CHAPTER 5:
Direct Manipulation and Virtual Environments

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

Fifth Edition

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in collaboration with

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Introduction

- 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

Examples of Direct-Manipulation Systems

Car driving

- Front window and windows at the sides
- Break/Accelerator systems
- Steer wheel system

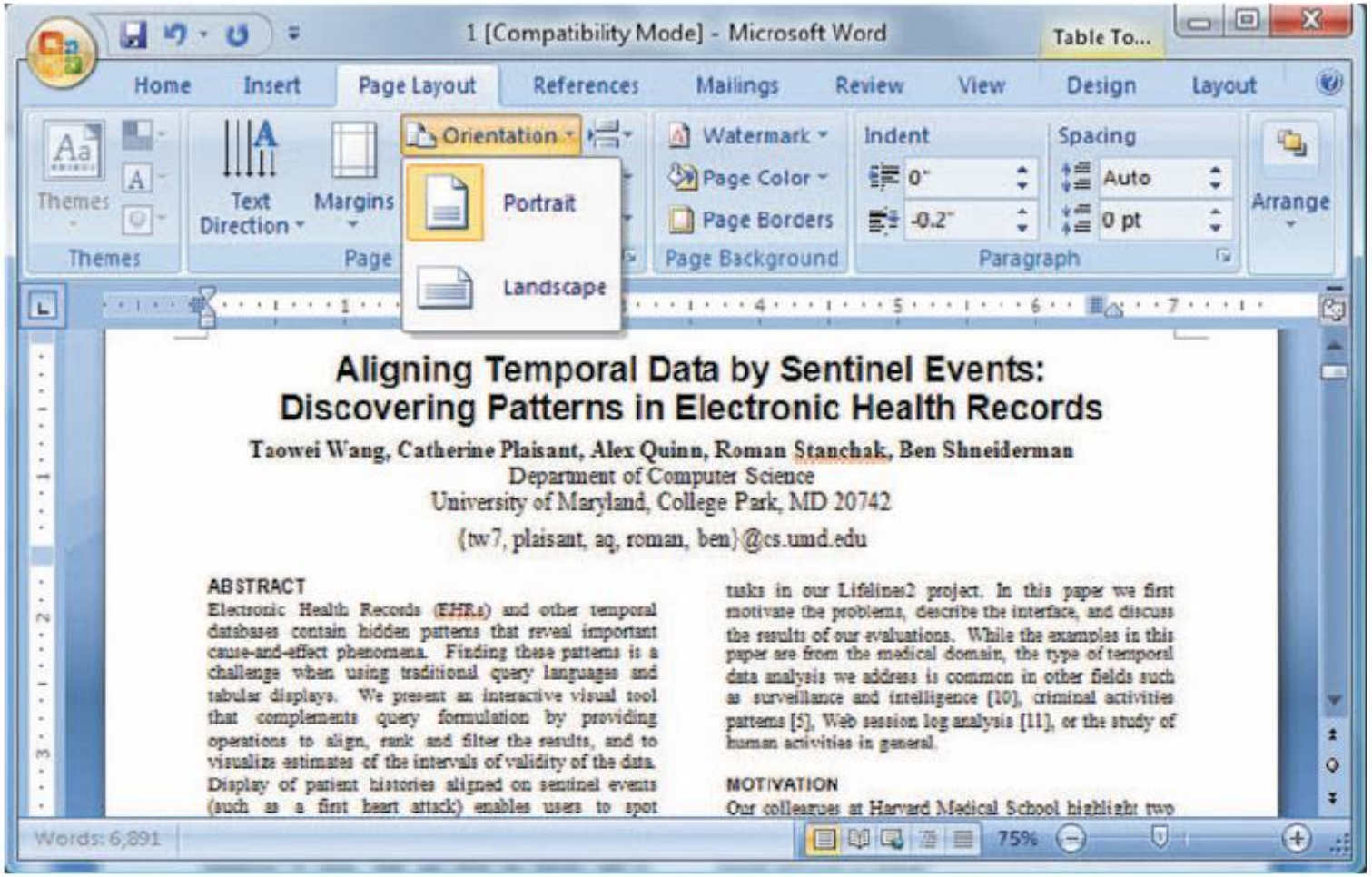
Examples of Direct-Manipulation Systems

Command line vs. display editors and word processors

- Training times with display editors are much less than line editors
- Line editors are generally more flexible and powerful
- 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:

WYSIWYG word processing



Examples of Direct-Manipulation Systems (cont.)

