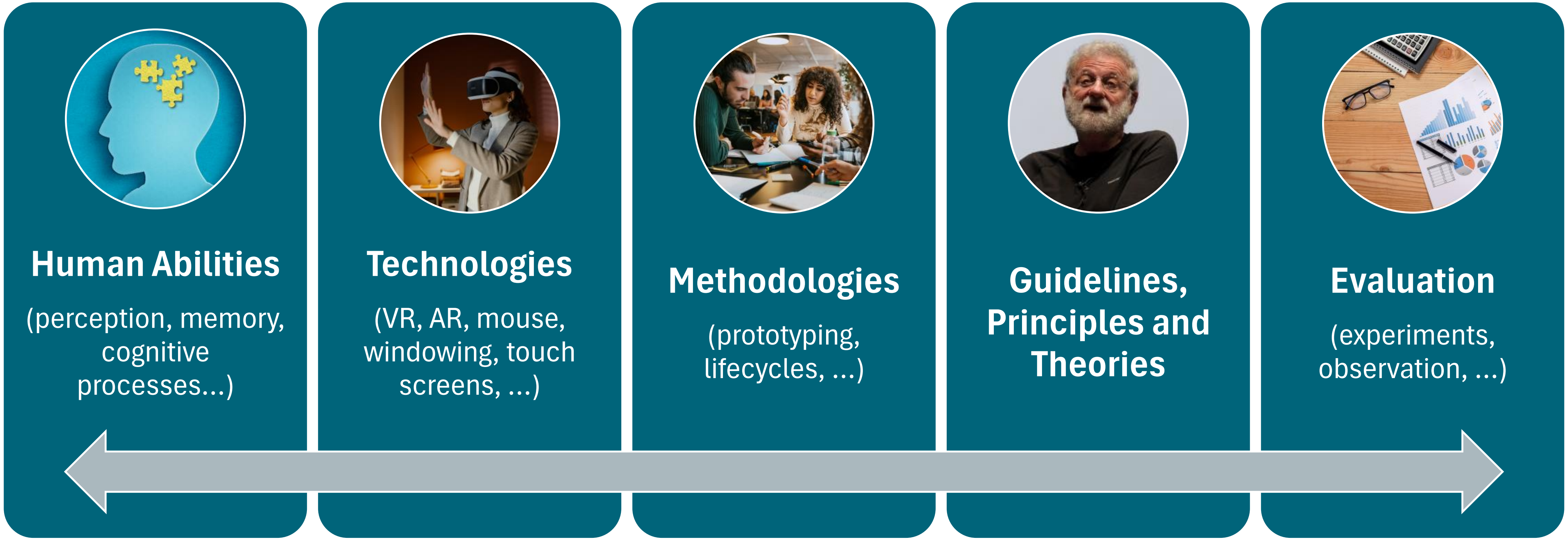
Previously, on Software Engineering

Usability Edition

- We have seen what **usability** is, and why it does matter for basically any kind of software
- We've seen Jakob Nielsen's five **usability attributes**:
  - **Learnability**
  - **Efficiency**
  - **Memorability**
  - **(Lack of) Errors**
  - **Subjective Satisfacion**

Previously, on Software Engineering Usability Edition

- We introduced HCI as the multi-disciplinary approach studying how humans interact with Computer Systems



Human Abilities

(perception, memory, cognitive processes...)

Technologies

(VR, AR, mouse, windowing, touch screens, ...)

Methodologies

(prototyping, lifecycles, ...)

Guidelines, Principles and Theories

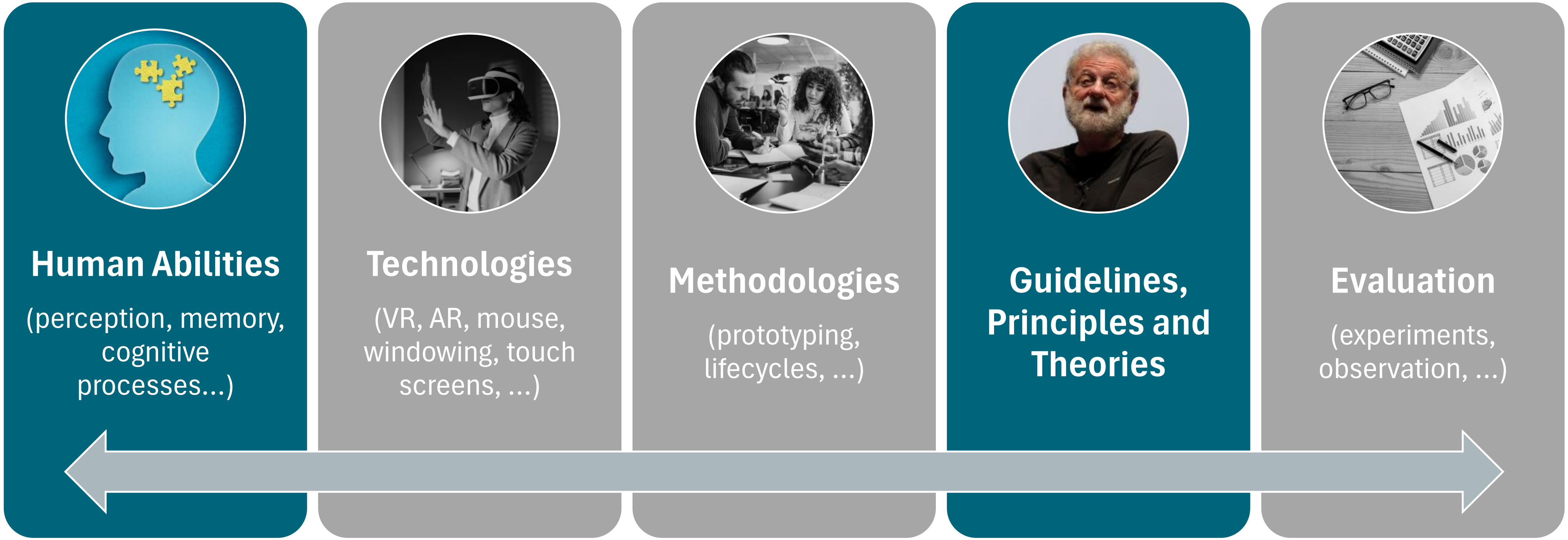
Evaluation

(experiments, observation, ...)

Today, on Software Engineering

Usability Edition

- Today, we start getting into the psycho-cognitive processes behind our interactions with everyday things (including computer systems)



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Guidelines, Principles and Theories

Evaluation

(experiments, observation, ...)

