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

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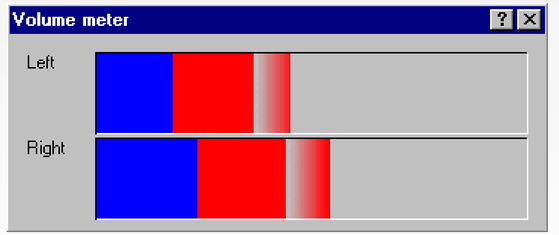
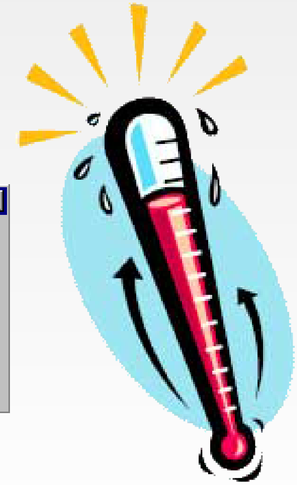
http://hci.rwth-aachen.de/dis

Mappings

Mappings





- Relationship between the controls, the actions, and intended results
- Connect UI elements to real world
  - Examples for input and output?

Mappings & Conceptual Model

- To remember how mappings work, we develop conceptual models

drivingtesttips.biz

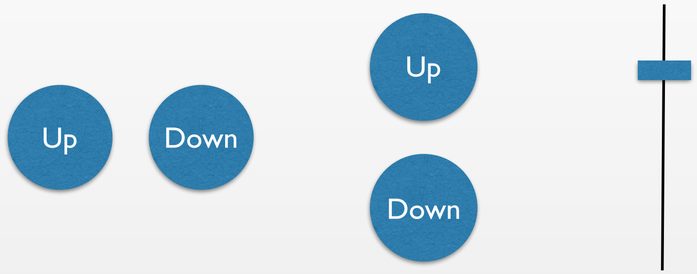
dearcars.com

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!

Theatre Party


99
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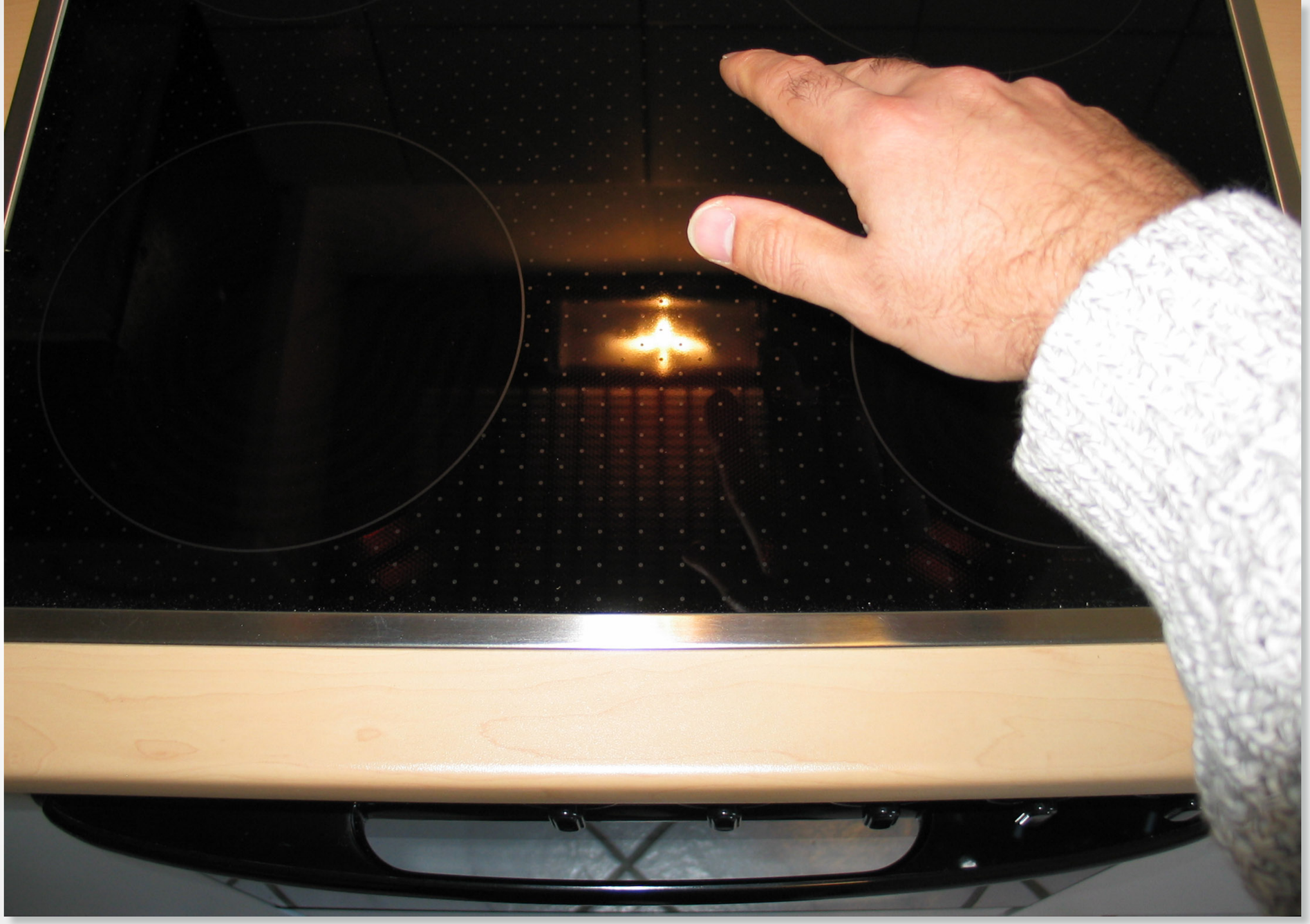
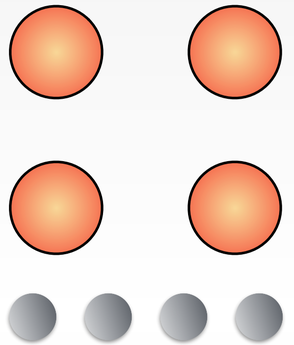
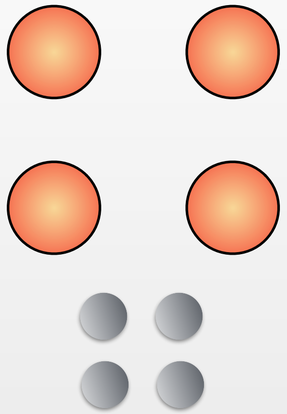
Jan's stove