Technologies that derive from the word processor:

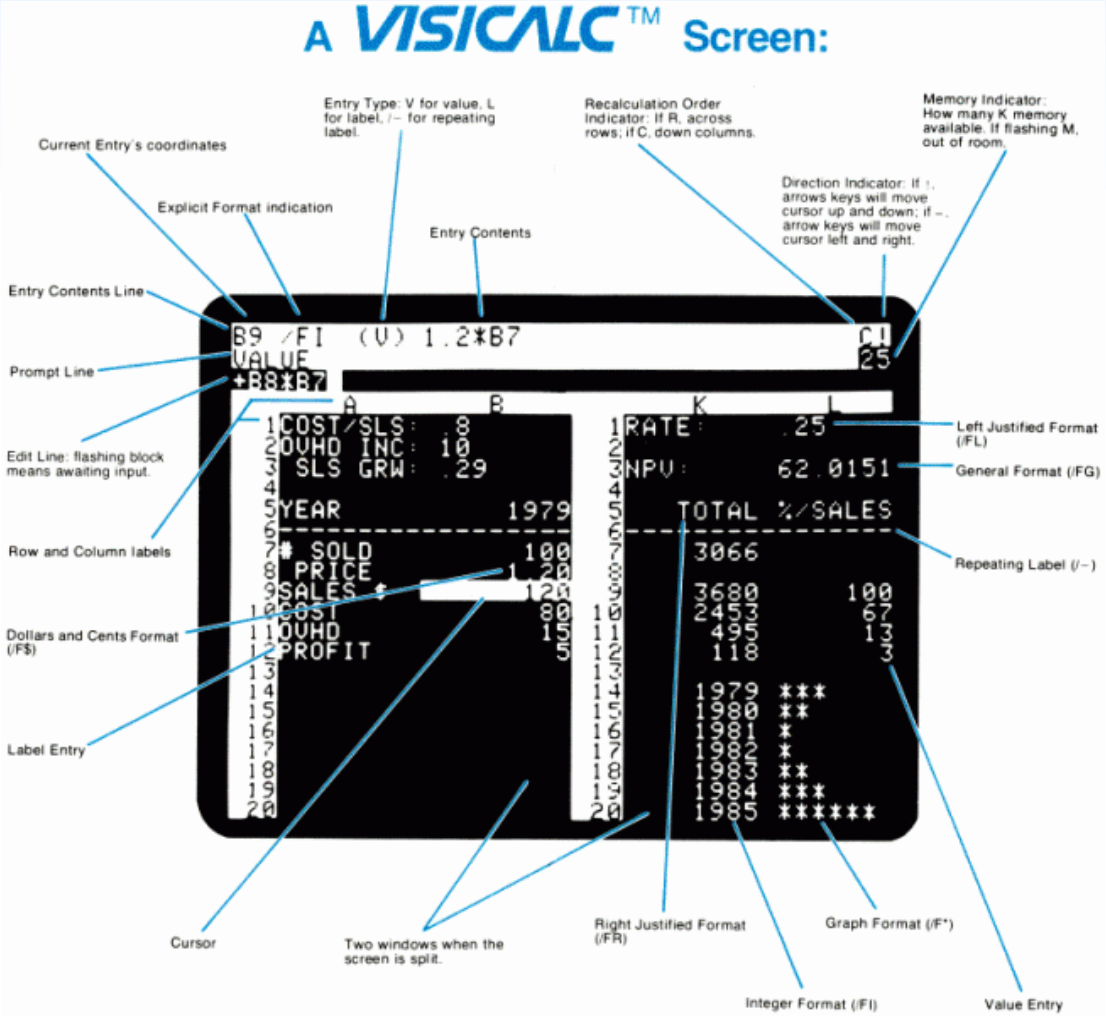
- Integration
- Desktop publication software
- Slide-presentation software
- Hypermedia environments
- Improved macro facilities
- Spell checker and thesaurus
- Grammar checkers

Examples of Direct-Manipulation Systems (cont.)

