Lecture 9: Direct Manipulation and Virtual Environments

Chapter 5: Sections 5.1, 5.2 and 5.3

Direct Manipulation = *Visual* Representations of Actions and Objects

Examples of Direct-Manipulation Systems

Command line vs. display editors and word processors

- The advances of WYSIWYG word processors:
  - Display a full page of text
  - Display of the document in the form that it will appear when the final printing is done
  - Show cursor action
  - Control cursor motion through physically obvious and intuitively natural means
  - Use of labeled icon for actions
  - Display of the results of an action immediately
  - Provide rapid response and display
  - Offer easily reversible actions

Examples of Direct-Manipulation Systems (cont.)

Technologies that derive from the word processor:

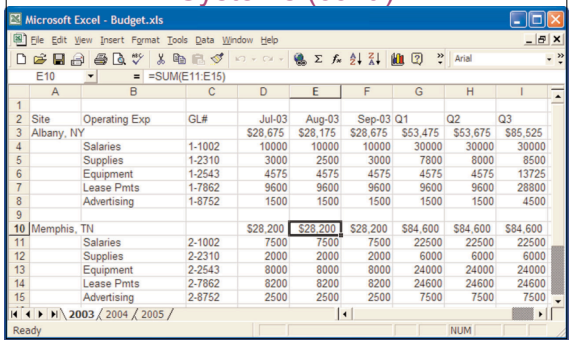
- Desktop publication software
- Slide-presentation software
- Graphics editors
- Hypermedia environments
- Improved macro facilities
- Spell checker and thesaurus
- Grammar checkers
- *Note*: Integration of applications

Examples of Direct-Manipulation Systems (cont.)

The VisiCalc spreadsheet and its descendants

- VisiCalc users delighted in watching the program propagate changes across the screen.
- The "killer app" for direct manipulation!
- In some cases, spatial representations provide a better model of reality
- Successful spatial data-management systems depend on choosing appropriate:
  - Icons
  - Graphical representations
  - Natural and comprehensible data layouts

Examples of Direct-Manipulation Systems (cont.)



	A	B	C	D	E	F	G	H	I
1									
2	Site	Operating Exp	GL#	Jul-03	Aug-03	Sep-03	Q1	Q2	Q3
3	Albany, NY			$28,675	$28,175	$28,675	$53,475	$53,675	$85,525
4		Salaries	1-1002	10000	10000	10000	30000	30000	30000
5		Supplies	1-2310	3000	2500	3000	7800	8000	8500
6		Equipment	1-2543	4575	4575	4575	4575	4575	13725
7		Lease Pmts	1-7862	9600	9600	9600	9600	9600	28800
8		Advertising	1-8752	1500	1500	1500	1500	1500	4500
9									
10	Memphis, TN			$28,200	$28,200	$28,200	$84,600	$84,600	$84,600
11		Salaries	2-1002	7500	7500	7500	22500	22500	22500
12		Supplies	2-2310	2000	2000	2000	6000	6000	6000
13		Equipment	2-2543	8000	8000	8000	24000	24000	24000
14		Lease Pmts	2-7862	8200	8200	8200	24600	24600	24600
15		Advertising	2-8752	2500	2500	2500	7500	7500	7500

Examples of Direct-Manipulation Systems (cont.)

Video games

- From PONG to Nintendo GameCube, Sony PlayStation 2, and Microsoft Xbox
- Field of action is visual and compelling
- Commands are physical actions whose results are immediately shown on the screen
- No syntax to remember
- Most games continuously display a score
- Direct manipulation in SimCity
- Myst well received
- DOOM and Quake controversial

Definition of Direct Manipulation

The OAI Model explanation of direct manipulation

1. Continuous representation of the objects and actions of interest
2. Physical actions or presses of labeled buttons instead of complex syntax
3. Rapid incremental reversible operations whose effect on the object of interest is immediately visible

Human Factors Issues: Usability Measures

- Learning time (Novices)
  - Training times with display editors are much less than line editors
    - Why? Recall vs. recognition of commands
    - Why? Visual metaphor creates familiar tasks
- Performance time (Experts)
  - Line editors are generally more flexible and powerful
    - Why? Typing takes less time than pointing (.2sec/char vs. 1.2sec point)
- Fewer errors
  - Display editors cause fewer errors
    - Why? Recognition vs. recall; See incremental results immediately
- How can you combine the best of both?

Human Factors Issues : Usability Measures (cont.)

- Satisfaction
  - Positive feelings associated with good user interfaces:
    - Mastery of the interface
    - Competence in performing tasks
    - Ease in learning the system originally and in assimilating advanced features
    - Confidence in the capacity to retain mastery over time
    - Enjoyment in using the system
    - Eagerness to show the system off to novices
    - Desire to explore more powerful aspects of the system

Why does Direct Manipulation work?

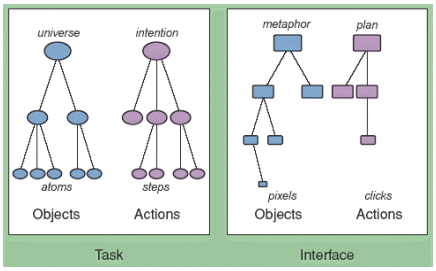
- An excursion into human memory

A Test of your Memory!