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

SOFTWARE ENGINEERING – LECTURE 10

The Design of Everyday Things and the Nature of Everyday Interactions

Prof. Luigi Libero Lucio Starace

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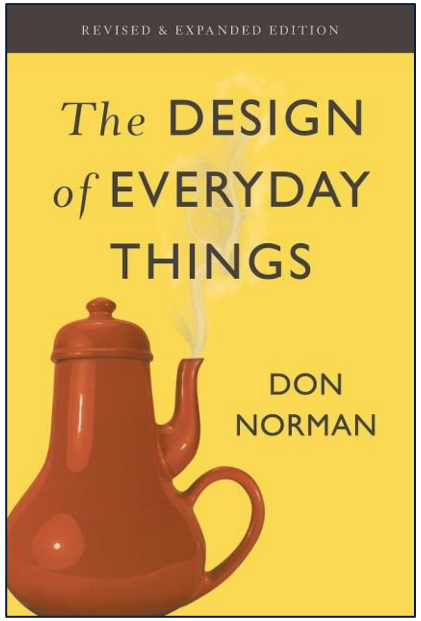
https://luistar.github.io

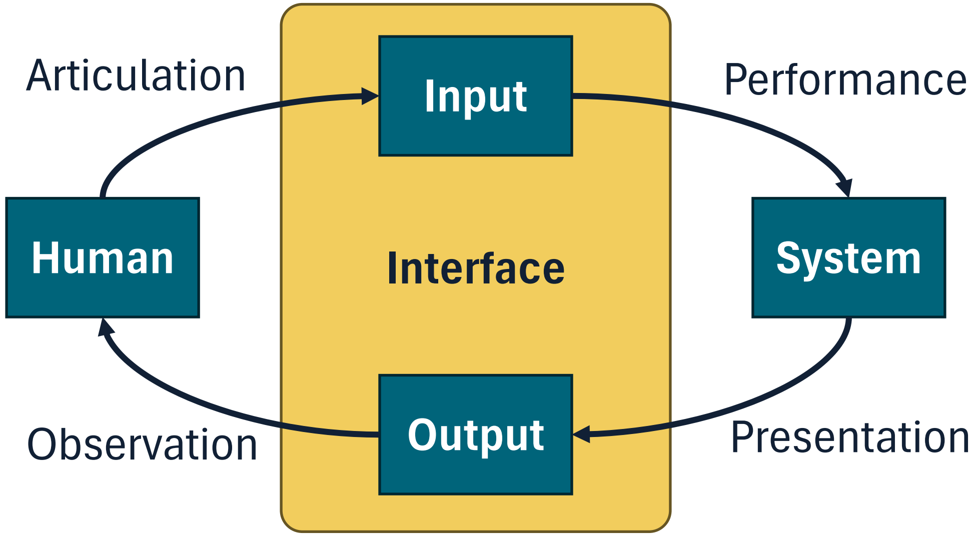
https://www.docenti.unina.it/luigiliberolucio.starace

The Design of Everyday Things

- How we interact with everyday objects
  - i.e., the **Psychology of Everyday Things**
  - How and why everyday objects fail or succeed in their design?
  - Insights on human cognition and behaviour
- We'll derive some principles that can be applied also to User Interfaces
- Remember: *It's never a user's fault!*



What is Interaction?



- Different kinds of interactions with a system
  - **Communicative** (information is sent)
  - **Receptive** (information is received)
  - **Two-way**
  - **Effective** (side effects result from the interaction)

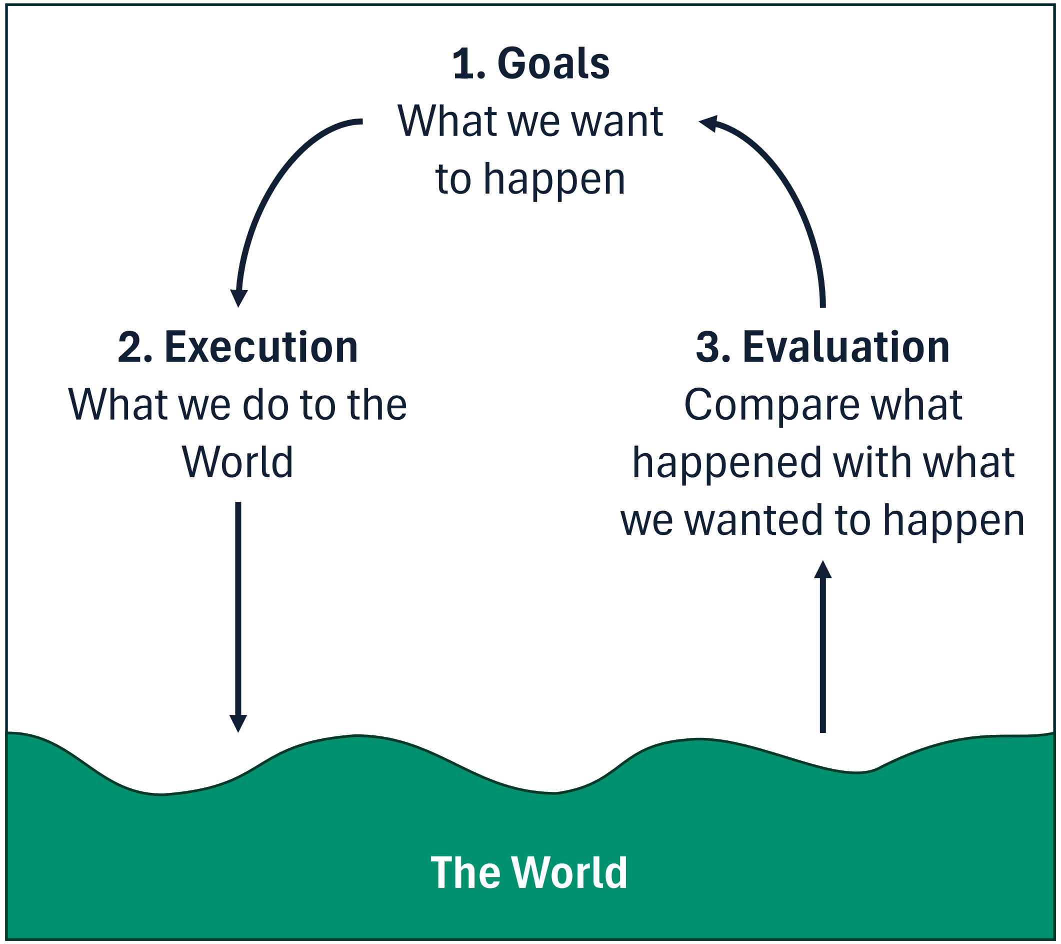
What makes an interaction «difficult»?

- Some interactions go more smootly than others
- Often, difficulties using a system do not come from deep, subtle complexity
- We fail to use many everyday objects!
- So, what makes an interaction difficult?
- To answer, we need to understand whan happens when someone does (or tries to do) something
- Don Norman formulated a theory to explain the **stages of action**

Do we push or pull?