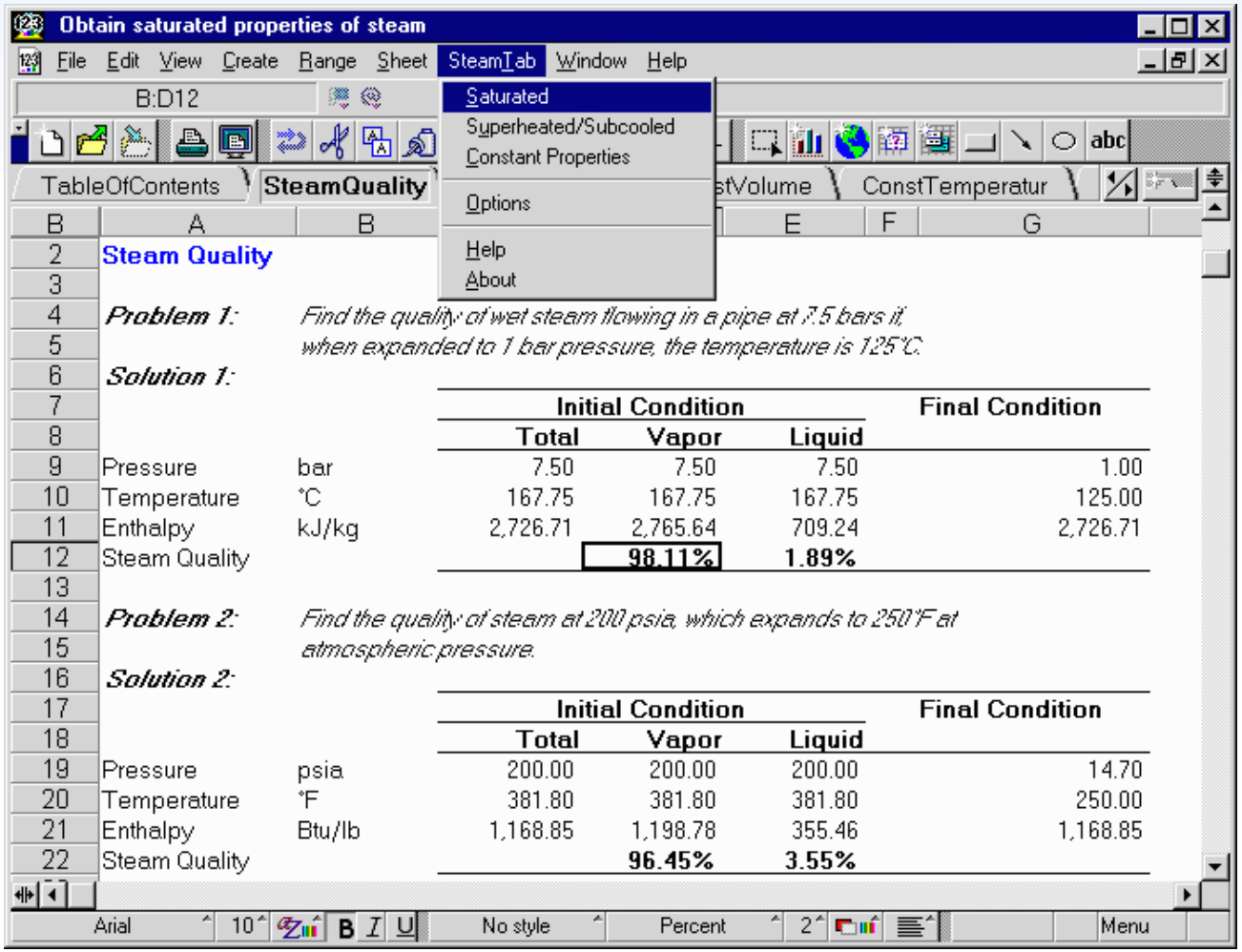
The VisiCalc spreadsheet and its descendants

- VisiCalc users delighted in watching the program propagate changes across the screen.
- 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.): Spreadsheet – VisiCalc



