Designing Interactive Systems I

Affordances and Signifiers, Conceptual Models

Prof. Dr. Jan Borchers
Media Computing Group
RWTH Aachen University

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https://hci.rwth-aachen.de/dis
Review

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

- How do you compute information content in user interfaces?
  - Analog vs. digital scales?
Utility of Affordances and Signifiers

- Perceived affordances provide strong clues
  - No extra signifiers (instructions, labels) needed
  - A design with labels is often a bad design!
  - Also true for many software UIs
  - But complex, abstract functions will usually need signifiers

- Product design can support usability when using perceived affordances and signifiers well
Example: Headlamp
Flat surfaces suggest pushing, so a label “PULL” is needed.
False Affordances, Accidental Affordances & Misleading Signifiers

• False affordances suggest actions that are not actually possible

• Accidental affordances are affordances unintended by the designer
  • People sitting on staircase (helpful)
  • Empty bottles on railings (not helpful)

• If a signifier does not suggest the right action, it’s a misleading signifier
Conceptual Models
Conceptual Models

• We are surrounded by innumerable objects (20,000 everyday things)

• How do we cope?
  • Mind aims to make sense of things
  • Affordances support using objects easily
  • Designers can provide a good image of how a system works

• Humans form a conceptual model of how something works when they encounter it
Providing Good Conceptual Models

• Principle of good design

• Allows to predict effects of our actions, and cope with problems

• Conceptual models are mental models of things
  • Other mental models: Of ourselves, others, the environment, …
  • Formed through experience, training, instruction
Design Model, System Image, and User’s Model

- By carefully crafting the system image, designers can provide a good idea of how a system works.

- Problems arise when the designer’s conceptual model is different from what emerges as the user’s mental model.

- Important concept to remember when designing UIs!
“Interface design is about crafting the user illusion.”
Revisiting the Remote Control

• Reexamine your remote control using what you have learned today

• Reflect:
  • What would you change? Why?
  • What should stay the same? Why?
Designing Interactive Systems I

Mappings, Constraints, Seven Stages Of Action

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Mappings
Mappings

- Relationships between controls, actions, and intended results
- Connect UI elements to real world
  - Input devices (controls) $\Rightarrow$ (real or virtual) world
  - (Real or virtual) world $\Rightarrow$ 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

Norman: DOET ’13
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

2. Betala
   Pay

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

1. Goal
2. Plan
3. Compare
4. Perceive
5. Perform
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

Goal

Plan

Compare

Specify

Interpret

Perform

Perceive

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

Plan \[\rightarrow\] Specify \[\rightarrow\] Perform

Compare \[\uparrow\] Interpret \[\uparrow\] Perceive

Goal

World
# Seven Stages of Action as a Design Guideline

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

<table>
<thead>
<tr>
<th></th>
<th>(Goal)</th>
<th></th>
<th>(Plan)</th>
<th></th>
<th>(Specify)</th>
<th></th>
<th>(Perform)</th>
<th></th>
<th>(Perceive)</th>
<th></th>
<th>(Interpret)</th>
<th></th>
<th>(Compare)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What do I want to accomplish?</td>
<td></td>
<td>What are the alternative action sequences?</td>
<td></td>
<td>What action can I do?</td>
<td></td>
<td>How do I do it?</td>
<td></td>
<td>What happened?</td>
<td></td>
<td>What does it mean?</td>
<td></td>
<td>Is this ok? Have I accomplished my goal?</td>
</tr>
</tbody>
</table>

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[ styling comments: Prof. Dr. Jan Borchers: Designing Interactive Systems I • WS 2023/24]
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