Designing Interactive Systems I

Mappings, Constraints, Seven Stages Of Action

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

Winter Semester ’20/’21

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

RWTH AACHEN UNIVERSITY

Review

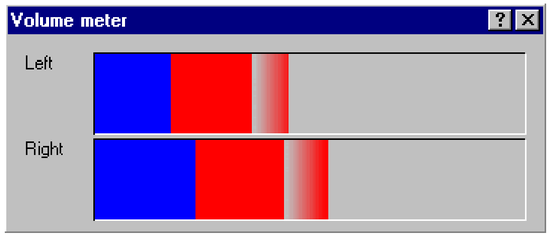
- What are Gestalt Laws for?
  - 8 sample laws?
- How do you compute information content in user interfaces?
  - Analog vs. digital scales?
- What was the key problem of the “Swedish Hair Dryer”?
- How are the conceptual models of designer and user related to each other?

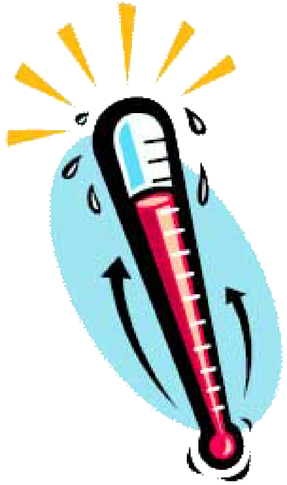
Mappings

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)



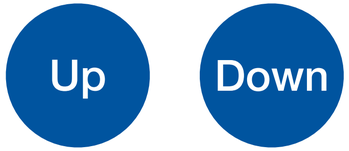


Natural Mappings

- Good mappings are **natural:**
  - Spatial analogies
  - Perceptual analogies
  - Biological or cultural analogies
- Advantages:
  - Understood immediately
  - Easier to remember
  - Enable better ease-of-use