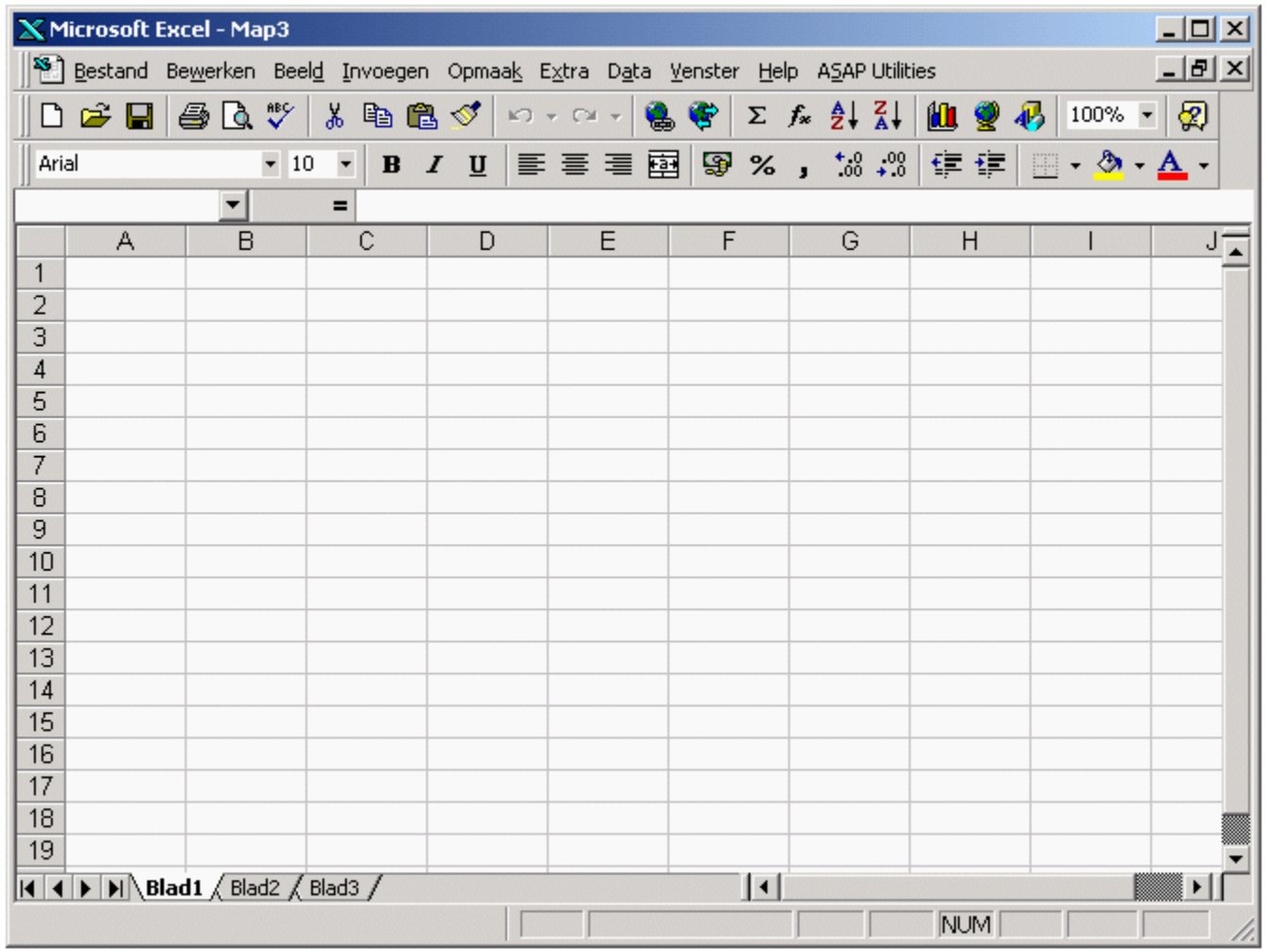
Examples of Direct-Manipulation Systems (cont.): Spreadsheet – Lotus 1-2-3



