Direct Manipulation and Virtual Environments

Designing the User Interface:

Strategies for Effective Human-Computer Interaction

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.

Examples of Direct-Manipulation Systems

- Word processors
- Integration
- Desktop publication software
- Slide-presentation software
- Hypermedia environments
- The VisiCalc spreadsheet and its descendants
- 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.)

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

Examples of Direct-Manipulation Systems (cont.)

Computer-aided design

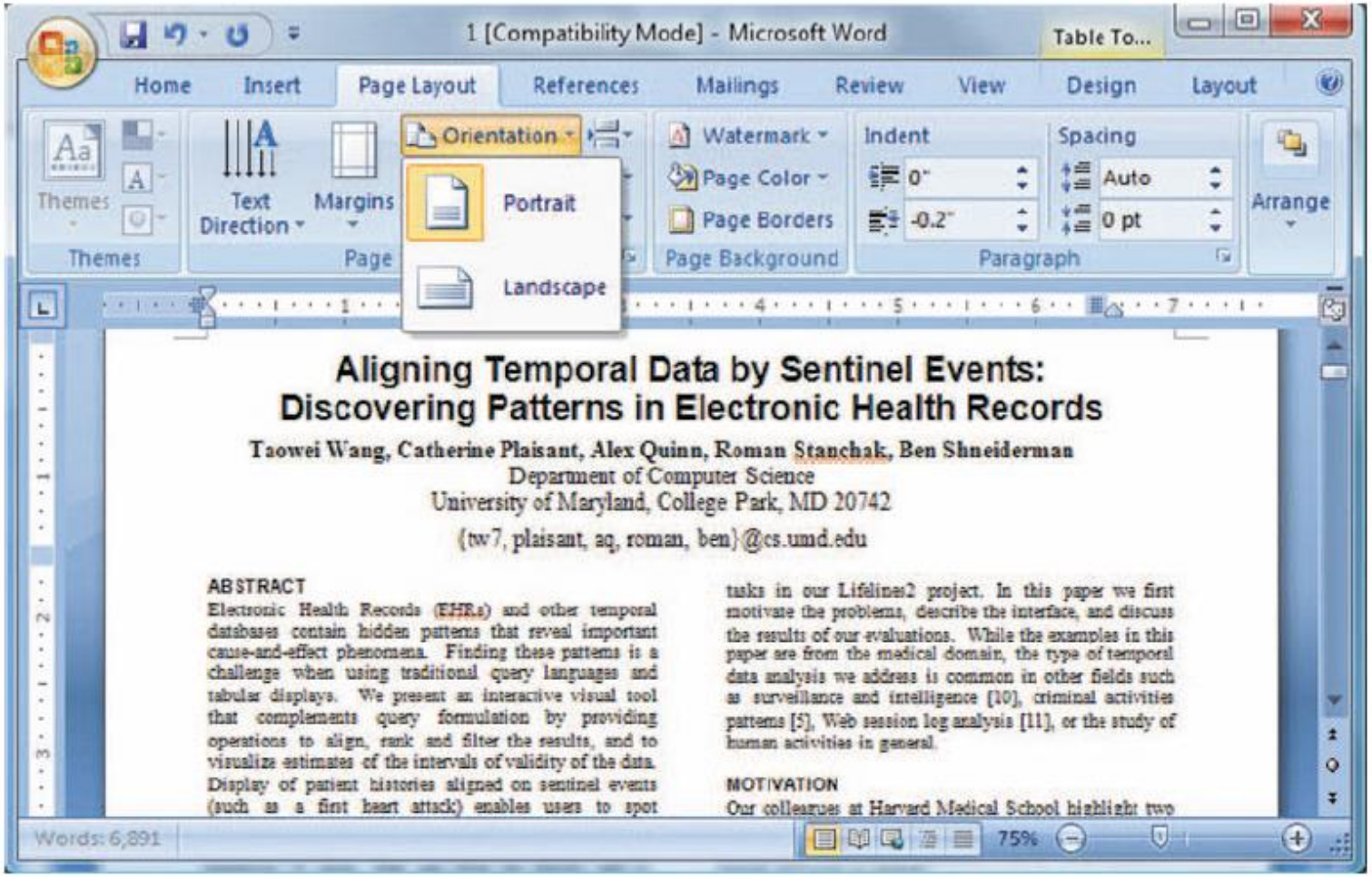
- Computer-aided design (CAD) use direct manipulation
- Manipulate the object of interest
- Generate alternatives easily
- Explain the impact
- Problem solving by analogy to the real-world