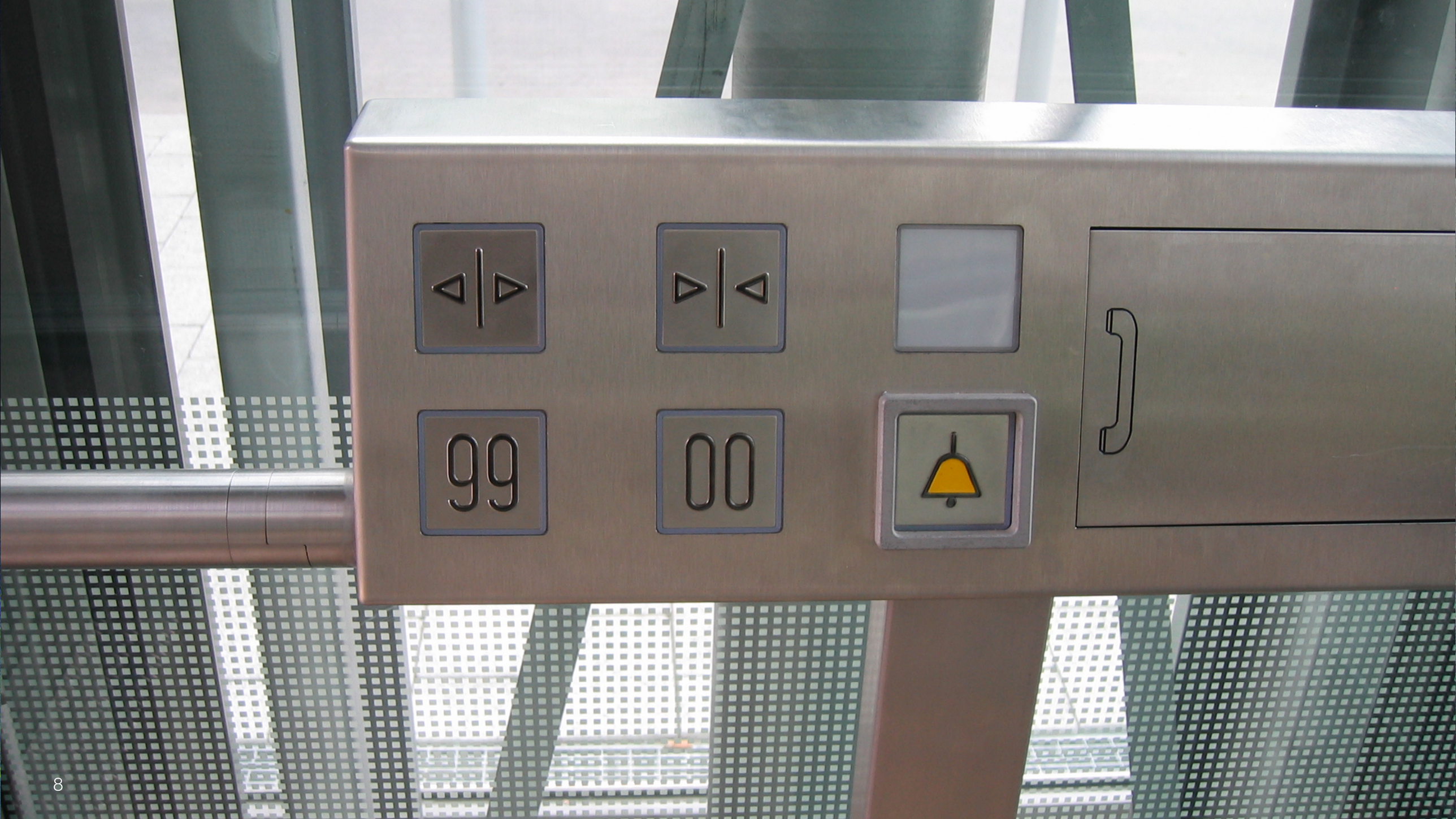
Spatial Analogies

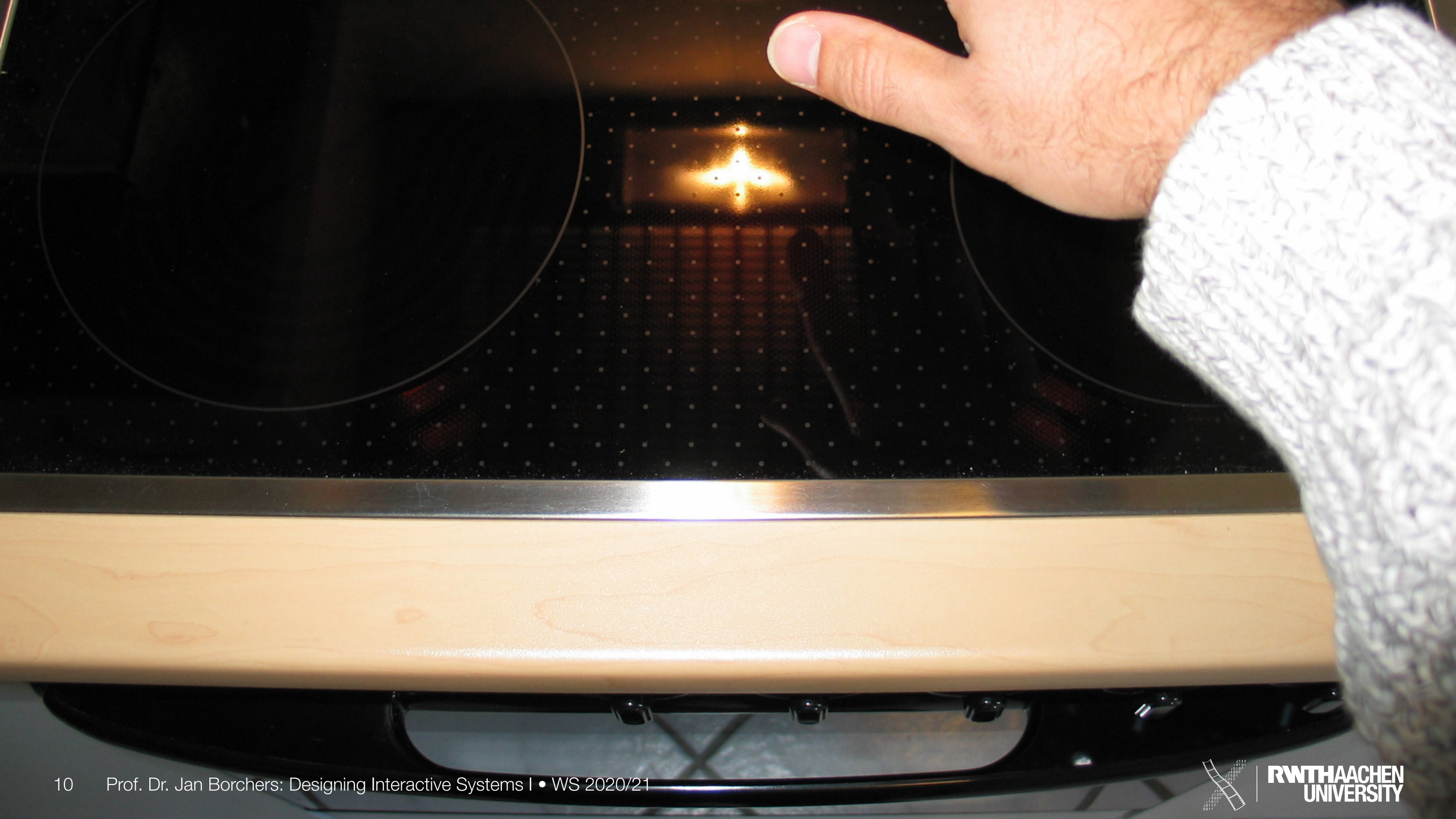
- Most prominent example of natural mappings
- How would you arrange the controls for this lifting platform?



Spatial Analogies

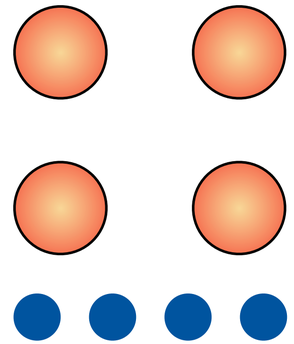
- Rule: **Arrange controls in the same way that their real-world counterparts are arranged**
  - Room lamps
  - Car stereo audio fader
- Does not work for **activity**-centered controls
  - Those can be disastrous if not designed carefully