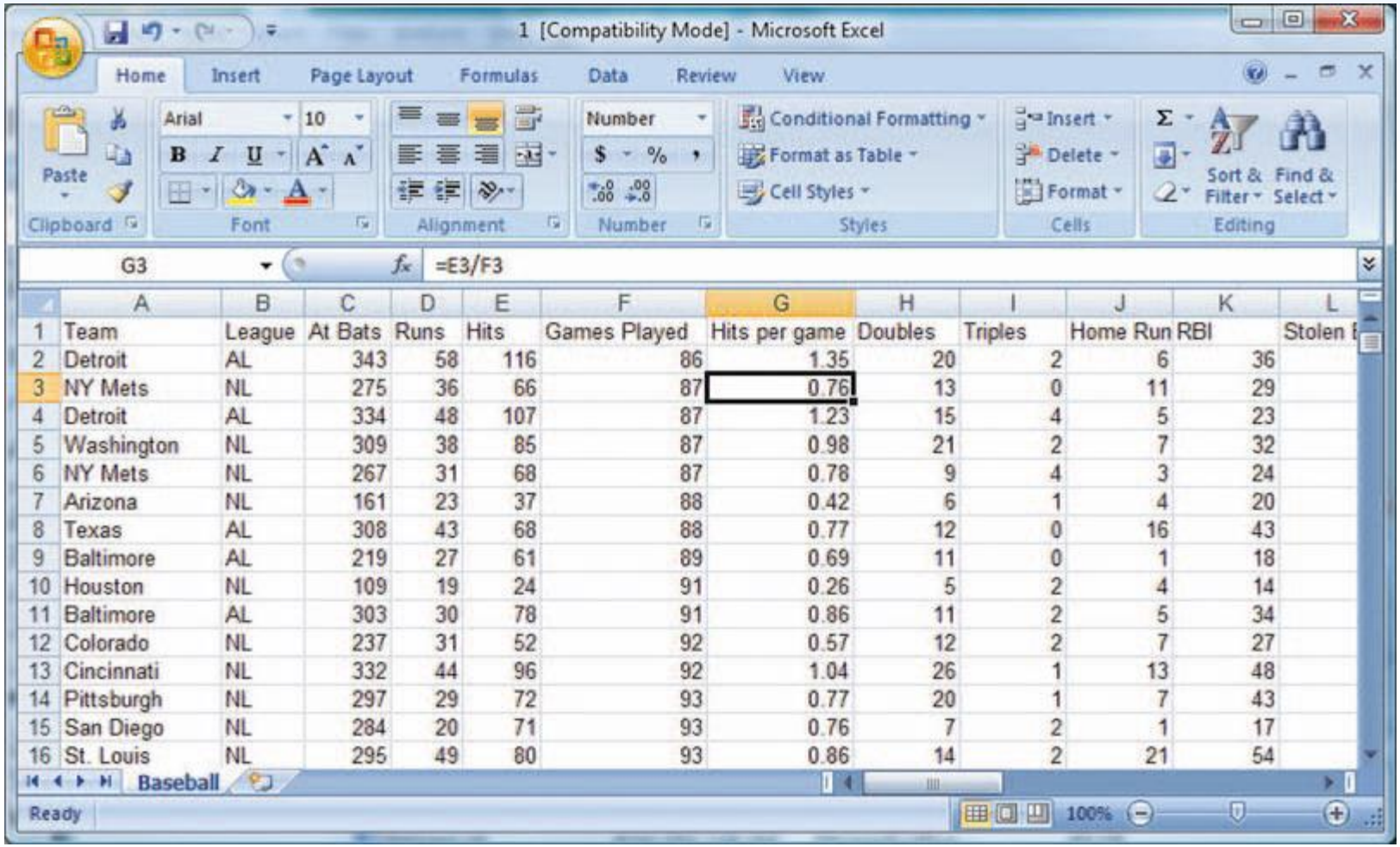
		Initial Condition			Final Condition
		Total	Vapor	Liquid	
Pressure	bar	7.50	7.50	7.50	1.00
Temperature	°C	167.75	167.75	167.75	125.00
Enthalpy	kJ/kg	2,726.71	2,765.64	709.24	2,726.71
Steam Quality			98.11%	1.89%	

		Initial Condition			Final Condition
		Total	Vapor	Liquid	
Pressure	psia	200.00	200.00	200.00	14.70
Temperature	°F	381.80	381.80	381.80	250.00
Enthalpy	Btu/lb	1,168.85	1,198.78	355.46	1,168.85
Steam Quality			96.45%	3.55%	

