Chapter 2: Interaction Styles

The Resonant Interface
HCI Foundations for Interaction Design
First Edition

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Chapter 2 Interaction Styles

• Frameworks for Understanding Interaction
• Coping with Complexity
  – Avoid “cluttering”, mixing-up, becoming too eclectic
  – Good for analysis/evaluation?
    • Consistency often thought of in re. to interaction styles
• Interaction Styles vs. Paradigms
  – Not so much to do with what we plan on using computers for
We are going to talk about two different (or more) interaction models/frameworks:

– Execution/Evaluation Action Cycle
– Interaction Framework
Frameworks for Understanding Interaction

• A framework is basically a structure that provides a context for conceptualizing something

• We can (also) use these frameworks to:
  – Structure the design process
  – Help us to identify problematic areas within the design
  – Help us to conceptualize the problem space as a whole
Execution/Evaluation Action Cycle (EEC)

• Donald Norman (1990) *The Design of Everyday Things*
  – *I think a book that you should consider reading!!!*
• The structure of an action has four basic part:
  – **Goals:** We begin with some idea of what we want to happen; this is our goal.
  – **Execution:** We must then execute an action in the world.
  – **World:** To execute and action, we must manipulate objects in the world.
  – **Evaluation:** Finally, we must validate our action and compare the results with our goal.
Execution/Evaluation Action Cycle (EEC)

Goals
What we want to happen

Execution
What we do to the world

Evaluation
Comparing what happened with what we wanted to happen

WORLD
Execution/Evaluation Action Cycle (EEC)

- Goals do not specify particular actions
- Goals and intentions do not have a one-to-one, relationship

- “Delete text” goal
  - Intention that involves the Edit menu
  - Intention that involves the Delete key
- Each intention involves a sequence of actions

Goal > Intention > Actions > Execution
Execution/Evaluation Action Cycle (EEC)

- Evaluate Results
  - Perceive new state
  - Interpret what we perceive
  - Evaluate new state with goal

Perceive > Interpret > Evaluate
Execution/Evaluation Action Cycle (EEC)

• Seven Stages of Action

- Execution
  - Goals: What we want to happen
  - Forming intention
  - Specifying action
  - Executing action

- Evaluation
  - Evaluating interpretation
  - Interpreting perception
  - Perceiving world state

WORLD
Execution/Evaluation Action Cycle (EEC)

• The seven stages form a cycle

• The cycle can be initiated at any point

  – Some goals are data-driven - initiated when an environmental event is perceived
    • Event-driven?
    • Recipient-designed?
  – Others are goal-driven - initiated when the person conceives of a new goal
Gulf of Execution

• Does the interface allow us to carry out the actions required by the intention?

Goal = save a file
Intention = use the file menu
Action = click the save option

• Is there a save option in the file menu?
Gulf of Evaluation

• Given a particular interface design, how easily can you:
  
  – Determine the function of the device?
  – Determine what actions are possible?
  – Determine mapping from intention to physical movement?
  – Perform the action?
  – Determine whether the system is in the desired state?
  – Determine the mapping from system state to interpretation?
  – Determine what state the system is in?

  (Norman, 1990)
Interaction Framework

• Abowd and Beale expanded on the EEC to include the system

• **System (S)** — Uses its core language (computational attributes related to system state)

• **User (U)** — Uses its task language (psychological attributes related to user state)

• **Input (I)** — Uses its input language

• **Output (O)** — Uses its output language
Interaction Framework / EEC

• **Execution Phase**
  – **Articulation**—The user formulates a goal, which is then articulated using the input language.
  – **Performance**—The input language is translated into the core language (operations that the system will carry out).
  – **Presentation**—The system manifests the result of the core-language operations using the output language.

• **Evaluation Phase**
  – **Observation**—The user interprets the results on the screen and reconciles them with the original goal.
We are going to talk about different strategies for doing this,...