99
00

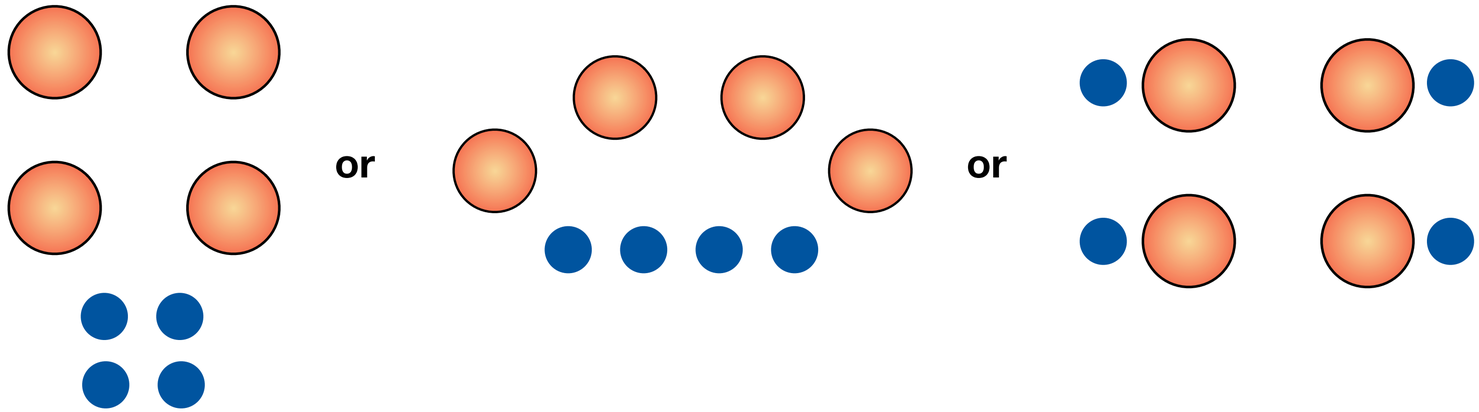


What's Wrong with This Stove?

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



- Better solutions?



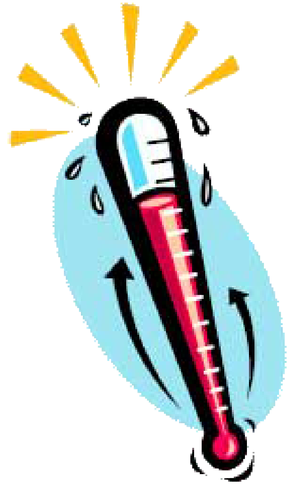
Perceptual Analogies

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

Biological Analogies

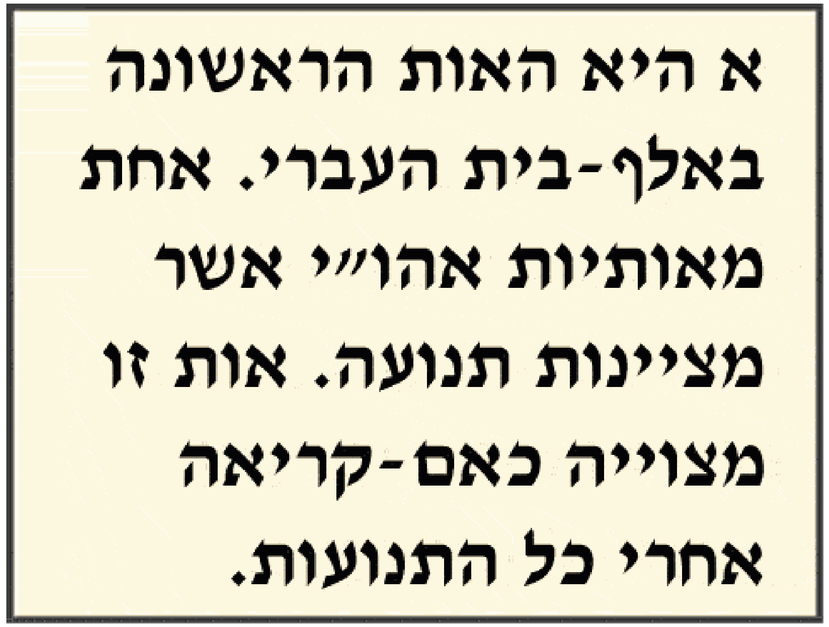
- In-class exercise: Classifying physical measurements