Office automation

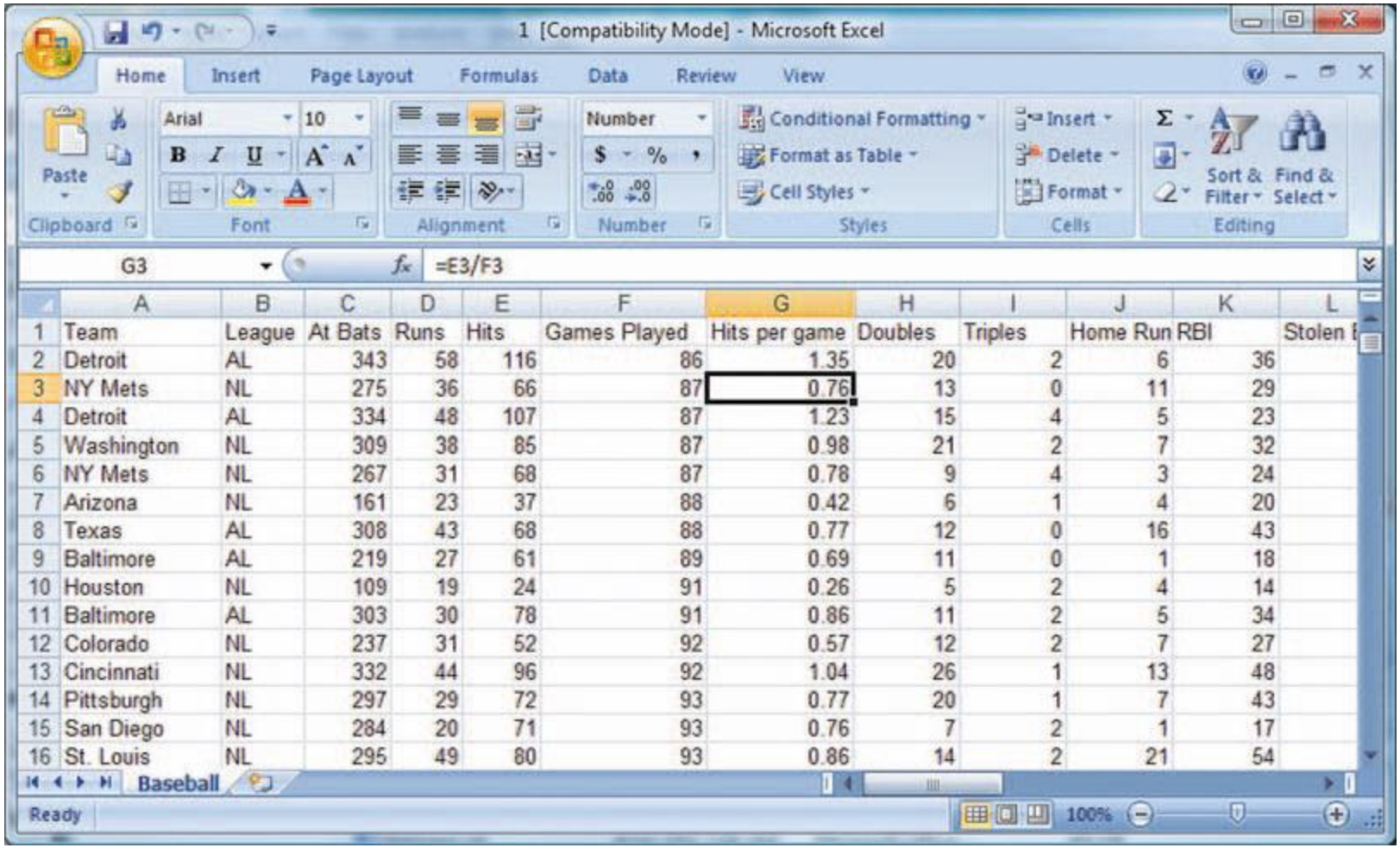
- Xerox Star was a pioneer with sophisticated formatting
- Apple Lisa System
- Rapid and continuous graphical interaction
- Microsoft Windows is a descendant

