Designing Interactive Systems I
Lecture 3: Conceptual Models, Mappings, Constraints, and Seven Stages of Action

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http://hci.rwth-aachen.de/dis
Mappings
Mappings

- Relationship between the controls, the actions, and intended results

- Connect UI elements to real world
  - Examples for input and output?
• To remember how mappings work, we develop conceptual models
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
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
  - Driving wheel
  - Car stereo audio fader
Activity-centered Controls

- A different perspective on mapping
- Controls are for activities instead of devices
- Note: Could be catastrophic if not done correctly!
Jan’s stove
What’s Wrong with This Stove?

- Controls do not use a natural mapping
- In-line leads to $4! = 4 \cdot 3 \cdot 2 \cdot 1 = 24$ possible arrangements
- Left/right pairing can be done
  - Still leaves 4 possible arrangements
  - Labeling required (often indicates bad design)
- Better solutions?
  - or
The UI element (input control or output display) is an imitation of the device itself.

“Voodoo Principle”

Example: car seat controls in Mercedes [Norman ’13]
Scrolling
Panning
Biological/Cultural Analogies

- In-class exercise: Classifying dimensions

- Example:

  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,…
Stockholm Ticket Machine

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

Source: http://peterkrantz.com/wud/nylage
Biological/Cultural Analogies

• Another natural analogy: Order from top to bottom

• How about from left to right?
Result: Some Design Principles

- **Discoverability** (state and actions easy to determine)
- **Good conceptual model**
  - Operations and results are presented consistently
  - User gets a coherent image of the system
- **Good (natural) mappings**
  - Between actions and results
  - Controls and their effects
  - 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 driver’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

1. Goal
2. Plan
3. Specify
4. Perform
5. Compare
6. Interpret
7. Perceive

Execution

Evaluation

World
• 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

More on the Seven Stages
Gulfs

- The model helps designers detect where things could breakdown
- 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 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
Example: Film Projector Threading

- Old projectors: unclear, difficult
- New projectors: automatic, but still visible
- VCR: invisible
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

Goal

Plan

Specify

Perform

Compare

Interpret

Perceive

World
Seven Stages of Action as a Design Guideline

• The model provides 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