- 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,…

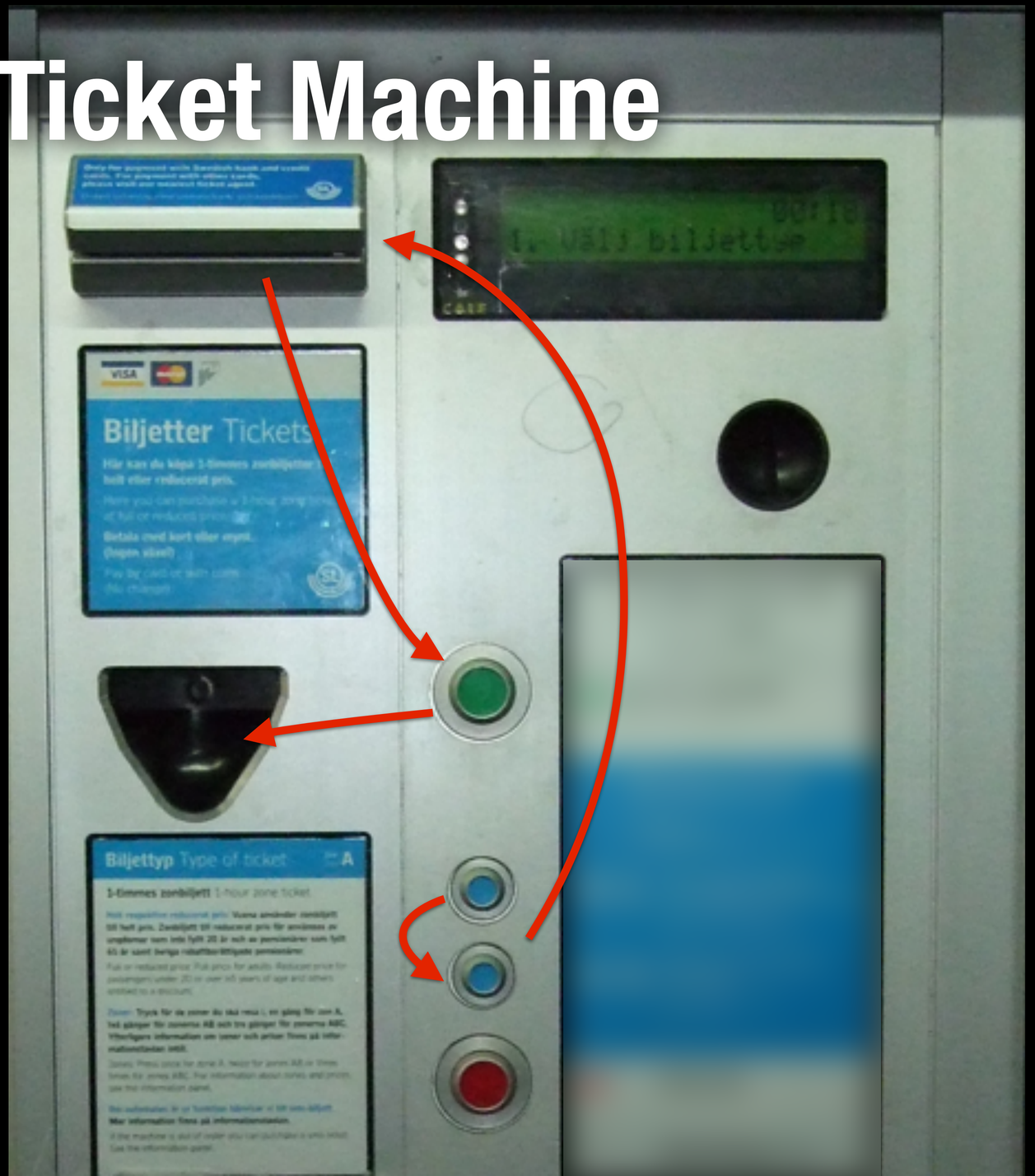


Biological and Cultural Analogies

- Another natural analogy: Order from top to bottom
- How about from left to right?