Examples of Direct-Manipulation Systems (cont.): Spreadsheet – Excel 97



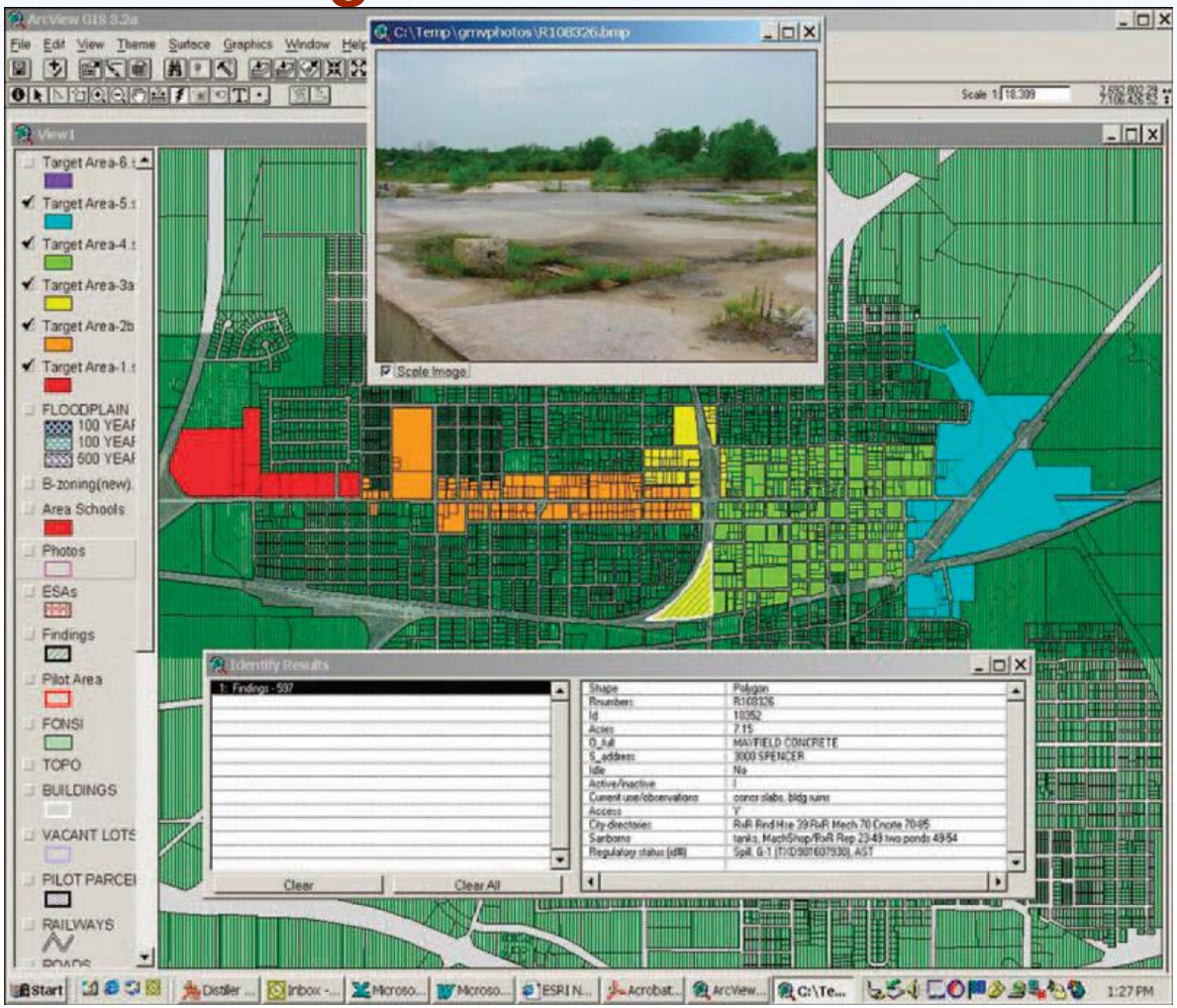
Examples of Direct-Manipulation Systems (cont.): Spreadsheet – Excel



	A	B	C	D	E	F	G	H	I	J	K	L
1	Team	League	At Bats	Runs	Hits	Games Played	Hits per game	Doubles	Triples	Home Run	RBI	Stolen
2	Detroit	AL	343	58	116	86	1.35	20	2	6	36	
3	NY Mets	NL	275	36	66	87	0.76	13	0	11	29	
4	Detroit	AL	334	48	107	87	1.23	15	4	5	23	
5	Washington	NL	309	38	85	87	0.98	21	2	7	32	
6	NY Mets	NL	267	31	68	87	0.78	9	4	3	24	
7	Arizona	NL	161	23	37	88	0.42	6	1	4	20	
8	Texas	AL	308	43	68	88	0.77	12	0	16	43	
9	Baltimore	AL	219	27	61	89	0.69	11	0	1	18	
10	Houston	NL	109	19	24	91	0.26	5	2	4	14	
11	Baltimore	AL	303	30	78	91	0.86	11	2	5	34	
12	Colorado	NL	237	31	52	92	0.57	12	2	7	27	
13	Cincinnati	NL	332	44	96	92	1.04	26	1	13	48	
14	Pittsburgh	NL	297	29	72	93	0.77	20	1	7	43	
15	San Diego	NL	284	20	71	93	0.76	7	2	1	17	
16	St. Louis	NL	295	49	80	93	0.86	14	2	21	54	

Examples of Direct-Manipulation Systems (cont.)

spatial data management



Examples of Direct-Manipulation Systems (cont.)

Video games

- Nintendo Wii, Sony PlayStation, 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 SimSity
- Second Life virtual world
- Spore
- Myst well received
- DOOM and Quake controversial

Examples of Direct-Manipulation Systems (cont.)

Guitar Hero video game

Examples of Direct-Manipulation Systems (cont.)