- Mental Models
- Mapping
- Semantic and Articulatory Distance
- Affordances
Mental Models

- A mental model is a cognitive representation of something that defines a logical and believable estimation as to how a thing is constructed or how it functions
  - Transparent objects expose their functions
    - Bicycles
  - Opaque objects hide their functions
    - Computers
- “Bee in a box”
Mental Models

- **Mental models are:**
  - **Unscientific**—They are often based on guesswork and approximations.
  - **Partial**—They do not necessarily describe whole systems, just the aspects that are relevant to the persons who formulate them.
  - **Unstable**—They are not concrete formulations, but evolve and adapt to the context.
  - **Inconsistent**—They do not necessarily form a cohesive whole; some parts may be incompatible with other parts of the same model.
  - **Personal**—They are specific to each individual and are not universal concepts that can be applied generically.
Mental Models

**Maxim**

Designs that align with a user’s mental model will be easier for him or her to use

• How can we ascertain information about a user’s mental model?
Mapping

- The concept of mapping describes how we make connections between things.

**Maxim**

Proper mapping can increase the usability of an interface.

Arbitrary mapping

Arbitrary mapping improved

Natural mapping

**Maxim**

Use natural mapping whenever possible.
Semantic and Articulatory Distance

• **Semantic Distance**
  – The distance between what people *want to do* and *the meaning* of an interface element.

• **Articulatory Distance**
  – The distance between the *physical appearance* of an interface element and what it actually *means*. 
Affordances

• The affordances of some interfaces can be intuitively understood: a steering wheel affords turning, and a door bell affords pushing.

• These connections allow us to make predictions about the results of our actions and help us to create usable mental models.
Affordances

- **Affordance Confusion** - when certain aspects of an object do not work in a way in which we assume they should

- Norman considers an affordance to be a relationship between an object and a user, not a property of an object
Affordances

• What may be an affordance to one person may not be to another

• The perception of affordance fosters usability

• The affordances a user may need must be present

• Affordances must not contradict the user’s expectations
Interaction Styles (list of)

- Command Line
- Menu-Based Interface
- Form Fill-In
- Question and Answer
- Direct Manipulation
- Metaphors
- Web Navigation
- Three-Dimensional Environments
- Zoomable Interface
- Natural Language
Interaction Styles - Command Line

• Command-line interfaces are fast and powerful.
  – Many commands are abbreviated
    • quick and efficient
  – Commands can be applied to many objects simultaneously
    • fast input
  – Some commands have multiple parameters that can be set and altered
    • precise and flexible
Interaction Styles - *Command Line*

- Command Line and the EECA
  - Intention formation, specification of the action, and the execution stages are complex
  - Requires a rather accurate mental model of the computer’s internal processing

- Command Line and the Interaction Framework
  - Translating the user’s task language into the input language requires knowledge of the core language
  - The output language can be confusing for inexperienced users - there is very little feedback
Interaction Styles - Command Line

• Command Line and Articulatory Distance
  – Articulatory distance is large because we are presented with only the command prompt - no indication of functionality
Interaction Styles - *Command Line*

- Advantages of command-line interfaces:
  - Suitable for repetitive tasks
  - Advantageous for expert users
  - Offer direct access to system functionality
  - Efficient and powerful
  - Not encumbered with graphic controls
    - Low visual load
    - Not taxing on system resources
Interaction Styles - *Command Line*

- Disadvantages of command-line interfaces:
  - Low command retention
  - Steep learning curve
  - High error rates
  - Heavy reliance on memory
  - Frustrating for novice users
Interaction Styles - *Menu-Based Interface*

- Menu-driven interfaces present users with sequential hierarchal menus that offer lists of functions.
  - Textual: key-in number of option
  - Graphical: use arrow keys or pointing device
Interaction Styles - Menu-Based Interface

Maxim

Menus are based on recognition as opposed to recall

- No need to remember commands
- Users search from a list of possible choices
- List provides constraints
- Appropriate for small screens (iPod)
Interaction Styles - *Menu-Based Interface*