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?





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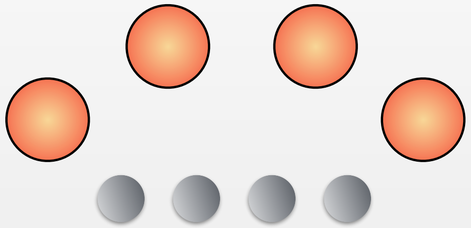

Perceptual Analogies

- 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


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Interactive Surfaces
MainController
convertClicked:
MainController
init
Canvas selected
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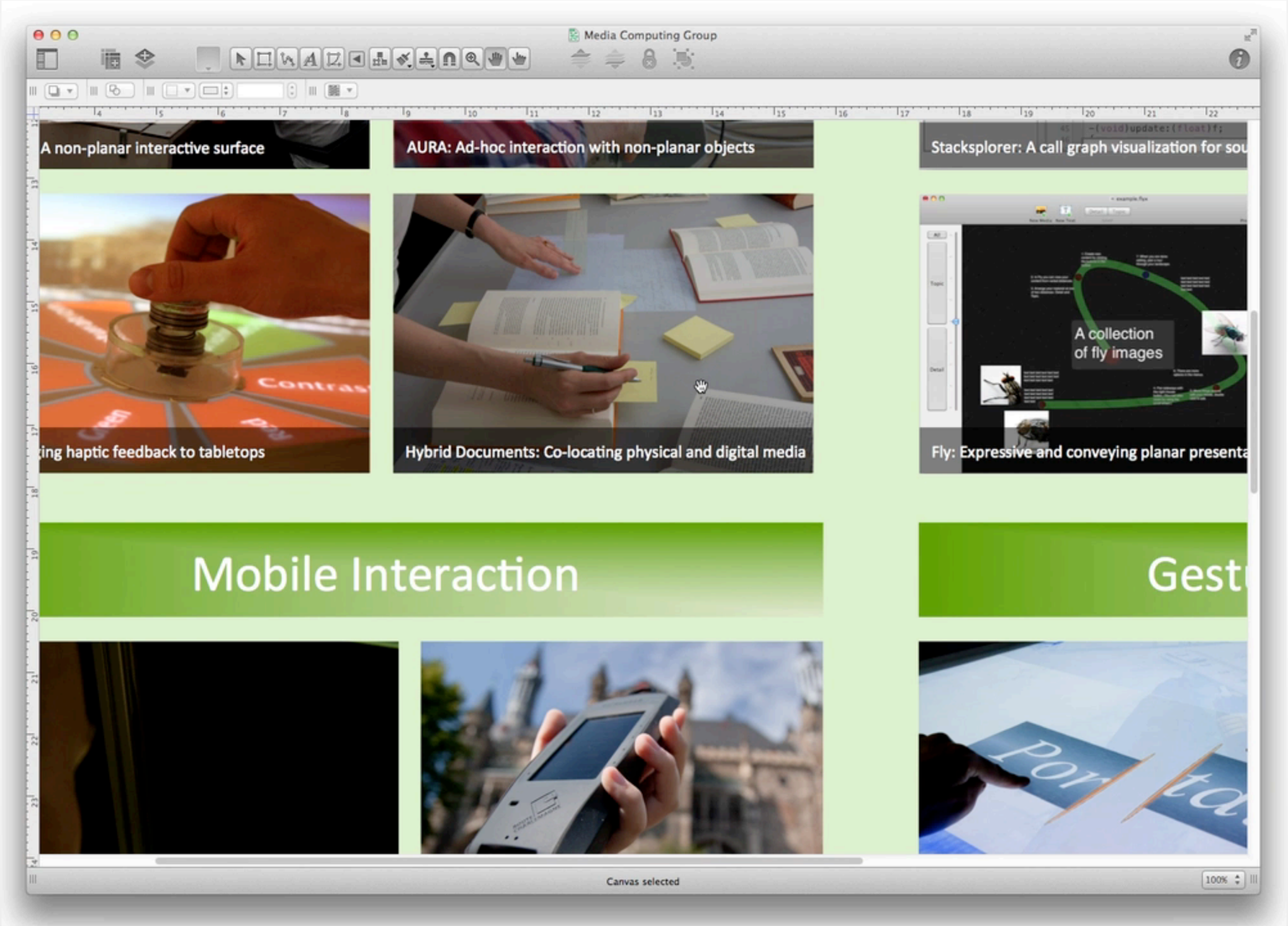
