Designing Interactive Systems I

Mappings, Constraints, Seven Stages Of Action

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Winter Semester '22/'23

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Review

• What are Gestalt Laws for?
  • 8 sample laws?

• How do you compute information content in user interfaces?
  • Analog vs. digital scales?

• How are the conceptual models of designer and user related to each other?
Mappings
Mappings

- Relationships between controls, actions, and intended results
- Connect UI elements to real world
  - Input devices (controls) ⇒ (real or virtual) world
  - (Real or virtual) world ⇒ output devices (displays)
Natural Mappings

• Good mappings are **natural**:  
  • Spatial analogies  
  • Perceptual analogies  
  • Biological or cultural analogies

• Advantages:  
  • Understood immediately  
  • Easier to remember  
  • Enable better ease-of-use
In-Class Exercise: Spatial Analogies

- Most prominent example of natural mappings
- How would you arrange the controls for this lifting platform?
Spatial Analogies

• Rule: **Arrange controls in the same way that their real-world counterparts are arranged**
  • Room lamps
  • Car stereo audio fader

• Does not work for **activity**-centered controls
  • Those can be disastrous if not designed carefully
What’s Wrong with This Stove?

- Controls do not use a natural mapping
  - In-line leads to $4! = 4 \times 3 \times 2 \times 1 = 24$ possible arrangements
  - Left/right pairing still leaves 4 possible arrangements
  - Requires labels (which often indicates bad design)

- Better solutions?
Perceptual Analogies

- The UI element (input/control or output/display) is an imitation of the device itself
- “Voodoo Principle”
- Example: Mercedes car seat controls
In-Class Exercise: Biological Analogies

• Classifying physical measurements

• Rising level = “more”, falling level = “less”
  • Natural for all additive dimensions, e.g., amount (water level), heat (thermometer), volume, line thickness, brightness, weight,…
  • But: not for substitutive dimensions, e.g., color, audio pitch(!), taste, location,…
Biological and Cultural Analogies

• Another natural analogy: Order from top to bottom

• How about from left to right?
Stockholm Ticket Machine

Photo: http://en.wikipedia.org/
Stockholm Ticket Machine (Redesigned)

1. **Välj zoner** (Choose zones)
   - 1 ZON
   - 2 ZONER
   - 3 ZONER

2. **Betalta** (Pay)
   - 00 Kr
   - Kortet går inte att läsa
   - Sorry your card is not working

3. **Ta biljett** (Get ticket)

Source: http://peterkrantz.com/wud/nylage
Mappings & Conceptual Models

• To remember how mappings work, we develop conceptual models
Result: Some Design Principles

• Discoverability (current states, available states, and actions easy to determine)

• Good conceptual model
  • System image presents operations and results consistently
  • User gets a coherent conceptual model of the system

• Good (i.e., natural) mappings
  • Between actions and results
  • Between controls and their effects
  • Between system state and its visualization

• Good feedback about results
  • Complete and continuous
Constraints
Constraints

- They limit the ways in which an object can be used
- Provide cues for the proper course of action in novel situations

Goals
- Avoid usage errors
- Minimize the information to be remembered

Types
- Physical
- Semantic
- Logical
- Cultural
Physical Constraints

• Rely upon the physical properties (shape, size, etc.) to constrain possible actions
  • Example: The size and shape of a traditional key constrains the action of fitting it into a different lock
  • More efficient and useful if constraint is visible ahead of time!
  • Example: Car key should fit both ways, but should then also work both ways
DO NOT TURN THIS LIGHT OFF!
Semantic Constraints

• Rely upon our knowledge of the current situation and of the world to constrain possible actions

• Example: In a model plane construction kit, there is only one meaningful location for the pilot’s figurine—in front the windshield, facing forward

• But: only use constraints that are meaningful for your user population!
Logical Constraints

• Rely upon logical conclusions to constrain possible actions

  • Examples:
    • All parts of a model plane construction kit are to be used (completeness)
    • Performing a task in an obvious order: 1, 2, 3 (sequence)

• Natural mappings often employ logical constraints
  • Example: Left switch = left lamp is natural/logical
Cultural Constraints

• Rely upon generally accepted cultural standards to constrain possible actions
  
  • Examples
    
    • Labels are to be read, so are expected not to be upside down — implies which side is up on a closed package
    
    • Red = Stop
  
  • But: Only applies to specific cultural group!
    