- Menu-based interfaces and the EEAC
  - Menu constraints can help the user to form the proper intentions and specify the proper action sequence
  - Provide a context to evaluate the output language
Interaction Styles - Menu-Based Interface

• Menu-based interfaces and:
  – Articulatory Distance
    • Menu options create small articulatory distance
  – Mental Models
    • Menu construction has a direct impact on user’s mental model
  – Affordances
    • Menu elements present affordances
Interaction Styles - *Menu-Based Interface*

- Most menus are a variation on a few basic categories:

  - Single
  - Sequential
  - Hierarchical
  - Star network
  - Web network
Interaction Styles - Menu-Based Interface

• Advantages of menu-based interfaces:
  – Low memory requirements
  – Self-explanatory
  – Easy to undo errors
  – Appropriate for beginners

• Disadvantages of menu-based interfaces:
  – Rigid and inflexible navigation
  – Inefficient for large menu navigation
  – Inefficient use of screen real estate
  – Slow for expert users
Interaction Styles - *Form Fill-In*

- Similar to menu interfaces – present screens of information

- Different than menu interfaces - used to capture information and proceed linearly not to navigate a hierarchical structure
Interaction Styles - *Form Fill-In*

**Maxim**
Always inform the user about the length of paged forms and where they are within the structure

- Forms can be presented using
  - Single scrolling screens
  - Multiple linked pages
- Form elements must be grouped logically
- Include “You Are Here” indications
Interaction Styles - Form Fill-In

Maxim
Form elements must be unambiguously labeled to increase data integrity

- Users must understand what data is required and what format should be used
  - Date information formats
    1/29/2005, 29/1/2005, or January 29, 2005?
Interaction Styles - *Form Fill-In*

- Advantages of form fill-in interfaces:
  - Low memory requirements
  - Self-explanatory
  - Can gather a great deal of information in little space
  - Present a context for input information

- Disadvantages of form fill-in interfaces:
  - Require valid input in valid format
  - Require familiarity with interface controls
  - Can be tedious to correct mistakes
Interaction Styles - Question and Answer

• Question and answer interfaces are also called wizards.
• They are restricting for expert users
• They are easy for novice users
  – However, they may not know the required information

MAXIM

Users must be able to cancel a menu without affecting the state of the computer
Interaction Styles - Question and Answer

- Microsoft Add Network Place Wizard

(a) Add Network Place wizard. (b) Select a service provider. (c) Address of the network place.
Interaction Styles - Question and Answer

• Advantages of question and answer interfaces:
  – Low memory requirements
  – Self-explanatory
  – Simple linear presentation
  – Easy for beginners

• Disadvantages of question and answer interfaces:
  – Require valid input supplied by user
  – Require familiarity with interface controls
  – Can be tedious to correct mistakes
Interaction Styles - *Direct Manipulation*

- Ben Shneiderman (1982)
  - Continuous representations of the objects and actions of interest with meaningful visual metaphors.
  - Physical actions or presses of labeled buttons instead of complex syntax.
  - Rapid, incremental, reversible actions whose effects on the objects of interest are visible immediately.
Interaction Styles - *Direct Manipulation*

- Three phases in Direct Manipulation - Cooper, Reimann (2003)
  - **Free Phase**—How the screen looks before any user actions
  - **Captive Phase**—How the screen looks during a user action (click, click-drag, etc.)
  - **Termination Phase**—How the screen looks after a user action
Interaction Styles - Direct Manipulation

• Direct Manipulation and the EEAC
  – The range of possible intentions is consistently wide
  – Users usually have multiple options for specifying action sequences
    • Can be overwhelming of novice users
  – Provide multiple ways of executing action sequences
Interaction Styles - *Direct Manipulation*