The Structure Of Action: The Action Cycle

- To get something done, you need to start with some notion of what we want to achieve (**goal**)
- Then, you need to act on the external world, to move and interact with someone or something (**execution**)
- Finally, we check whether our goal was actually achieved (**evaluation**)



1. Goals
What we want to happen

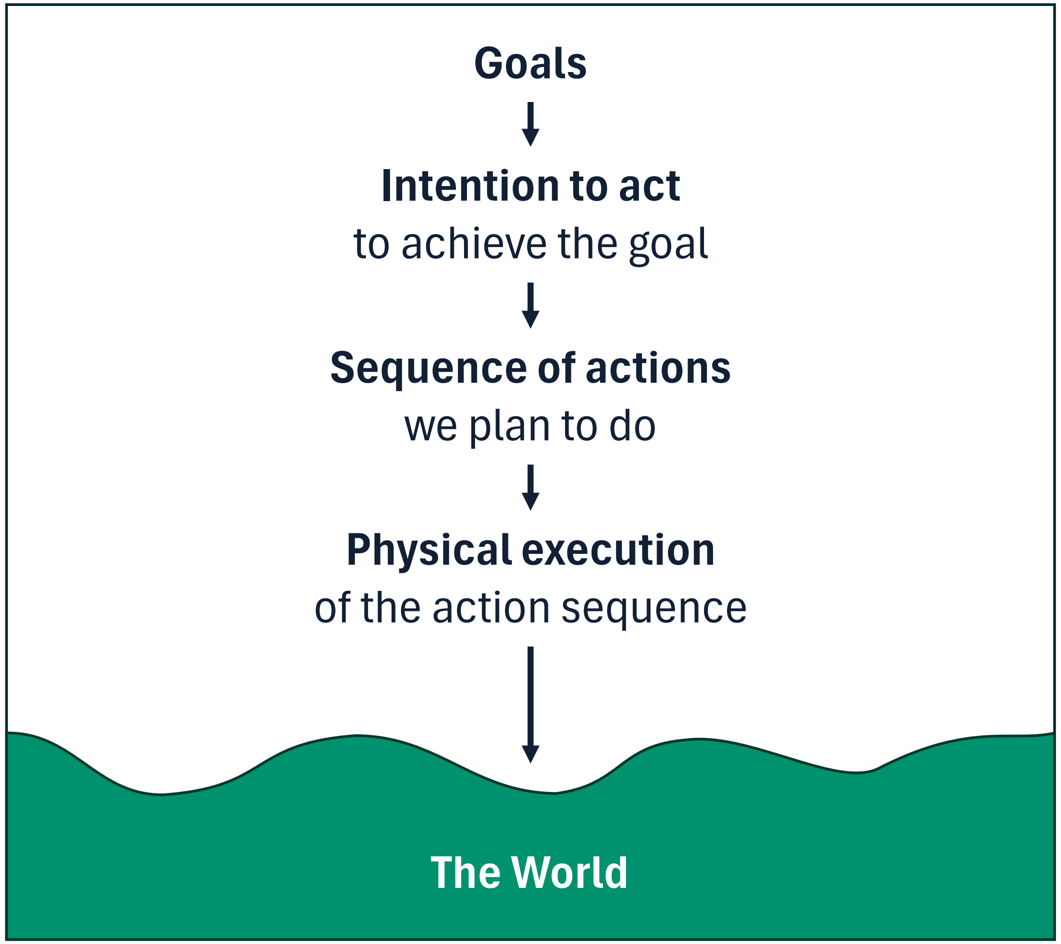
2. Execution
What we do to the World

3. Evaluation
Compare what happened with what we wanted to happen

The World

Stages of Execution

- To lead to actions, goals need to be transformed into a specific statement of what is to be done (**intention**)
- Intentions need to be translated into an **action sequence** to perform to satisfy the intention
- The action sequence needs to be **phisically executed**, i.e., performed upon the world