Computer-aided design

- Computer-aided design (CAD) use direct manipulation
- Manipulate the object of interest
- Generate alternatives easily
- Explain the impact
- Problem solving by analogy to the real-world

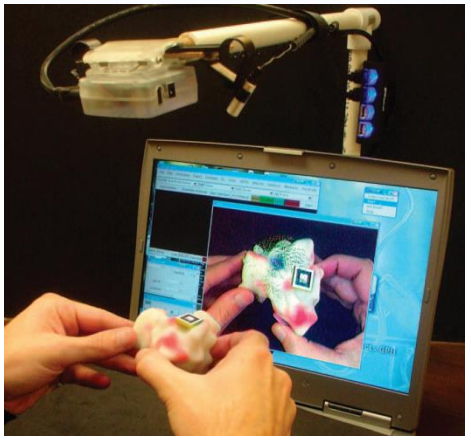
Office automation

- Xerox Star was a pioneer with sophisticated formatting
- Apple Lisa System
- Rapid and continuous graphical interaction
- Microsoft Windows is a descendant

Continuing evolution of Direct-Manipulation Systems

Direct-Manipulation interfaces are being used in a wide range of applications, e.g. management dashboard for a retail store

Continuing evolution of Direct-Manipulation Systems (cont.)



Discussion of Direct Manipulation

Problems with direct manipulation

- 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
- The visual representation may be misleading
- Typing commands with the keyboard may be faster

Principles of Direct Manipulation

1. Continuous representations of the objects and actions of interest with meaningful visual metaphors.
2. Physical actions or presses of labeled buttons, instead of complex syntax.
3. Rapid, incremental, reversible actions whose effects on the objects of interest are visible immediately.