• Advantages of direct manipulation interfaces:
  – Easy to learn
  – Low memory requirements
  – Easy to undo
  – Immediate feedback to user actions
  – Enables user to use spatial cues
  – Easy for beginners

• Disadvantages of direct manipulation interfaces:
  – Not self-explanatory
  – Inefficient use of screen real estate
  – High graphical system requirements
Interaction Styles - Metaphors

• GUIs use visual relationships to real-world objects (metaphors)
• Metaphors can help people relate to complex concepts and procedures by drawing on real-world knowledge
• Real-world affordances can be reflected

• What metaphors are used by contemporary GUIs?
Interaction Styles - *Metaphors*

Microsoft Windows XP  Apple OS X
Interaction Styles - Metaphors

**Maxim**

A metaphor’s function must be consistent with real-world expectations

- Metaphors that do not behave the way people expect will cause confusion and frustration
- Macintosh trashcan
Interaction Styles - *Metaphors*

**MAXIM**

Don’t force a metaphor

- Potential problems with metaphors
  - Run out of metaphors
    * Some virtual processes and objects have no real-world counterparts
  - Mixed metaphors
  - Carry connotations and association
Interaction Styles - Web Navigation

- Two basic interaction styles
  - Link-based navigation
    - Sensitive to articulatory distance
    - Ambiguous link labels increase the gulf of evaluation
  - Search
    - Sensitive to semantic distance
    - Inadequate search engine algorithms increase the gulf of execution
    - Slight advantage in development of mental models
Interaction Styles – 3D Environments

• 3D interaction is natural in the real-world
• 3D environments are common in digital games
• Rich graphical 3D environment are processor intensive
Interaction Styles – 3D Environments

• 3D Navigation
  – Involves two types of movement
    • Translation – movement on a plane
    • Rotation – movement around an axis

Yaw

Pitch
Interaction Styles – 3D Environments

• Web-based 3D
  – Use vector-based graphics to decrease file size
  – Virtual Reality Modeling Language (VRML)
    • Uses polygons with parameters
      – Transparency
      – Texture maps
      – shininess
  – X3-D is XML based - Web3D.org
    • Offers greater flexibility and control
Interaction Styles – 3D Environments

• Desktop 3D
  – Current GUIs are predominantly 2D
  – 3D environments presented on 2D screens are difficult to navigate

MAXIM
Three-dimensional navigation can quickly become difficult and confusing
Interaction Styles - *Zoomable Interface*

- **ZoomWorld (Jeff Raskin)** is based on the zooming interface paradigm (ZIP)
- **ZoomWorld Demo**
Interaction Styles - Zoomable Interface

Maxim

Zoomable interfaces allow us to use our sense of relative positioning

• ZIP is based on landmarks and relative positioning (organizational cues)
  – Proportion
  – Color
  – Patterns
  – Proximity

• Pad++: Zoomable User Interface (ZUI)
Interaction Styles - *Natural Language*

- Natural Language Interaction (NLI) - Interacting with computers using everyday language
- Obstacles
  - Language is ambiguous
  - Meaning depends on context
    - “Search results”
    - “She said she did not know”
  - Dependant on visual cues
Interaction Styles - *Natural Language*

- Applications for NLI
  - Speech Input
    - Hands-free operation
    - Poor Lighting Situations
    - Mobile Applications
    - In the home
  - Speech Output
    - On-board navigational systems
Interaction Styles - *Natural Language*

- Two areas of development
  - Speech recognition
  - Semantics
    - Grammar issues
    - Vague meanings
    - Contradictory statements

**MAXIM**

NLIs may require constant clarification of linguistic ambiguities
Interaction Styles - *Natural Language*

• **Advantages of NLI:**
  – Ease of learning
  – Low memory requirements
  – Flexible interaction
  – Low screen requirements
  – Appropriate for beginners

• **Disadvantages of NLI:**
  – Requires knowledge of the task domain
  – May require tedious clarification dialogues
  – Complex system development