Goals

Intention to act
to achieve the goal

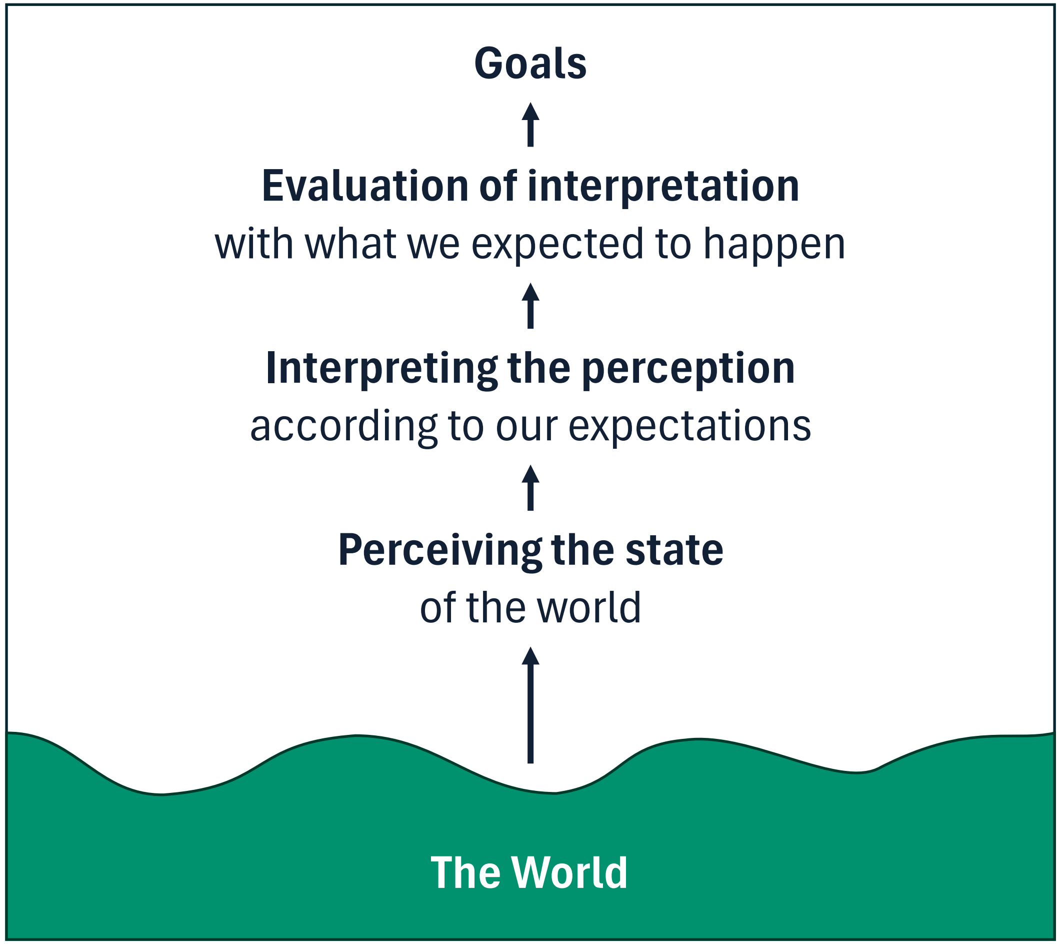
Sequence of actions
we plan to do

Physical execution
of the action sequence

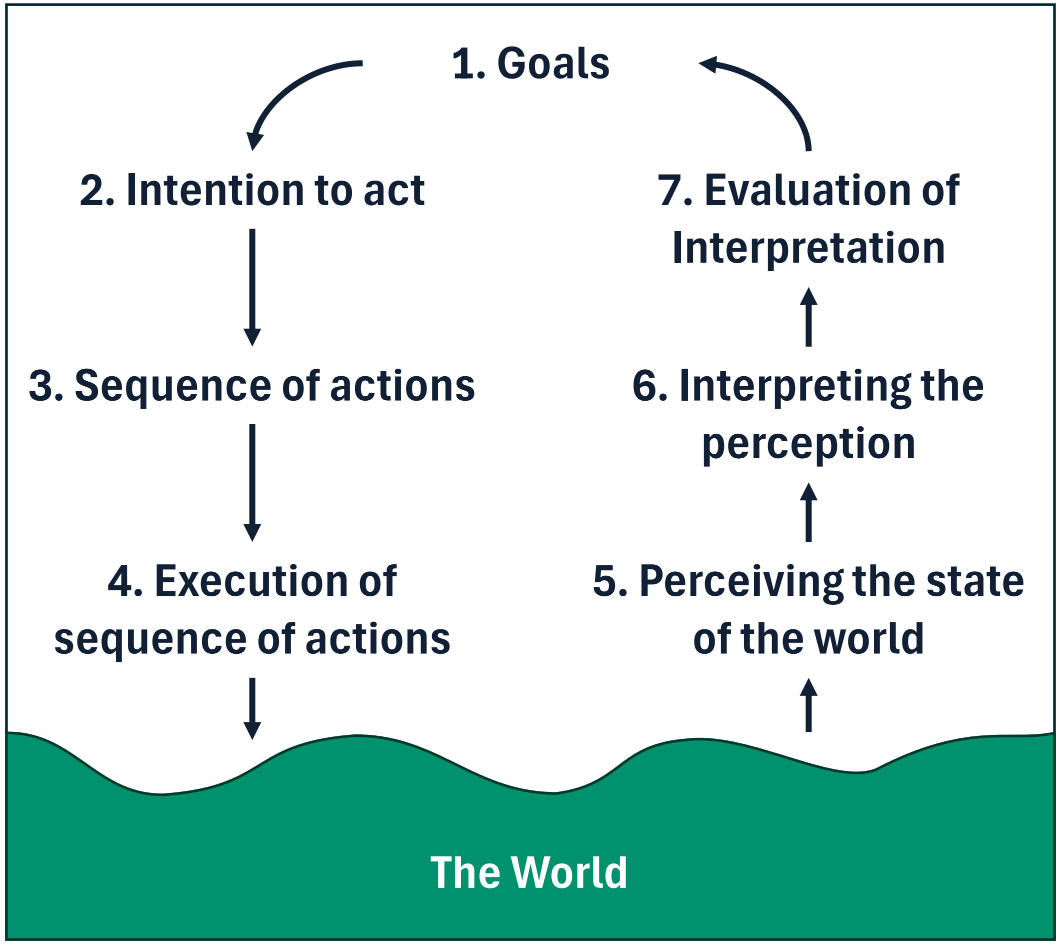
The World

Stages of Evaluation

- Evaluation starts with our **perception** of the world
- Perception needs to be **interpreted** according to our expectations
- Then, the interpretation is **evaluated** with respect to our intentions and our goal


Goals
Evaluation of interpretation
with what we expected to happen
Interpreting the perception
according to our expectations
Perceiving the state
of the world
The World

Don Norman’s Seven Stages of Action


1. Goals
2. Intention to act
3. Sequence of actions
4. Execution of sequence of actions
5. Perceiving the state of the world
6. Interpreting the perception
7. Evaluation of Interpretation
The World

Seven Stages of Action: Example

We are reading a book and the room is getting too dark to read

- **Establish the goal**

  Increase light in the room

- **Form the intention**

  To turn on the lamp

- **Specify the action sequence**

  Walk to the lamp, reach for the switch, flip the switch

- **Execute the action sequence**

  [walk, reach, flip]

- **Perceive the system state**

  [hear "click" sound, see light from lamp]

- **Interpret the system state**

  The flip switched position. The lamp is emitting light. The lamp seems to work

- **Evaluate system state with respect to goals and intentions**

  Light level increased [goal satisfied]

Don Norman’s Seven Stages of Action

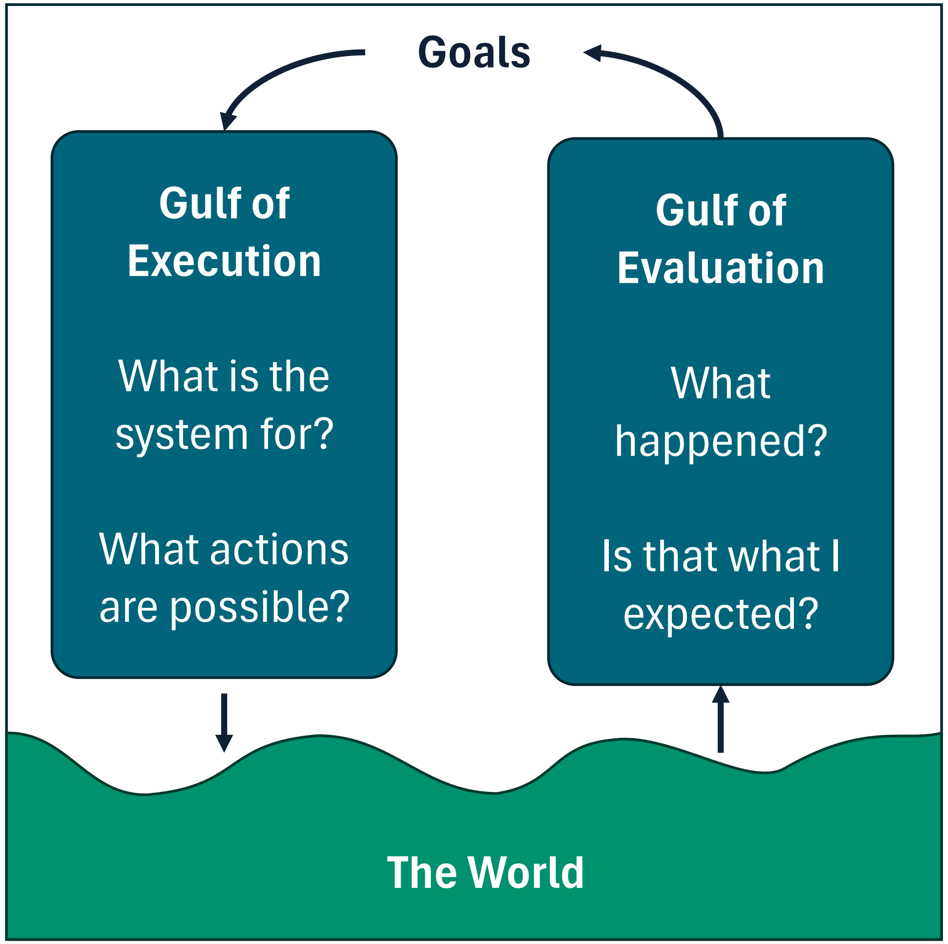
- The seven stages of action are an **approximate** model
- The process can start at any step
    - People not always behave as a logical organism
    - Goals may be confused, ill-formed and vague
    - We may respond to events of the world (event-driven behaviour)
    - Some actions are **opportunistic** rather than planned
        - We perform them if the opportunity arises