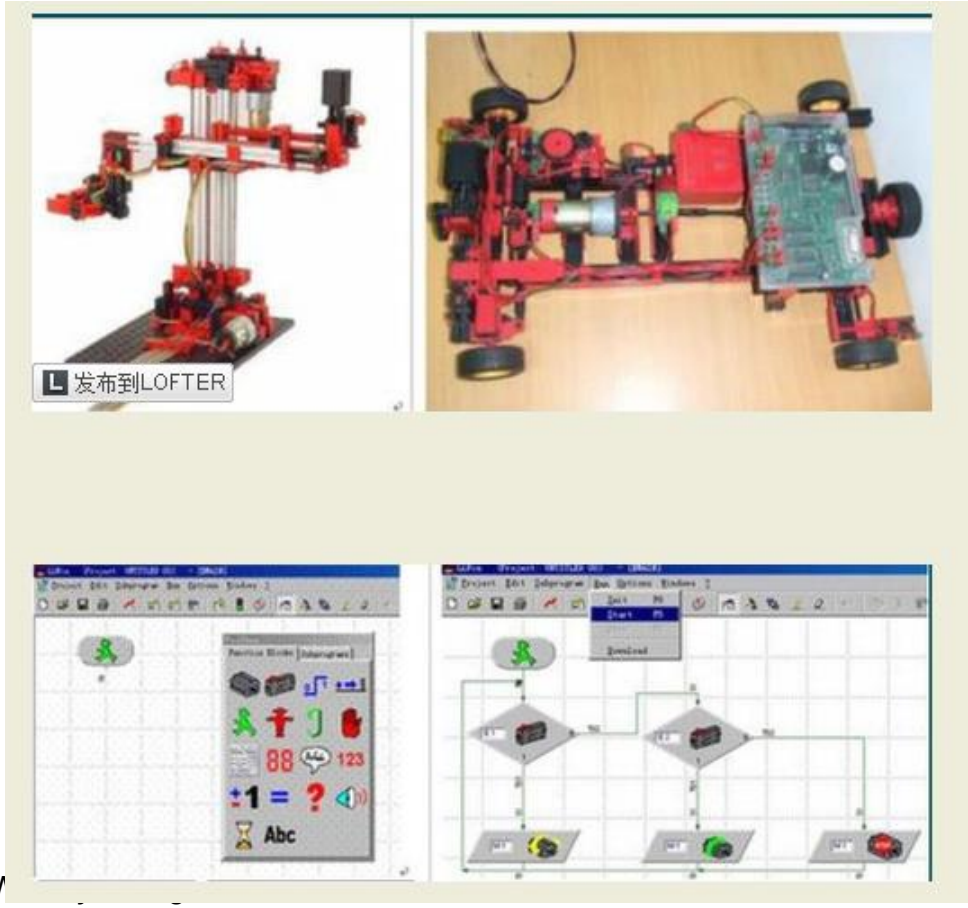
Interface-Building Tools

Visual Thinking and Icons

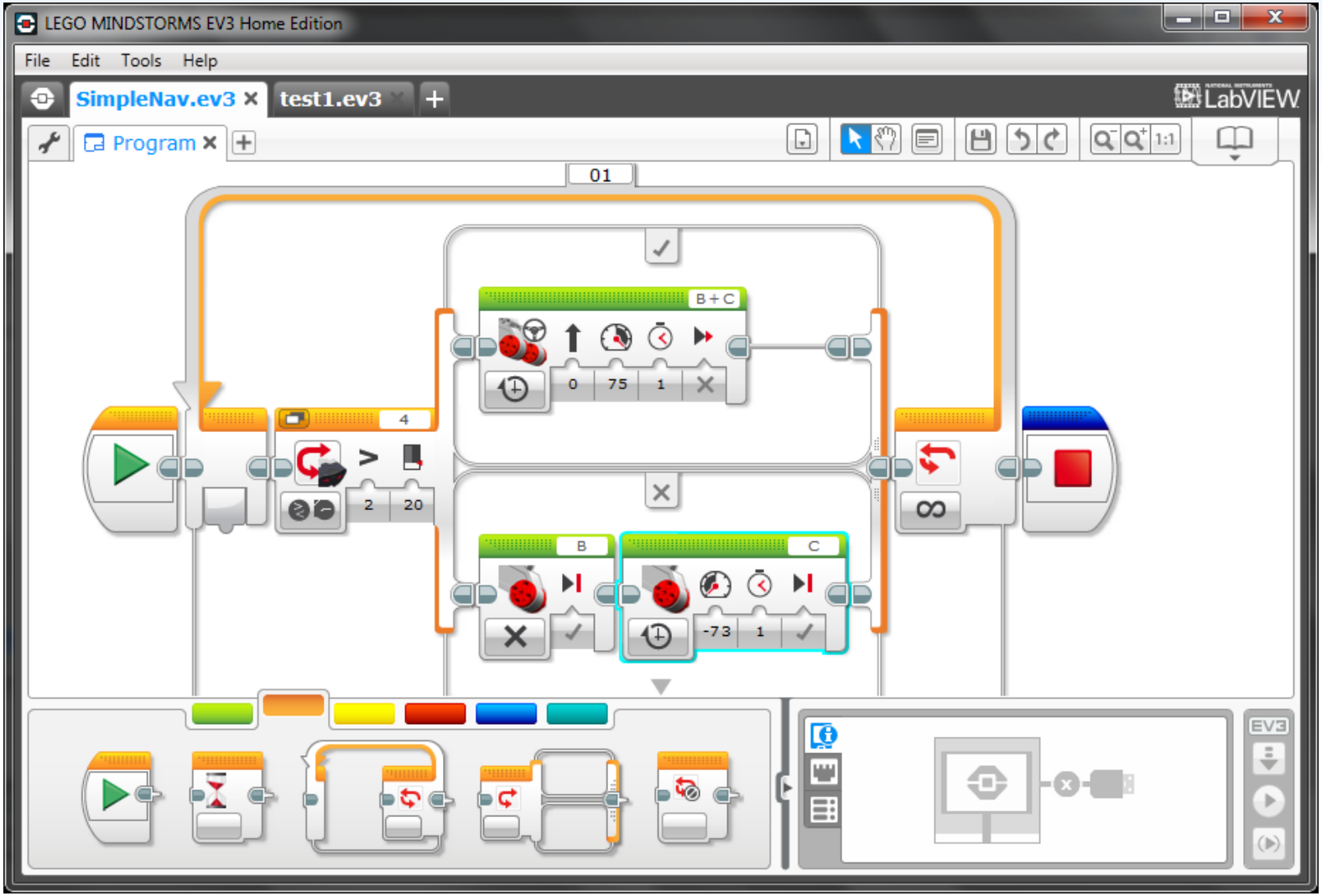
- The visual nature of computers can challenge the first generation of hackers
- An icon is an image, picture, or symbol representing a concept
- Icon-specific guidelines
  - Represent the object or action in a familiar manner
  - Limit the number of different icons
  - Make icons stand out from the 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

Direct-manipulation programming

- Programming by direct manipulation?



Direct-manipulation programming



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
- 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 teleoperation
- 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.

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

Virtual and Augmented Reality (cont.)

Impact of this technology in our everyday lives