Panning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A non-planar interactive surface
AURA: Ad-hoc interaction with non-planar objects
Stacksplorer: A call graph visualization for sou
ing haptic feedback to tabletops
Hybrid Documents: Co-locating physical and digital media
A collection of fly images
Fly: Expressive and conveying planar presenta
Mobile Interaction
Gest
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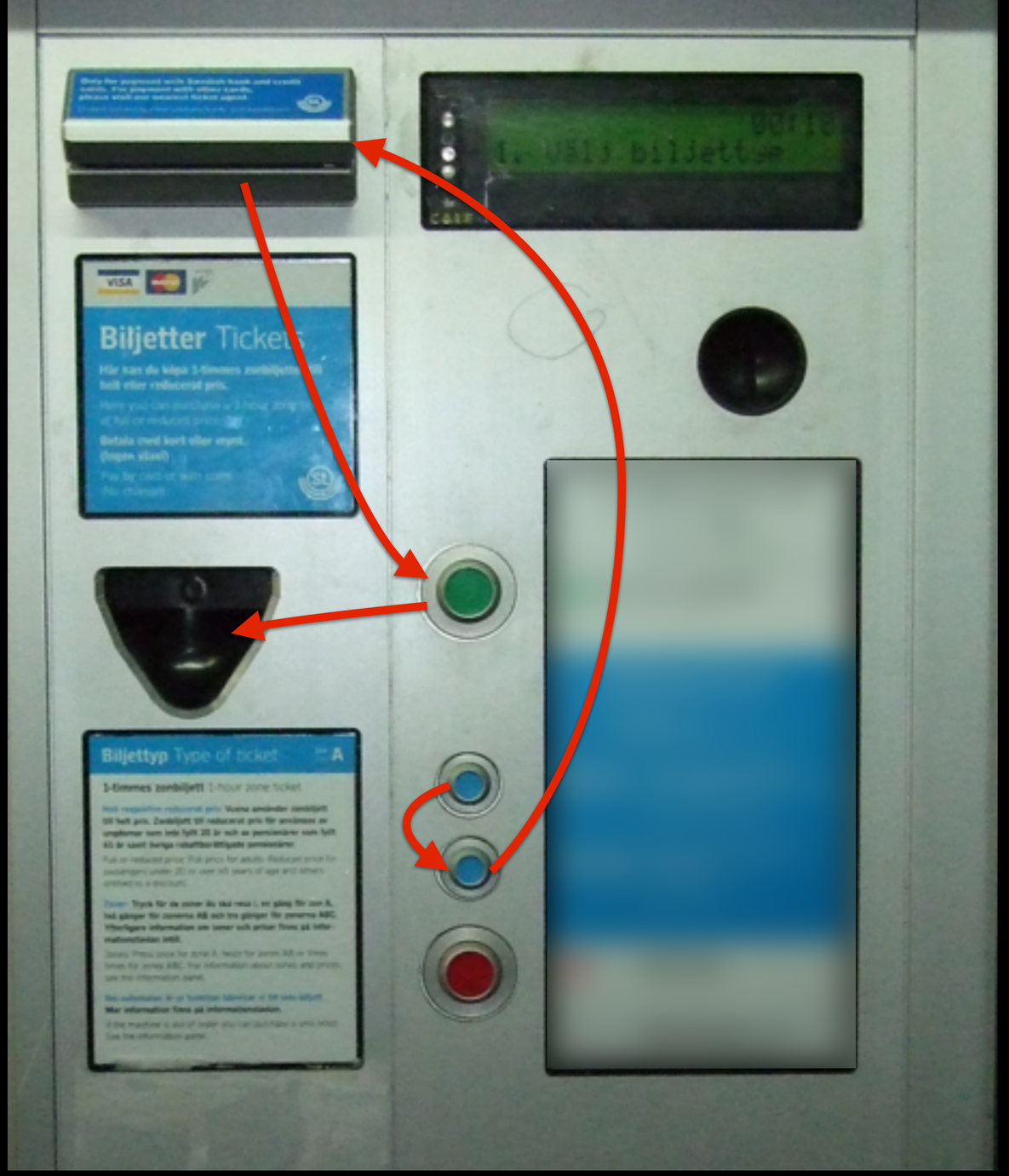
Biological/Cultural Analogies