Examples of Direct-Manipulation Systems:

WYSIWYG word processing



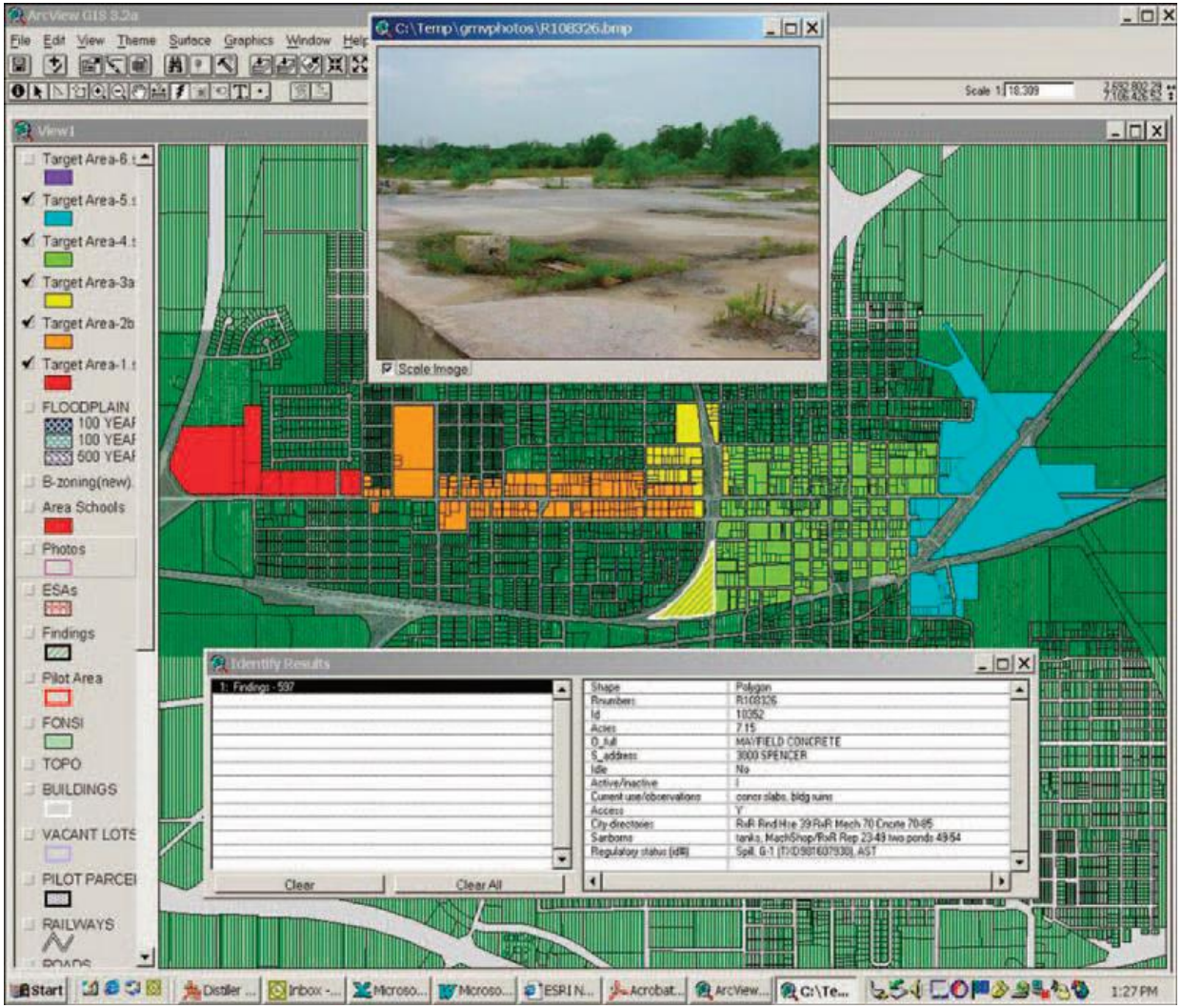
Examples of Direct-Manipulation Systems (cont.): spreadsheet



	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.)