Seven Stages of Action: Alternatives

- Notice that a given goal may be satisfied using different intentions and different action sequences!
- If somebody entered the room and passed by the lamp, we may alter our intention from flipping the switch to asking the other person to do it for us

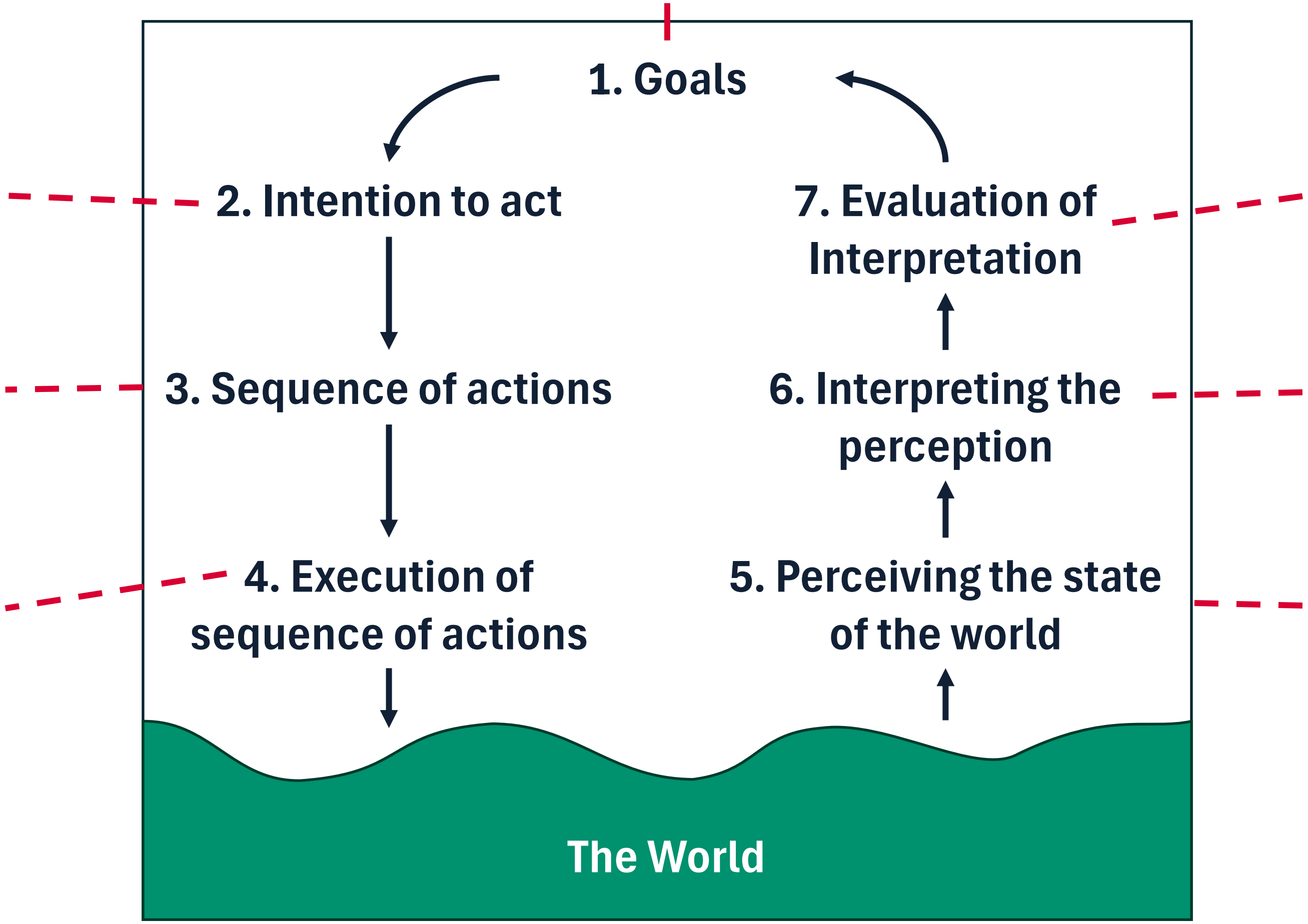
So, what makes some interactions «difficult»?

- Difficulties often reside entirely in deriving the relationships between mental intentions and interpretations and physical actions and states.
- Norman identifies two “**gulfs**” that separate mental and physical states
  - **Gulf of Execution** and **Gulf of Evaluation**
  - Each gulf reflects one aspect of the distance between the mental representation of the user and the physical components and states of the environment



Bridging the Gulfs: How Easily Can Users...

Determine the function
of the System?



1. Goals

2. Intention to act

3. Sequence of actions

4. Execution of sequence of actions

5. Perceiving the state of the world

6. Interpreting the perception

7. Evaluation of Interpretation

The World

Tell what actions are possible?

Determine mapping from intention to physical movement?

Perform the action?

Tell if System is in desired state?

Determine mapping from system state to interpretation?

Tell what state the system is in?