- In-class exercise: Classifying dimensions
- Example:

  Rising level = "more", falling level = "less"

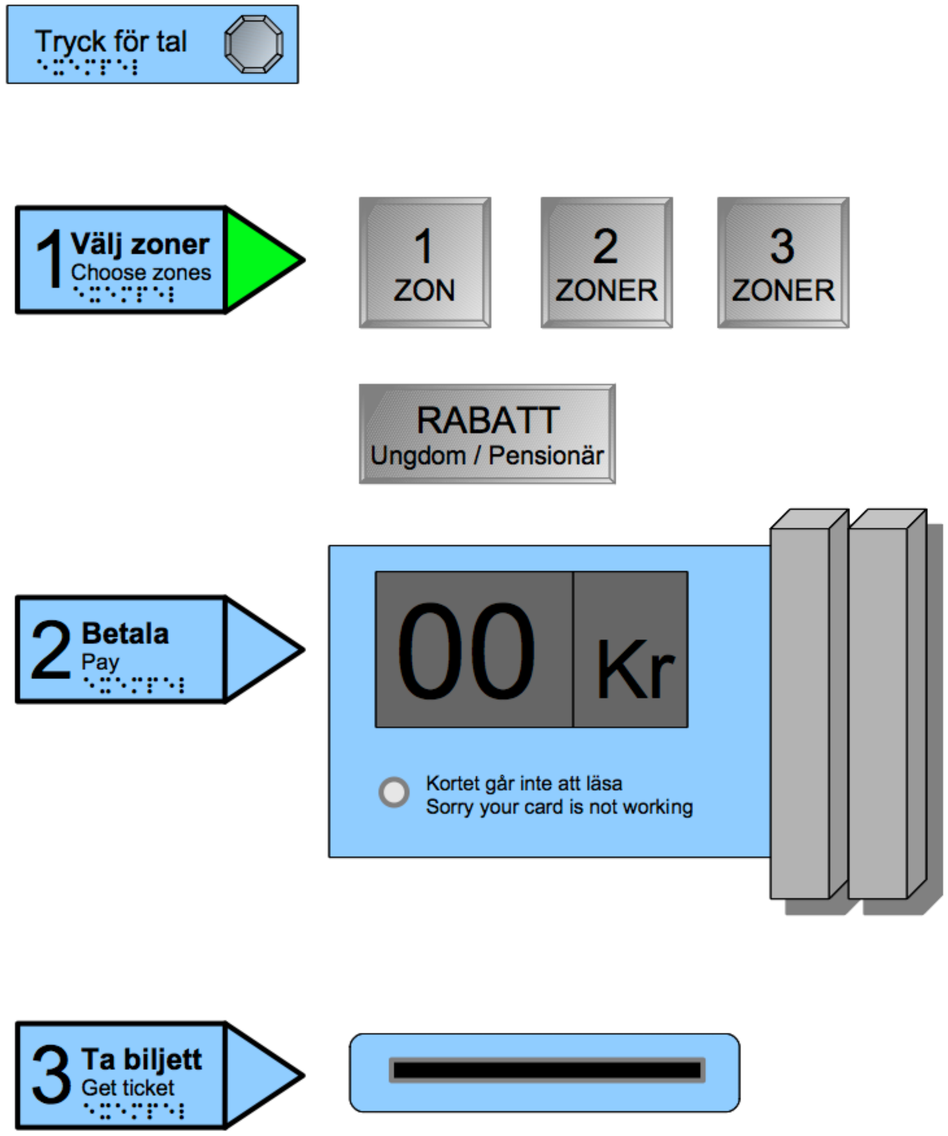
  - Natural for all additive dimensions, e.g., amount (water level), heat (thermometer), volume, line thickness, brightness, weight,…
  - But: not for substitutive dimensions, e.g., color, audio pitch(!), taste, location,…