Guitar Hero video game

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

Interface-Building Tools

Visual Thinking and Icons

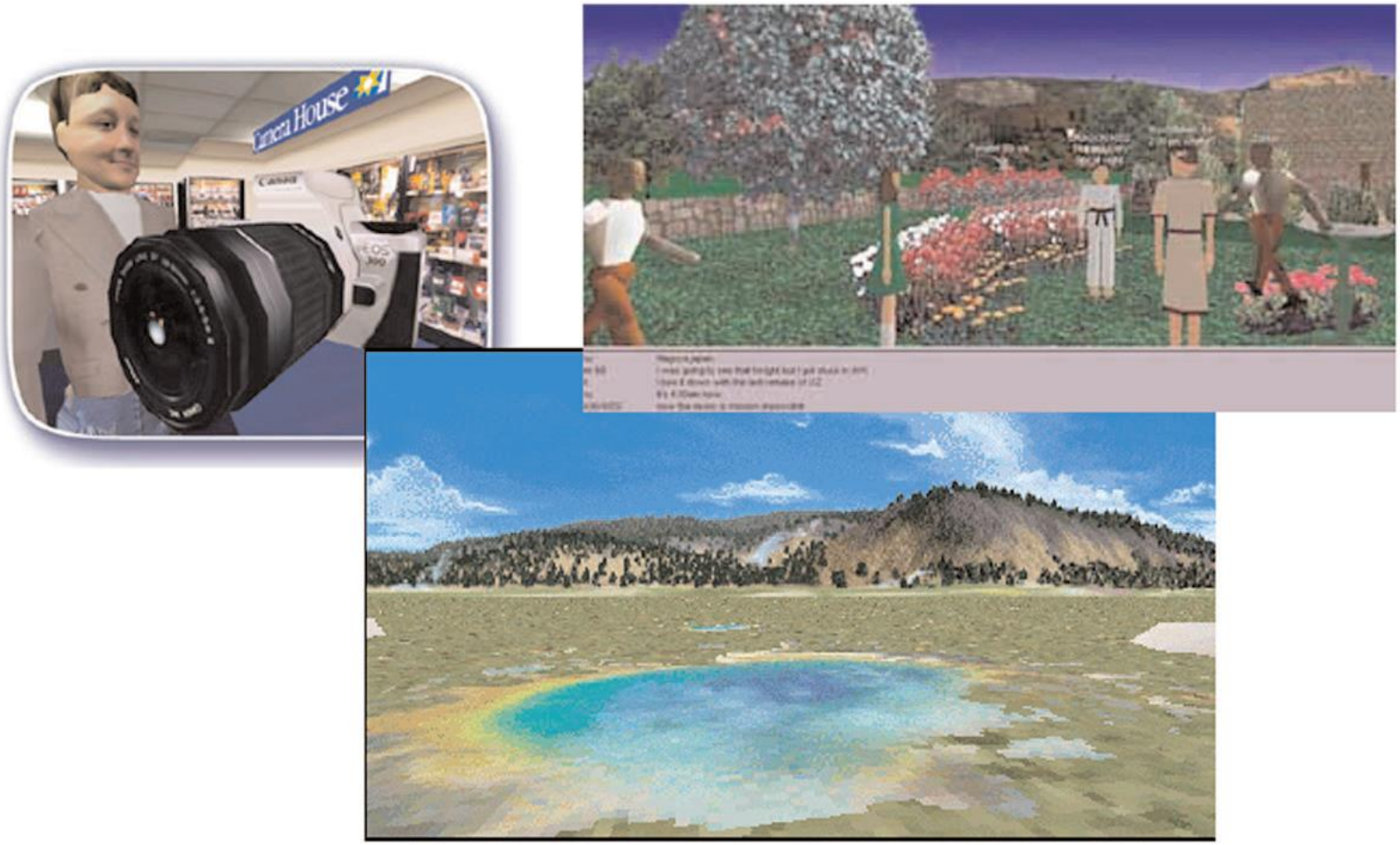
- The visual nature of computers can challenge the first generation of hackers
- An icon is an image, picture, or symbol representing a concept
- Icon-specific guidelines
  - Represent the object or action in a familiar manner
  - Limit the number of different icons
  - Make icons stand out from the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

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, e.g. combination actions

- “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

3D Interfaces (cont.)