Design Principles to help us bridge the gulfs

Affordances

Constraints

Feedback

Consistency

Metaphors

Mappings

Design Principles to help us bridge the gulfs

Affordances

Constraints

Feedback

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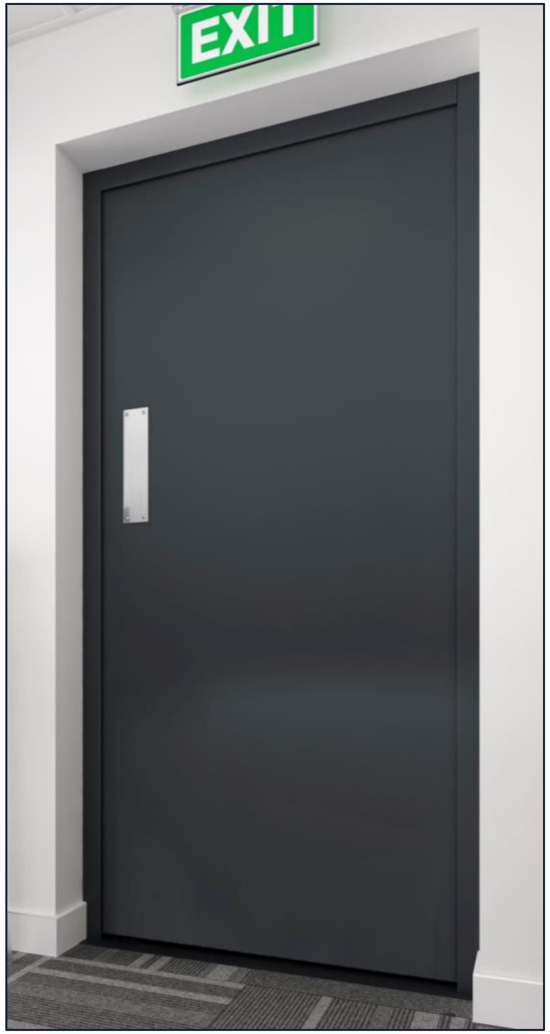
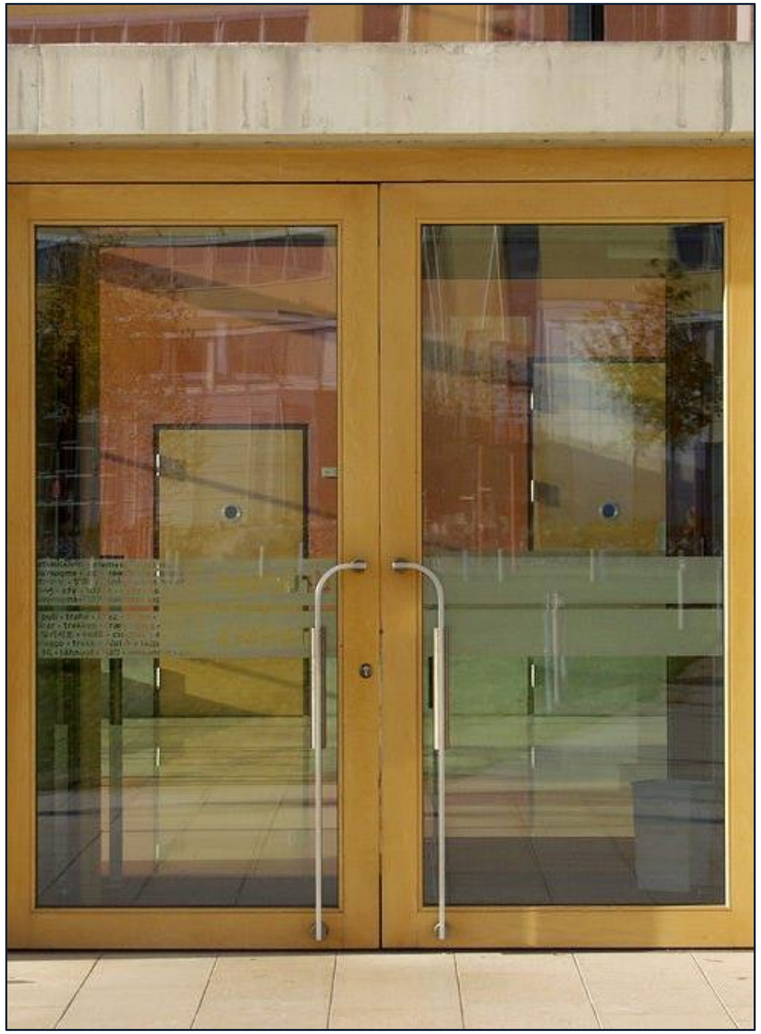
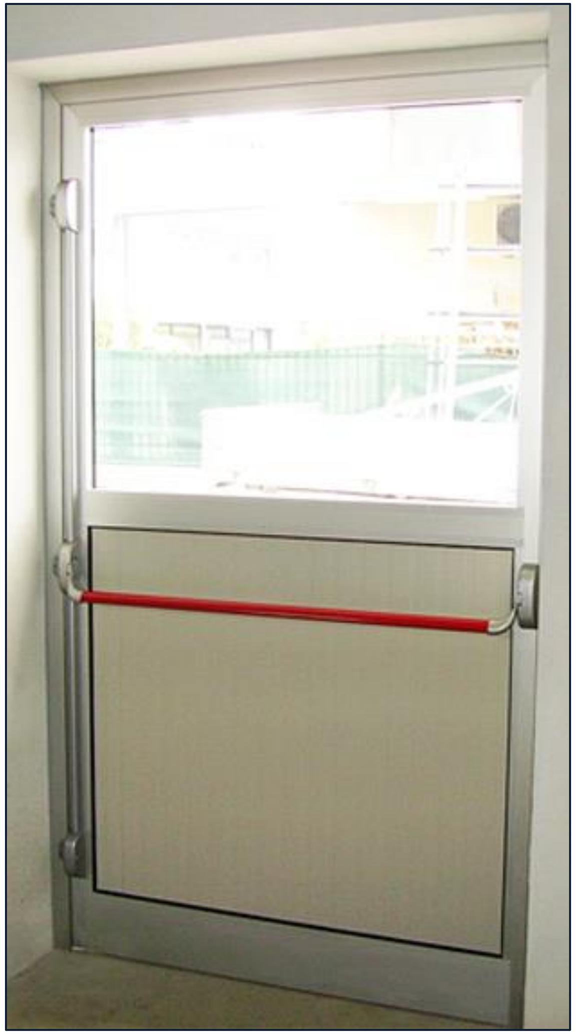
Metaphors

Mappings

Which doors are easy to open?