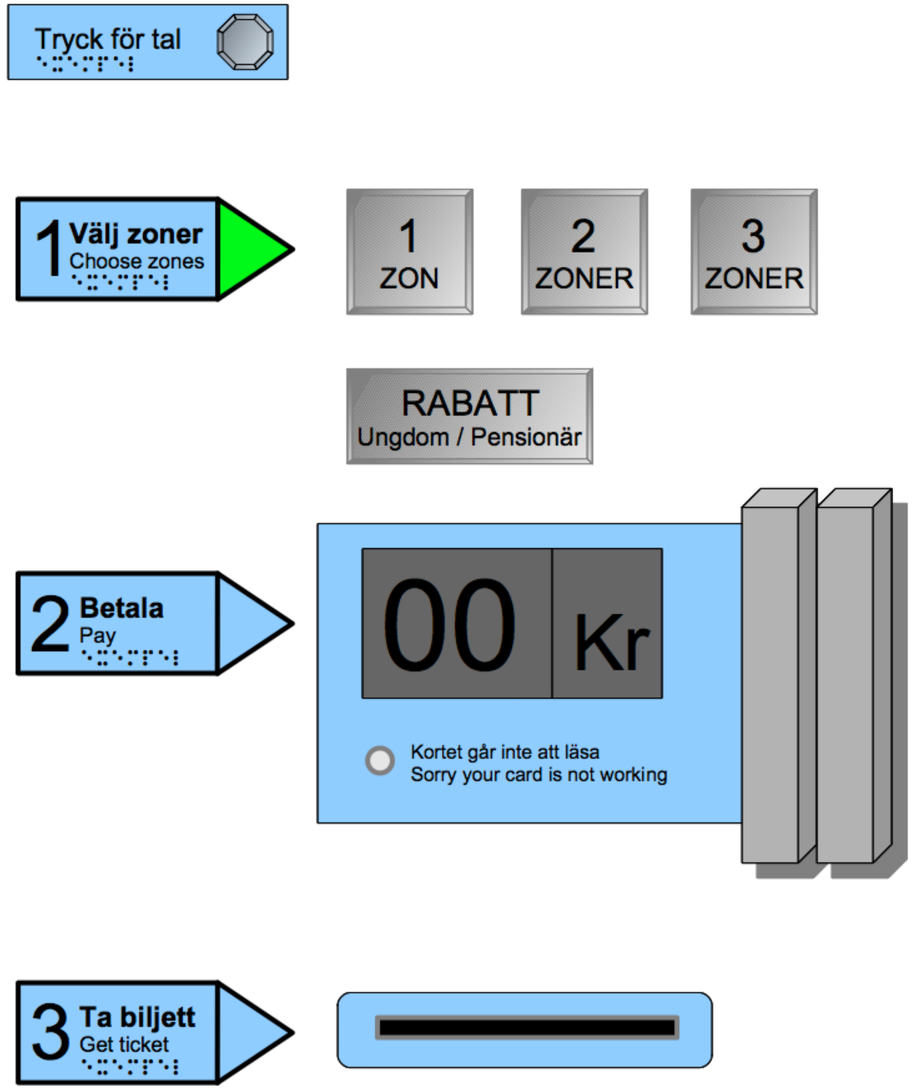
Stockholm Ticket Machine



Source: http://www.peterkrantz.com/2007/man-machine-interface/
Photo: http://en.wikipedia.org/

RWTH AACHEN UNIVERSITY

Stockholm Ticket Machine (Redesigned)



Source: http://peterkrantz.com/wud/nylage

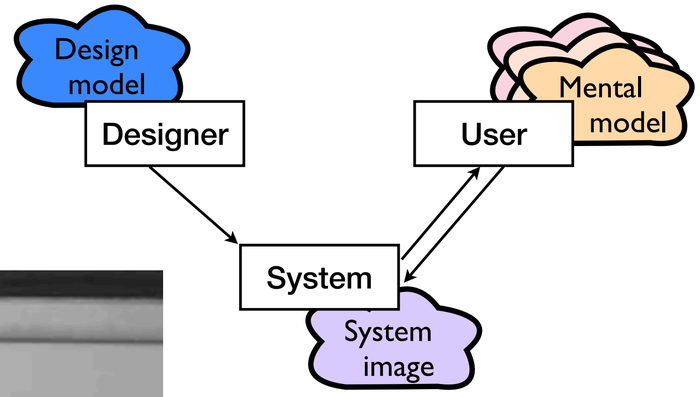

http://uk.ibtimes.com/

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

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

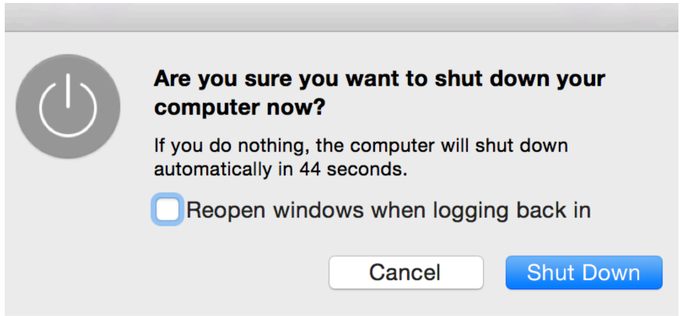
- Rely upon generally accepted cultural standards to constrain possible actions
  - Examples
    - Labels are to be read, so are expected not to be upside down — implies which side is up on a closed package
    - Red = Stop
- But: Only applies to specific cultural group!
  - Chinese labeling does not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