Stockholm Ticket Machine



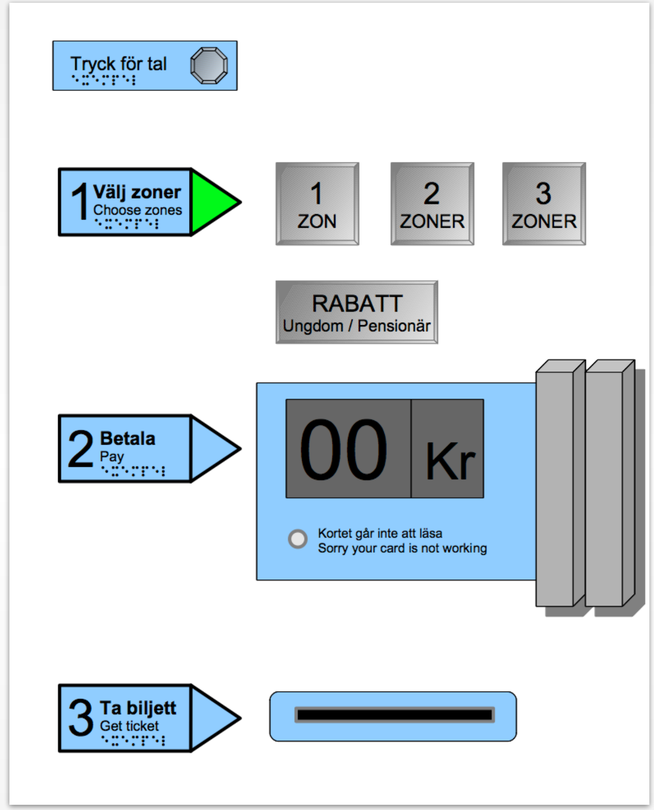
Source: http://www.peterkrantz.com/2007/man-machine-interface/
Photo: http://en.wikipedia.org/

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?

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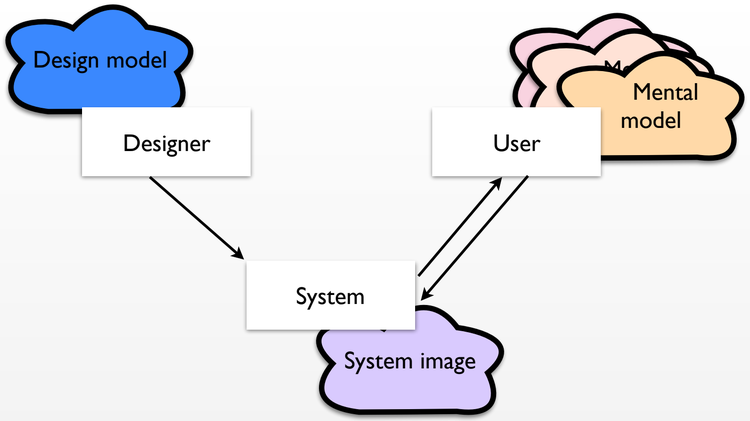
מאותיות אהו״י אשר
מציינות תנועה. אות זו
מצוייה כאם-קריאה
אחרי כל התנועות.