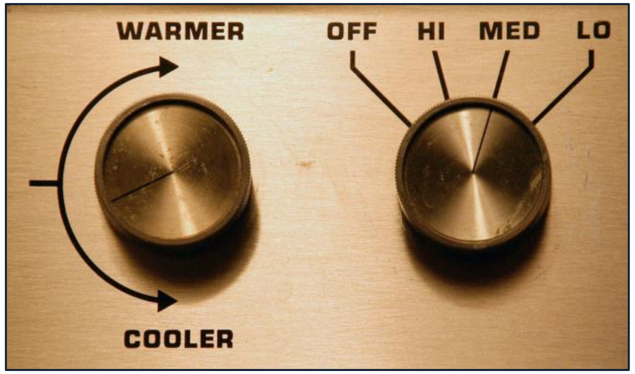




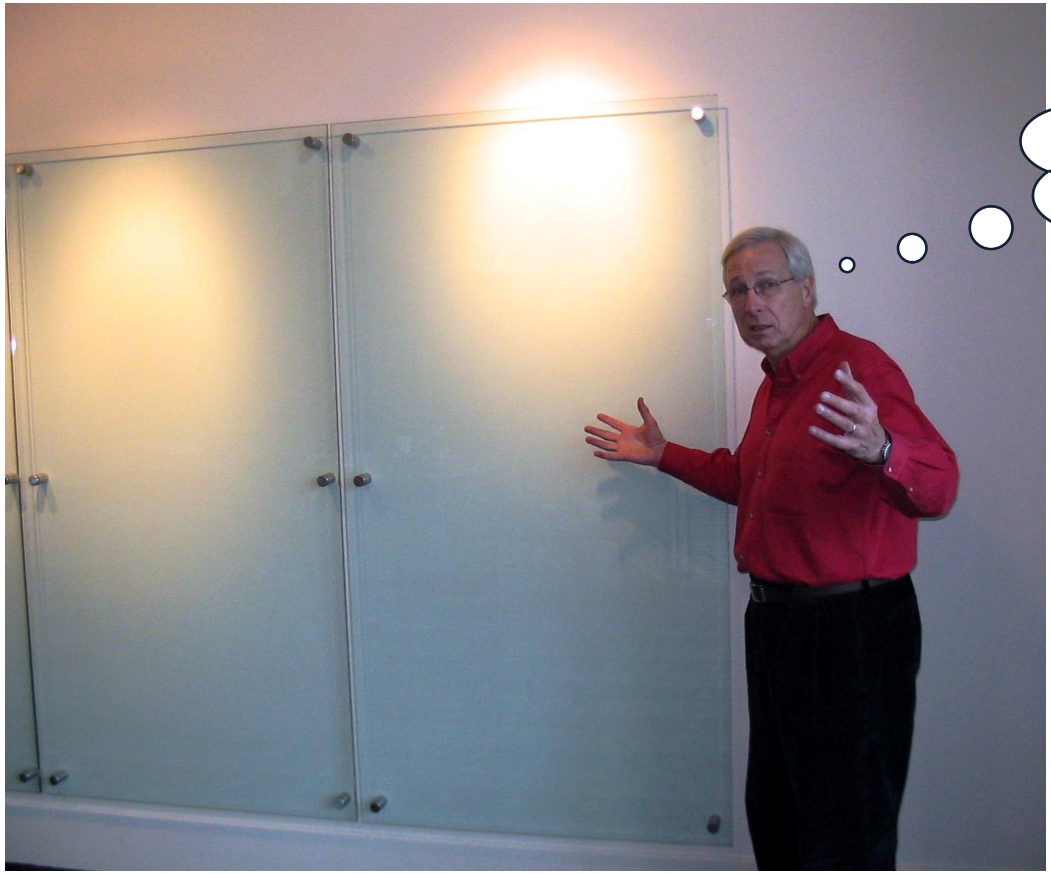


Affordances

- Affordances provide strong clues to the operations of things.
- Buttons are for pushing. Knobs are for turning. Slots are for inserting things into. Balls are for throwing or bouncing.
- When affordances are taken advantage of, users know what to do just by looking: no picture, label, or instruction is required.
  - Complex things may require explanation, but simple things should not!



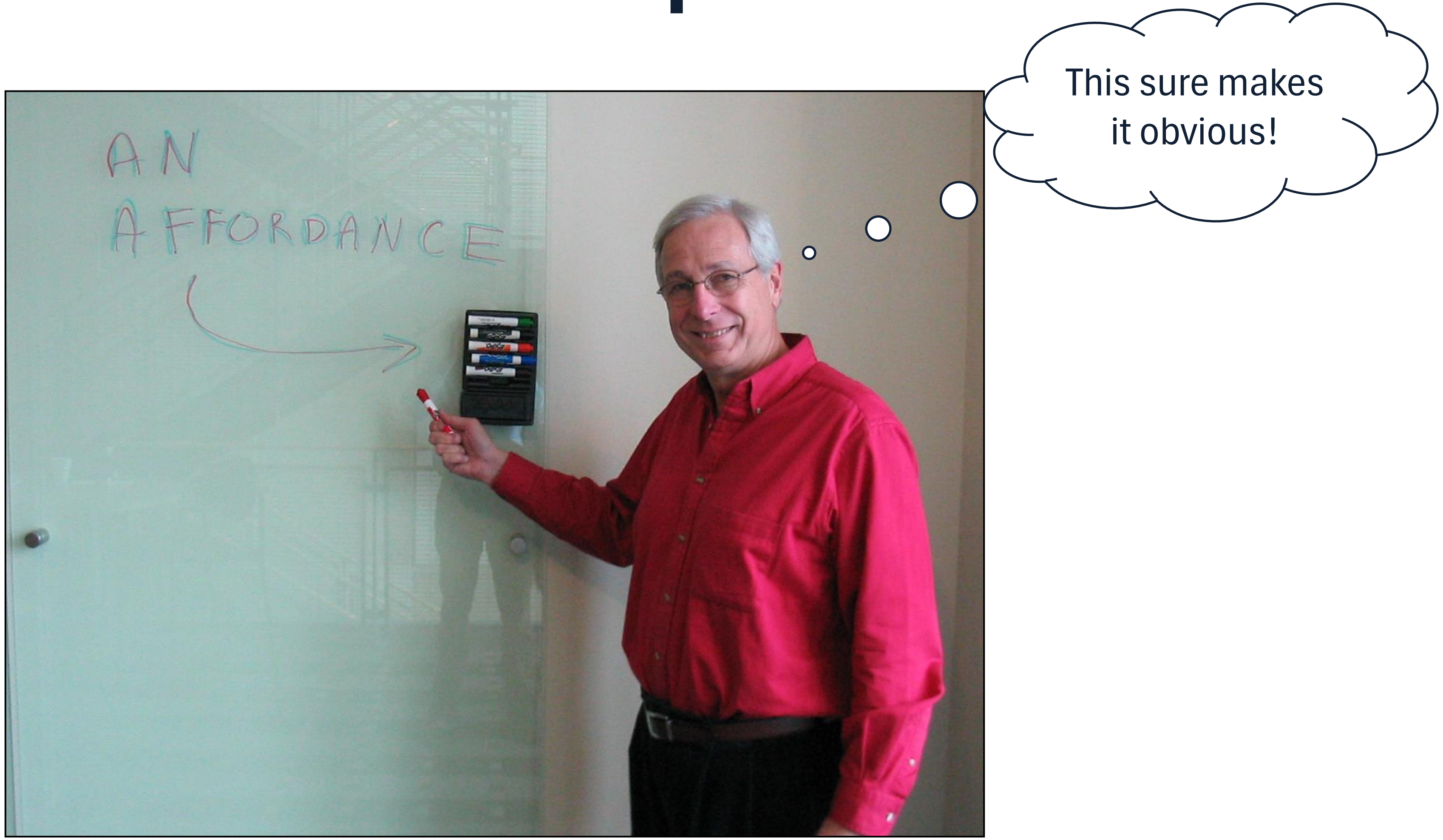
Lack of Affordances: Example



What in the world is this glass for?