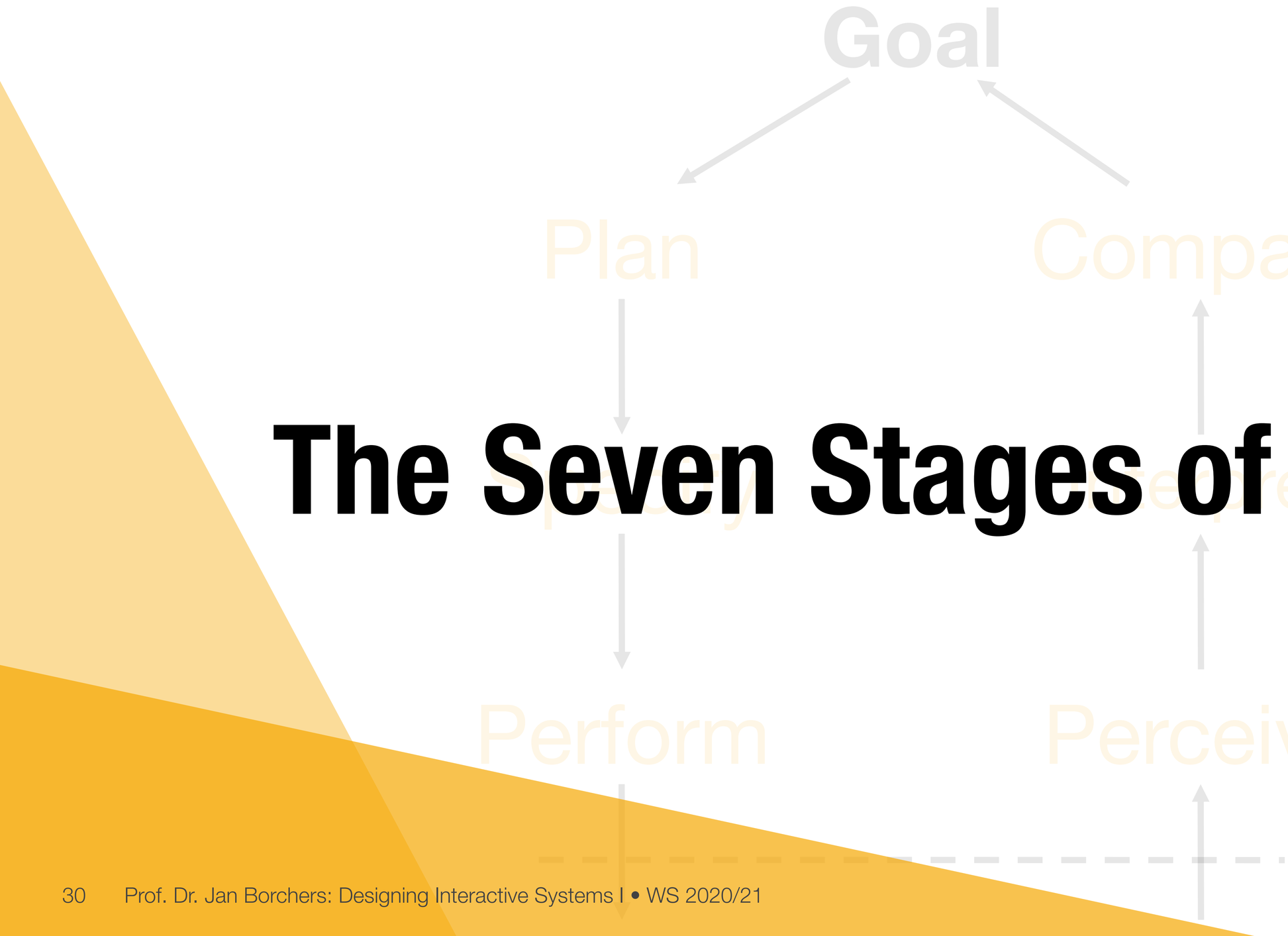
In-Class Exercise: Constraints

- 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

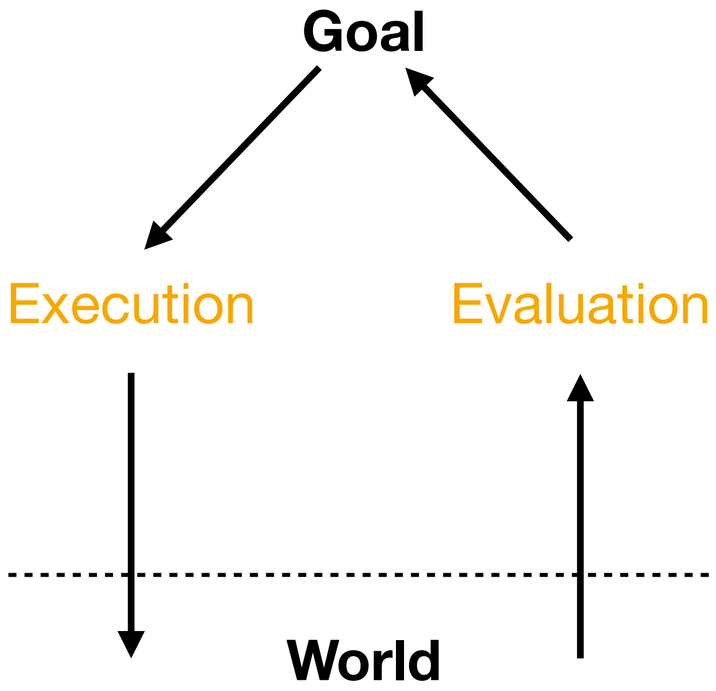




The Seven Stages of Action

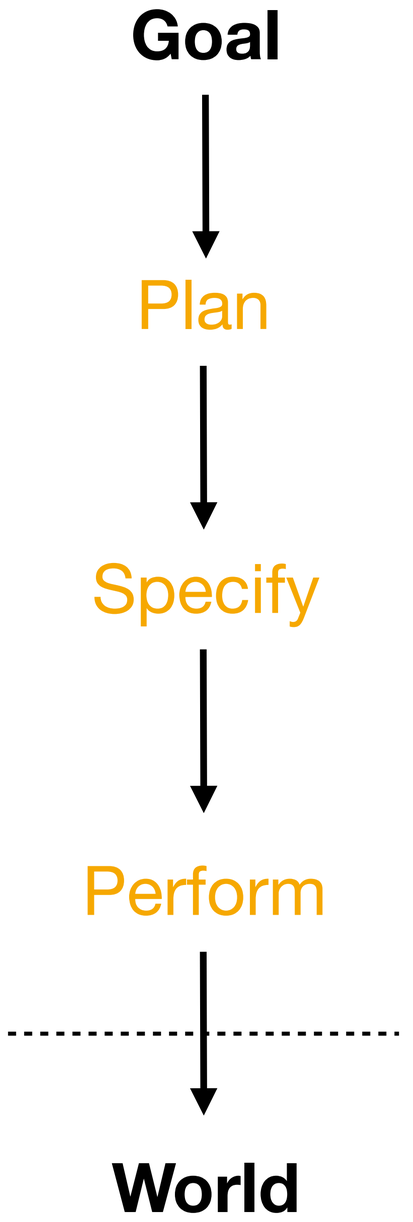
The Seven Stages of Action

- 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)