3D Interfaces (cont.)

Features for effective 3D

- Use 3D techniques such as occlusion, shadows, perspective, and others 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.

Teleoperation

- 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
  - Enables users to see the real world with an overlay of additional interaction.

Menu Selection, Form Fill-In, and Dialog Boxes

Menus

- Use appropriate menu
  - Single Menus
  - Binary Menus
  - Multiple-item Menus
  - Multiple-selection menus or check boxes
  - Pull-down, pop-up, and toolbar menus
  - Menus for long lists
  - Embedded menus and hotlinks

Single Menus (cont.)

Combination of multiple menus

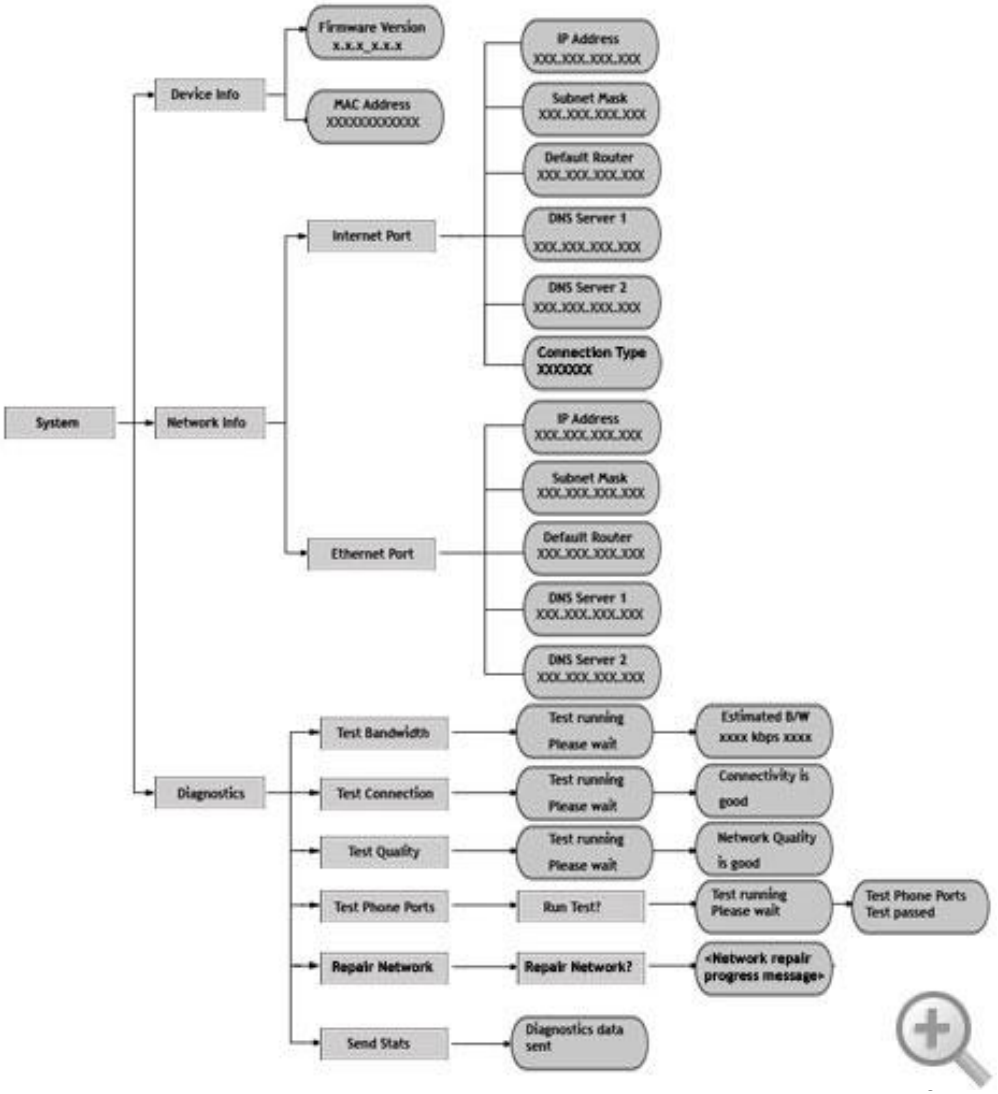
- **Linear menu sequences and simultaneous menus**
  - Linear
    - Guide the user through complex decision-making process.
      - E.g. cue cards or "Wizards"
    - Effective for novice users performing simple tasks
  - Simultaneous
    - Present multiple active menus at the same time and allows users to enter choices in any order

