when overload occurs
- Adapt physical response to changes in situation

Machines Generally Better

- Sense stimuli outside human's range
- Count or measure physical quantities
- Store quantities of coded information accurately
- Monitor prespecified events, especially infrequent ones
- Make rapid and consistent responses to input signals
- Recall quantities of detailed information accurately
- Process quantitative data in prespecified ways
- Reason deductively: infer from a general principle
- Perform repetitive preprogrammed actions reliably
- Exert great, highly controlled physical force
- Perform several activities simultaneously
- Maintain operations under heavy information load
- Maintain performance over extended periods of time

Automation and human control (cont.)

- 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 (cont.)

- 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 (cont.)

- 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 (cont.)

- 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 (cont.)

- **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**

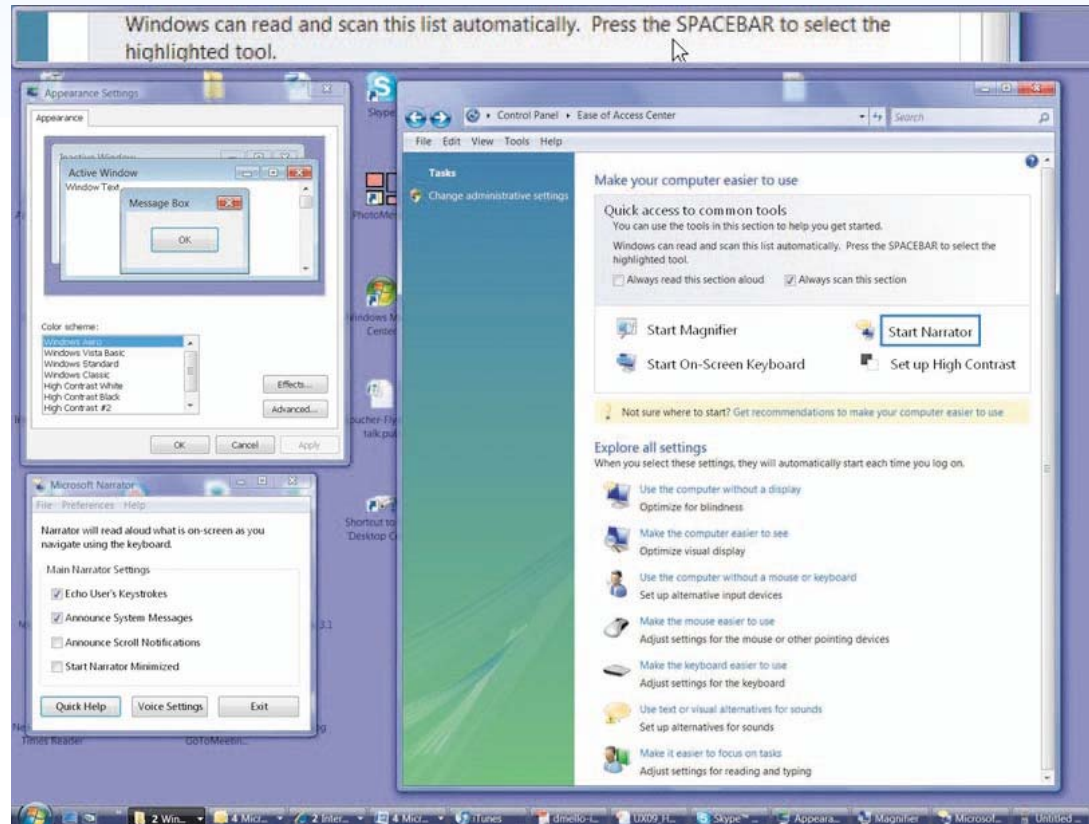
Automation and human control (concluded)



Features to aid in universal access

Above: Mac OS X system preference settings

Right: Windows Vista Control Panel



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 tasks

- **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.

Conceptual, semantic, syntactic, and lexical model

- **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**
 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**

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

Consistency through grammars

Consistent user interface goal

- Definition is elusive - multiple levels sometimes in conflict
- Sometimes advantageous to be inconsistent.

Consistent

delete/insert character

delete/insert word

delete/insert line

delete/insert paragraph

Inconsistent A

delete/insert character

remove/bring word

destroy/create line

kill/birth paragraph

Inconsistent B

delete/insert character

remove/insert word

delete/insert line

delete/insert paragraph

Consistency through grammars (cont.)

Inconsistent action verbs

- Take longer to learn
- Cause more errors
- Slow down users
- Harder for users to remember

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 (cont.)

- 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 (concluded)

- 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

Contextual Theories

- User actions are situated by time and place
 - You may not have time to deal with shortcuts or device dependent syntax, such as on mobile devices, when hurried
 - Physical space is important in ubiquitous, pervasive and embedded devices, e.g. a museum guide stating information about a nearby painting
- A taxonomy for mobile device application development could include:
 - Monitor and provide alerts, e.g. patient monitoring systems
 - Gather information
 - Participate in group collaboration
 - Locate and identify nearby object or site
 - Capture information about the object and share that information