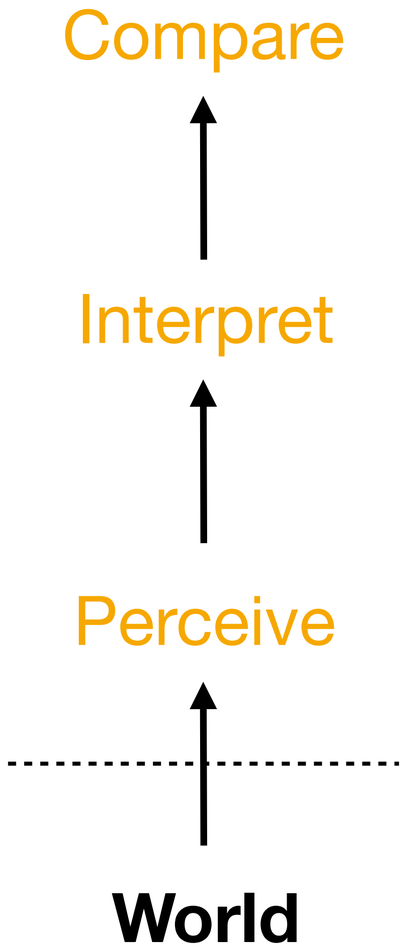


Goal Formulation

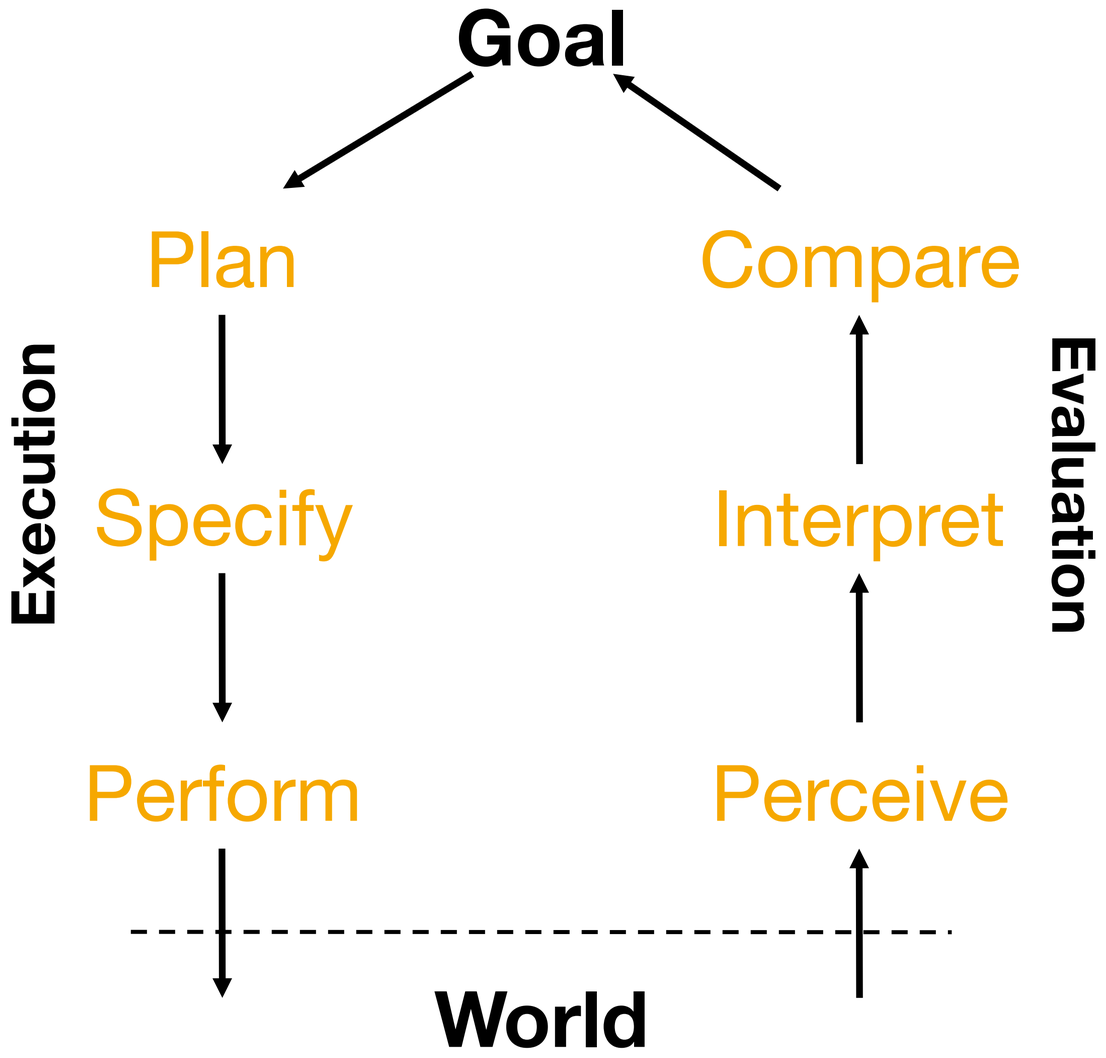
- Goals are often very vague, and problem-oriented
  - “I need more light”
- They need to be translated into goal-oriented plans
  - “Operate the light switch”
- These then need to be specified into concrete action sequences
  - “Turn around, stretch out arm, put finger on switch”

Evaluation

- Perceive (the state of the world)
- Interpret (the perception)
- Compare (the outcome to the goal)