Combination of multiple menus (cont.)

- **Tree-structured menus**
  - Designers can form categories of similar items to create a tree structure
    - E.g., fonts, size style, spacing
  - Fast retrieved if natural and comprehensive
  - Use terminology from the task domain
  - Expanding menus maintain the full context of each choice
    - E.g., Windows Explorer

Combination of multiple menus (cont.)

- **Menu Maps**
  - Menu maps can help users stay oriented in a large menu tree
  - Effective for providing overviews to minimize user disorientation.



Content Organization

- **Task-related grouping in tree organization**
  - Create groups of logically similar items
  - Form groups that cover all possibilities
  - Make sure that items are no overlapping
  - Use familiar terminology, but ensure that items are distinct from one another

Content Organization (cont.)

- **Item Presentation Sequence**
  - The order of items in the menu is important, and should take natural sequence into account when possible:
    - Time
    - Numeric ordering
    - Physical properties
  - When cases have no task-related orderings, the designer must choose from such possibilities as:
    - Alphabetic sequence of terms
    - Grouping of related items
    - Most frequently used items first
    - Most important items first.

Content Organization (cont.)

- **Menu layout guidelines**
  - **Establish consistency guidelines for components**
    - **Titles**
    - **Graphic layout and design**
    - **Techniques / Format**
    - **Keyboard shortcuts**

Data Entry with Menus: Form Fill-in, Dialog Boxes, and Alternatives

- **Form Fill-in**
  - Appropriate when many fields of data must be entered:
    - Full complement of information is visible to user.
    - Display resembles familiar paper forms.
    - Few instructions are required for many types of entries.
  - Users must be familiar with:
    - Keyboards
    - Use of TAB key or mouse to move the cursor
    - Error correction methods
    - Field-label meanings
    - Permissible field contents
    - Use of the ENTER and/or RETURN key.

Data Entry with Menus: Form Fill-in, Dialog Boxes, and Alternatives

- **Format-specific field**
  - **Coded fields**
    - Telephone numbers
    - Social-security numbers
    - Times
    - Dates
    - Dollar amounts (or other currency)

Data Entry with Menus: Form Fill-in, Dialog Boxes, and Alternatives

- **Dialog Boxes**
  - Combination of menu and form fill-in techniques.
  - Internal layout guidelines:
    - Meaningful title, consistent style
    - Top-left to bottom-right sequencing
    - Clustering and emphasis
    - Consistent layouts (margins, grid, white space, lines, boxes)
    - Consistent terminology, fonts, capitalization, justification
    - Standard buttons (OK, Cancel)
    - Error prevention by direct manipulation
    - Apply validity checks and provide clear feedback on errors

Data Entry with Menus: Form Fill-in, Dialog Boxes, and Alternatives

- **Dialog Boxes (cont.)**
  - External Relationship
    - Smooth appearance and disappearance
    - Distinguishable but small boundary
    - Size small enough to reduce overlap problems
    - Display close to appropriate items
    - No overlap of required items
    - Easy to make disappear
    - Clear how to complete/cancel

Audio Menus and Menus for Small Displays

- Menu systems in small displays and situations where hands and eyes are busy are a challenge.
  - **Audio menus**
    - Verbal prompts and option descriptions
  - **Menu for small displays**
    - Learnability is a key issue
    - Hardware buttons
    - Tap interface
    - Use GPS and radio frequency identification to provide some automatic input