More on Human Memory

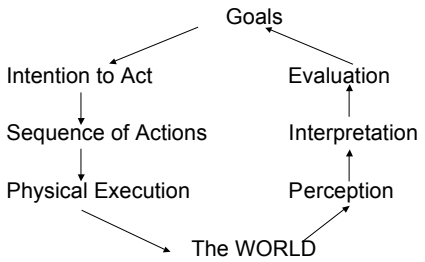
- Human memory is not perfect!
- How can we survive?
  - Information in the world
    - reminding
  - Great precision not required for most decisions, just need to select between alternatives
    - recall vs. recognition
  - Natural constraints are present
  - Cultural constraints are present

From Task to UI



Model of Human Action

(after Hutchins, Holland & Norman)



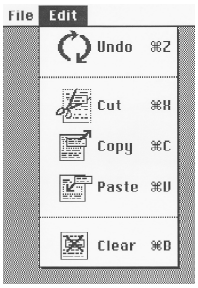
Designing Icons

- An icon is an image, picture, or symbol representing a concept
- Five levels of icon design:
  - **Lexical qualities**. Machine-generated marks—pixel shape, color brightness, blinking
  - **Syntactics**. Appearance and movement—lines, patterns, modular parts, size, shape
  - **Semantics**. Objects represented—concrete versus abstract, part versus whole
  - **Pragmatics**. Overall legibility, utility, identifiability, memorability, pleasingness
  - **Dynamics**. Receptivity to clicks—highlighting, dragging, combining

Icons as a Language

What would be good icons for the following text editing functions? Design a pulldown menu.

Cut
Clear
Copy
Paste
Undo



Designing Icons (cont.)

- Icon-specific guidelines
  - Represent the object or action in a familiar manner
  - Limit the number of different icons
  - Make icons stand out from the background
  - Consider three-dimensional icons
  - Ensure a selected icon is visible from unselected icons
  - Design the movement animation
  - Add detailed information
  - Explore combinations of icons to create new objects or actions

Summary of Direct Manipulation

Benefits:

- Novices learn quickly
- Experts work rapidly
- Intermittent users can retain concepts
- Error messages are rarely needed
- Users see if their actions are furthering their goals
- Users experience less anxiety
- Users gain confidence and mastery

Summary of Direct Manipulation

Problems:

- Spatial or visual representations can be too spread out
- High-level flowcharts and database-schema can become confusing
- Designs may force valuable information off of the screen
- Users must learn the graphical representations
  - Icons can be difficult to recognize
- The visual representation may be misleading
- Typing commands with the keyboard may be faster

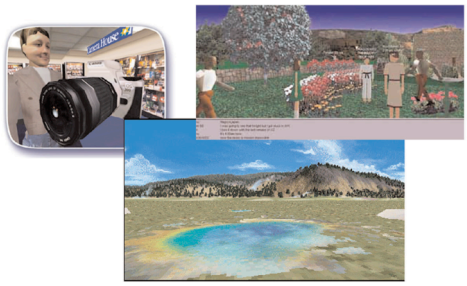
3D Interfaces, Teleoperation & Virtual Reality

Chapter 5: Section 5.4 - 5.6

3D Interfaces

- "Pure" 3D interfaces have strong utility in some contexts, e.g., medical, product design. In other situations, more constrained interaction may actually be preferable to simplify interactions.
- "Enhanced" interfaces, better than reality, can help reduce the limitations of the real-world, e.g., providing simultaneous views.
- Avatars in multiplayer 3-D worlds,
  - e.g., ActiveWorlds
- First person games

3D Interfaces (cont.)



3D Interfaces (cont.)

Features for effective 3D

- Use occlusion, shadows, perspective, and other 3D techniques carefully.
- Minimize the number of navigation steps for users to accomplish their tasks.
- Keep text readable.
- Avoid unnecessary visual clutter, distraction, contrast shifts, and reflections.
- Simplify user movement.
- Prevent errors.
- Simplify object movement
- Organize groups of items in aligned structures to allow rapid visual search.
- Enable users to construct visual groups to support spatial recall.

3D Interfaces (cont.)

Guidelines for inclusion of enhanced 3D features:

- Provide overviews so users can see the big picture
- Allow teleportation (rapid context shifts by selecting destination in an overview)
- Offer X-ray vision so users can see into or beyond objects.
- Provide history keeping
- Permit rich user actions on objects
- Enable remote collaboration
- Give users control over explanatory text and let users select for details on demand.
- Offer tools to select, mark, and measure.

3D Interfaces (cont.)

Guidelines for inclusion of enhanced 3D features (cont.):

- Implement dynamic queries to rapidly filter out unneeded items.
- Support semantic zooming and movement
- Enable landmarks to show themselves even at a distance
- Allow multiple coordinated views
- Develop novel 3D icons to represent concepts that are more recognizable and memorable.

3D Graphics Example

- Google Earth
  - http://earth.google.com/
- Brain Explorer from Brain Atlas site
  - http://www.brainatlas.org/aba/

Teleoperation

- Two "parents": direct manipulation in personal computers and process control in complex environments
- Physical operation is remote
- Complicating factors in the architecture of remote environments:
  - Time delays
    - transmission delays
    - operation delays
  - Incomplete feedback
  - Feedback from multiple sources
  - Unanticipated interferences

Virtual and Augmented Reality

- Virtual reality breaks the physical limitations of space and allow users to act as though they were somewhere else
- Augmented reality shows the real world with an overlay of additional overlay
- Situational awareness shows information about the real world that surrounds you by tracking your movements in a computer model
- Augmented reality is an important variant
  - Enables users to see the real world with an overlay of additional interaction.

Virtual and Augmented Reality (cont.)

- Successful virtual environments depend on the smooth integration of:
  - Visual Display
  - Head position sensing
  - Hand-position sensing
  - Force feedback
  - Sound input and output
  - Other sensations
  - Cooperative and competitive virtual reality