The Seven Stages of Action

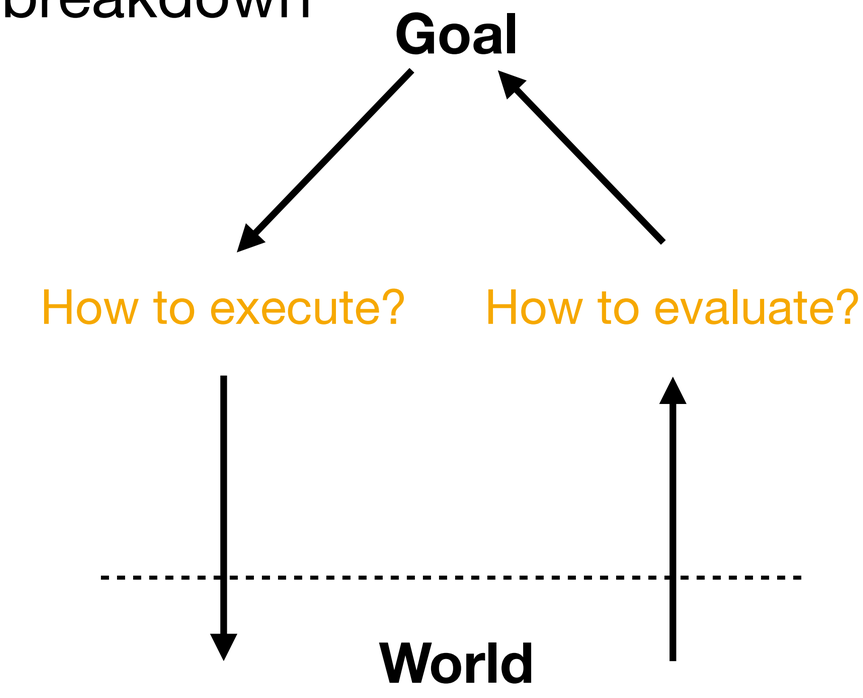


More on the Seven Stages

- 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 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, …!

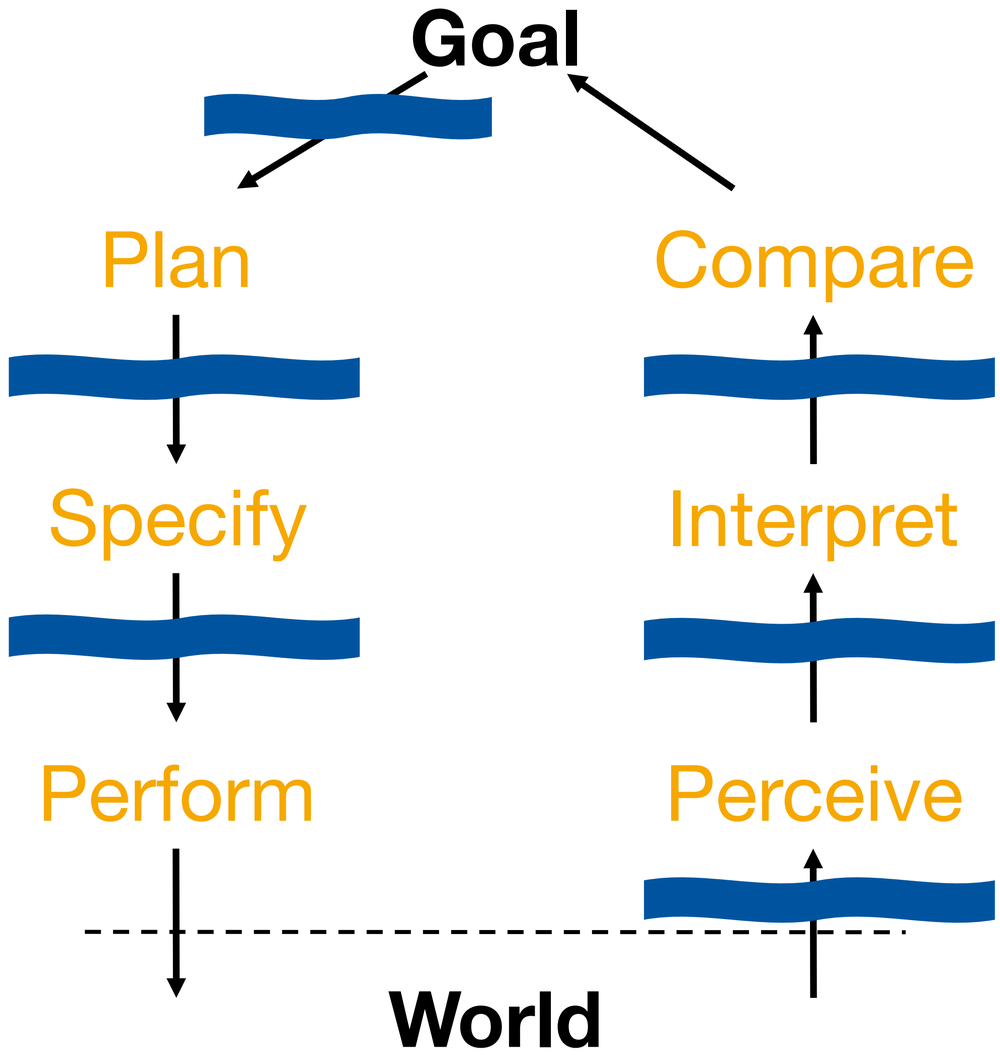
Gulf of Execution

- 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



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