http://uk.ibtimes.com/

verydemotivational.com

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

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

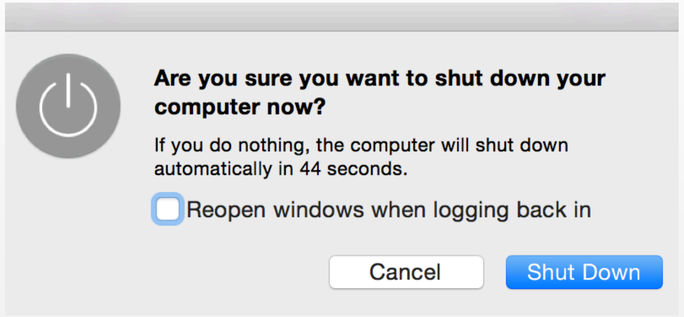
- Rely upon generally accepted cultural standards to constrain possible actions
  - Examples
    - Labels are to be read, so are expected not to be upside down — implies which side is up on a closed package
    - Red = Stop
- But: Only applies to specific cultural group!
  - Chinese labeling does not 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

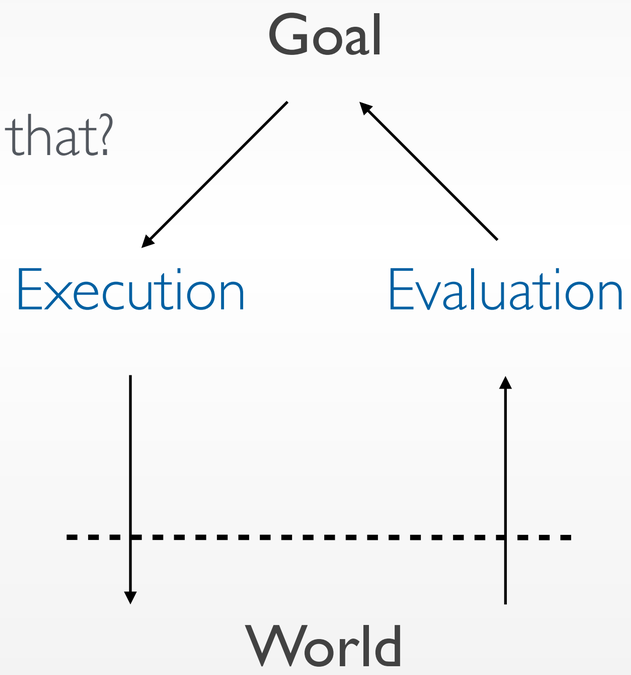
- Can help to avoid errors; extreme physical constraints
- But: Think through the burden on normal operation!
  - E.g., seat belts
- Lock-out prevents an action
  - E.g., stairways to basements
- Lock-in prevents prematurely stopping an action
  - E.g., soft power-off switch on computers to avoid data 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)