    • Chinese labeling does not give most Westerners an idea where “up” is
    
    • A root problem of universal design
In-Class Exercise: Constraints

• Think about three examples for objects where constraints help us use them correctly

• Try to find examples for the different types of constraints
  • Physical, semantic, logical, cultural

• Sample areas: kitchen appliances, security devices, vending machines,…
Forcing Functions

• Can help to avoid errors; extreme physical constraints

• But: Think through the burden on normal operation!
  • E.g., seat belts

• Lock-out prevents an action
  • E.g., stairways to basements

• Lock-in prevents prematurely stopping an action
  • E.g., soft power-off switch on computers to avoid data loss

• Interlock enforces correct sequence
  • E.g., microwave turning off when opened, shelves in restroom
The Seven Stages of Action
The Seven Stages of Action

• How do people do things?

• What happens if something goes wrong? How to detect and correct that?

• Two parts to an action
  • Executing the action
  • Evaluating the results

• The Seven Stages of Action models this activity
Execution

- Goal (form the goal)
- Plan (the action)
- Specify (an action sequence)
- Perform (the action sequence)
Goal Formulation

• Goals are often very vague, and problem-oriented
  • “I need more light”

• They need to be translated into goal-oriented plans
  • “Operate the light switch”

• These then need to be specified into concrete action sequences
  • “Turn around, stretch out arm, put finger on switch”
Evaluation

- Perceive (the state of the world)
- Interpret (the perception)
- Compare (the outcome to the goal)
The Seven Stages of Action

- Plan
- Compare
- Specify
- Interpret
- Perform
- Perceive
- Goal

Execution

Evaluation

World
More on the Seven Stages

- In reality, steps are hard to distinguish
- Complex tasks include sequences or hierarchies of goals (feedback loop)
- Goals are forgotten, discarded, changed
- Many actions are opportunistic, not planned
  - Meeting leads to talk, deadline-driven work
- Cycle can be event-driven (world) or goal-driven
Gulfs

• The model helps designers detect where things could break down

• Gulf of Execution
  • How to operate a device?

• Gulf of Evaluation
  • How to interpret the state of a device?

• The role of the designer is to bridge these gulfs
  • Gulf of Execution: with signifiers, constraints, mappings, and conceptual models
  • Gulf of Evaluation: with feedback and conceptual models
Gulf of Execution

• Even simple actions can seem difficult

• Reason: Cannot see how system works or what to do
  • Example: Peanut bags…

• Connection between plans and execution unclear

• What is the problem? — Mappings, Signifiers, …!
Gulf of Execution

- Gulf of Execution opens up through differences between
  - actions the user plans, and
  - actions the system offers — affordances!

- Ideally, the system lets user execute planned actions directly, without any extra effort
Gulf of Evaluation

• It is often unclear whether an action was successful or what its effect was

• Problem: Missing feedback

• Ideal: System state is easy to perceive and interpret and matches conceptual model that the user has of the system

• Example: Blinking printer LED
  • Still working, or crashed?

• Example: Switches in Myst
  • Part of the fun of the game

Gulfs

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# Seven Stages of Action as a Design Guideline

The model provides a basic checklist of questions to avoid gulfs:

- **What do I want to accomplish?** (Goal)
- **What are the alternative action sequences?** (Plan)
- **What action can I do?** (Specify)
- **How do I do it?** (Perform)
- **What happened?** (Perceive)
- **What does it mean?** (Interpret)
- **Is this ok? Have I accomplished my goal?** (Compare)
Summary

• Mappings
  • Spatial, perceptual, biological and cultural analogies

• Constraints
  • Physical, semantic, logical, cultural

• Seven Stages of Action
  • Engineering model
  • Gulfs in execution and evaluation
  • Form goal, plan, specify action sequence, perform, perceive, interpret, and compare

Read Norman’s book until page 122!