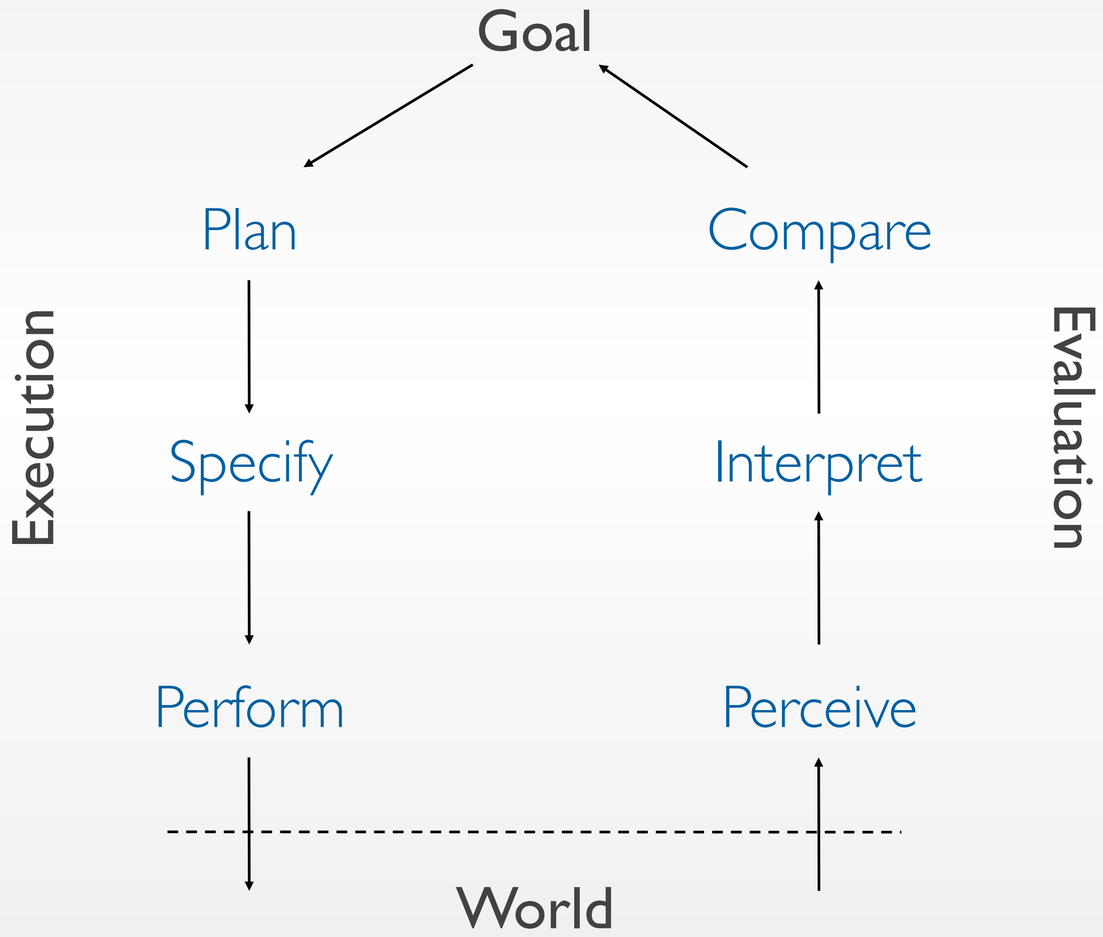
Goal Formulation

- 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

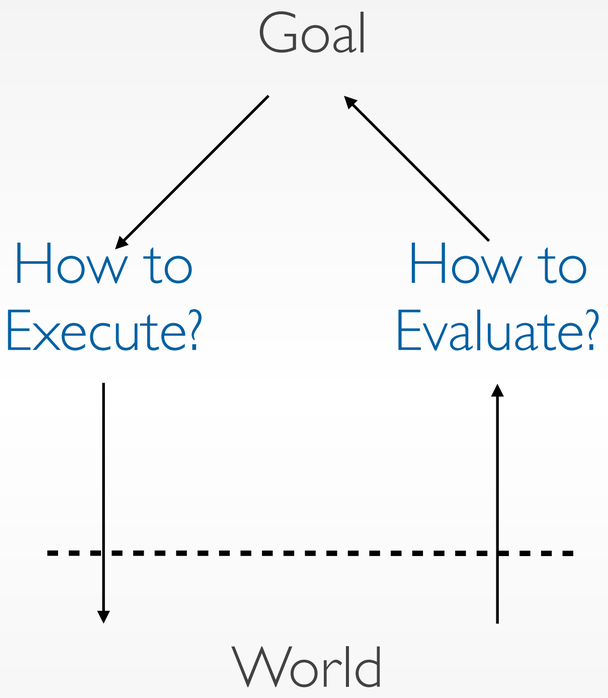


More on the Seven Stages

- 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

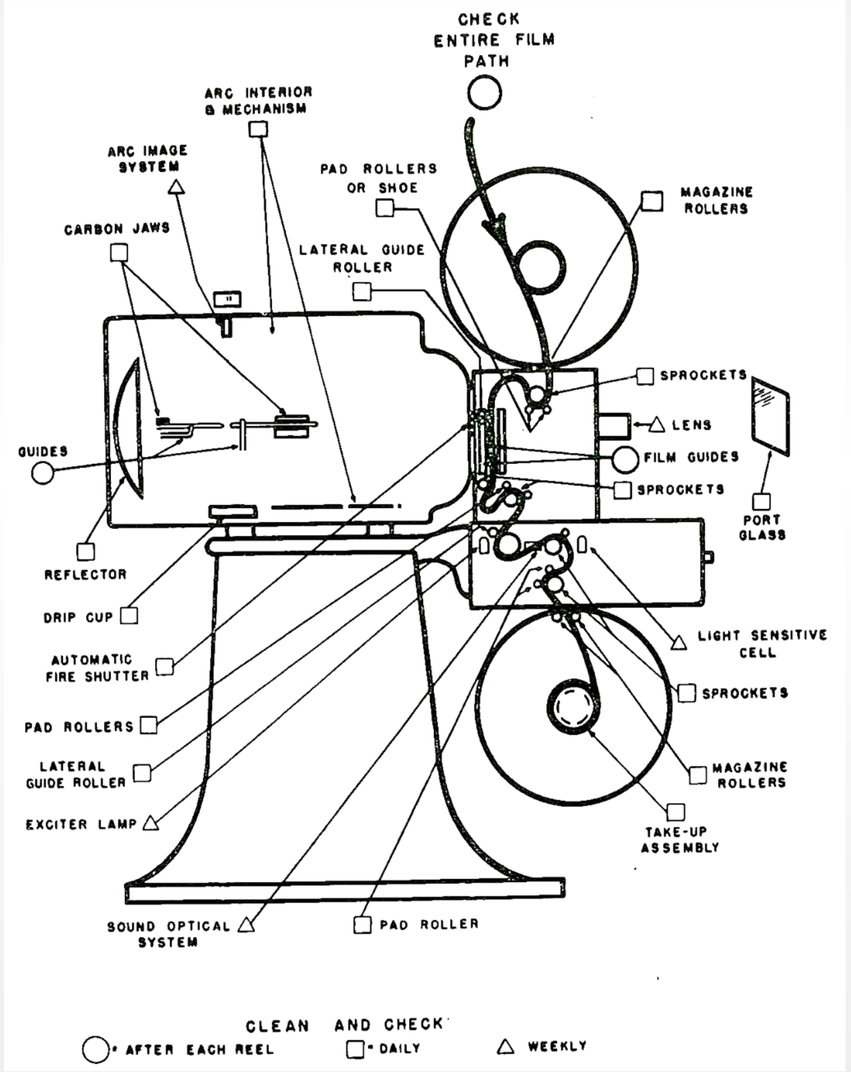
- Even simple actions can seem difficult
- Reason: Cannot see how system works or what to do
  - Example: Peanut bags…
- Connection between plans and execution unclear
- What is the problem? — Mappings, Signifiers, …!

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

Example: Film Projector Threading

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



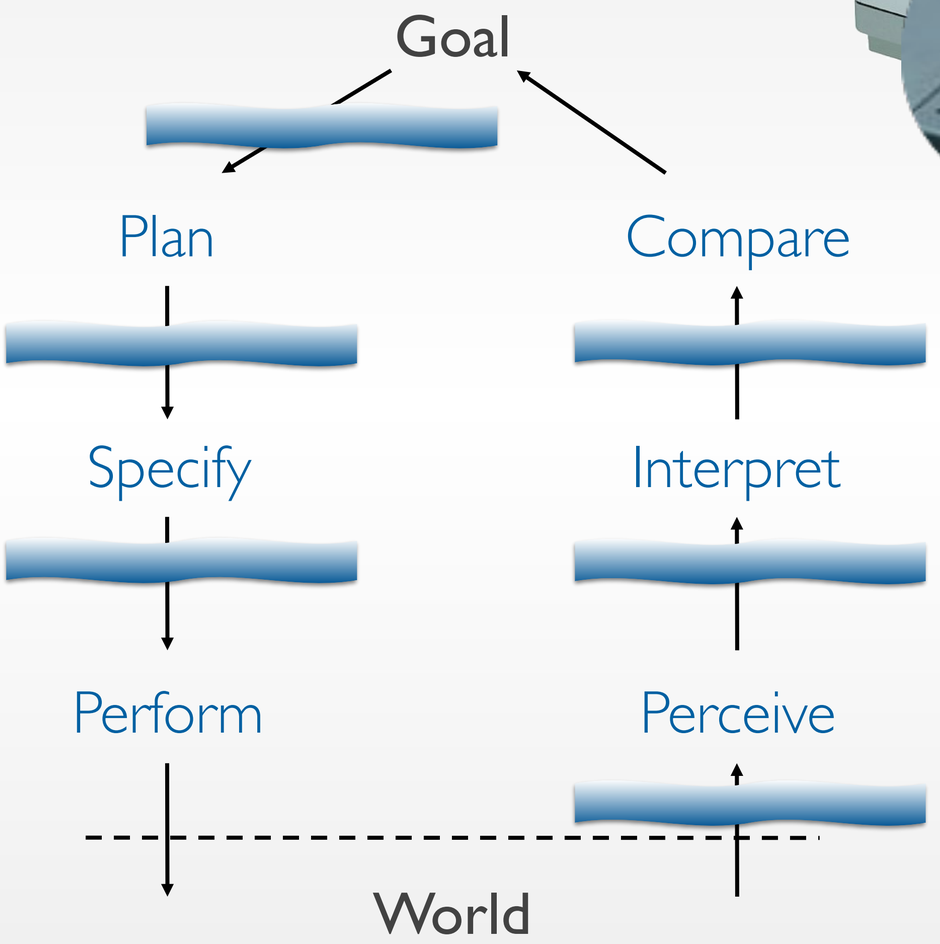

Mode

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


Gourmet
Virginia Peanuts
Unsalted


Goal
Plan
Compare
Specify
Interpret
Perform
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