James Foley, Professor at Georgia Tech, College of Computing

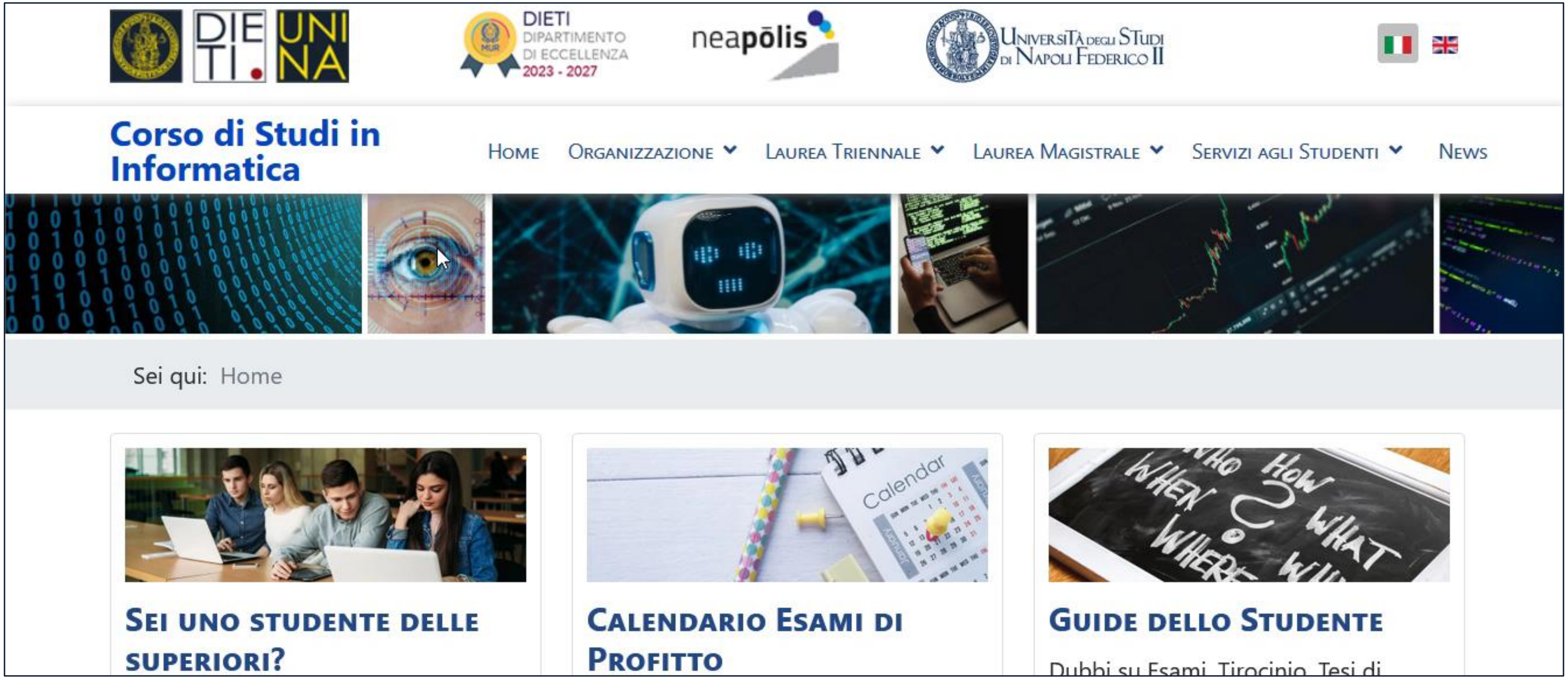
Lack of Affordances: Example



This sure makes
it obvious!

James Foley, Professor at Georgia Tech, College of Computing

Affordances in UI



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Corso di Studi in Informatica

Sei qui: Home

Sei uno studente delle superiori?

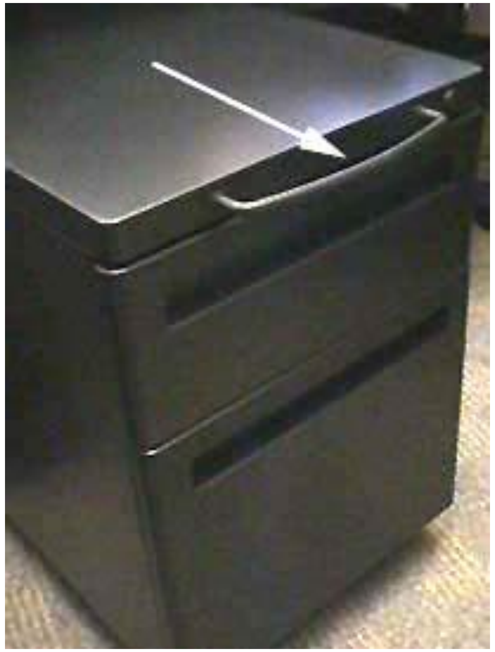
Calendario Esami di Profitto

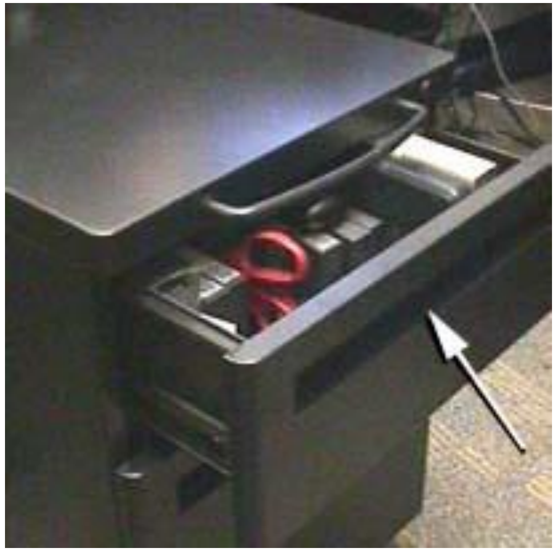
Guide dello Studente

Dubbi su Esami, Tirocinio, Tesi di

False Affordances

- False affordances appear to afford a particular capability, but actually afford a different one (or none at all!)

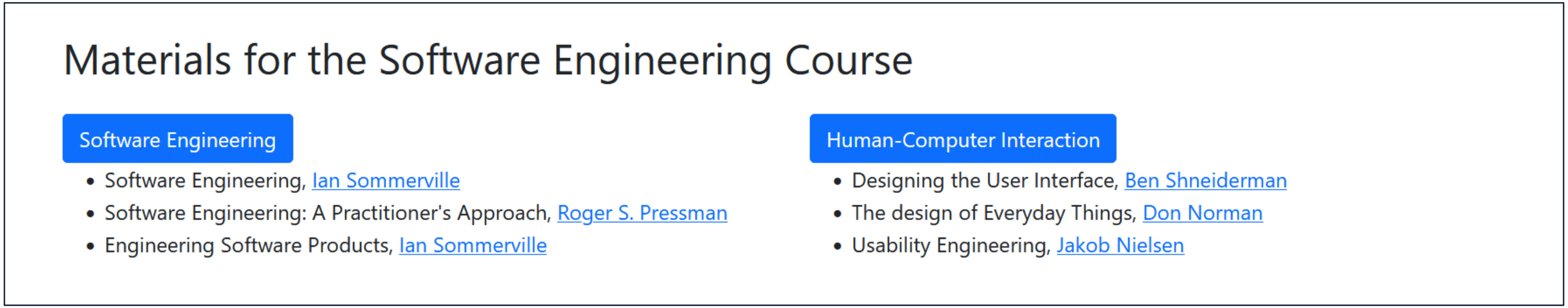




Mischievous file cabinet, from http://www.baddesigns.com/file.html

False Affordances In UI

- E.g.: If something looks like a button but is not clickable



Materials for the Software Engineering Course

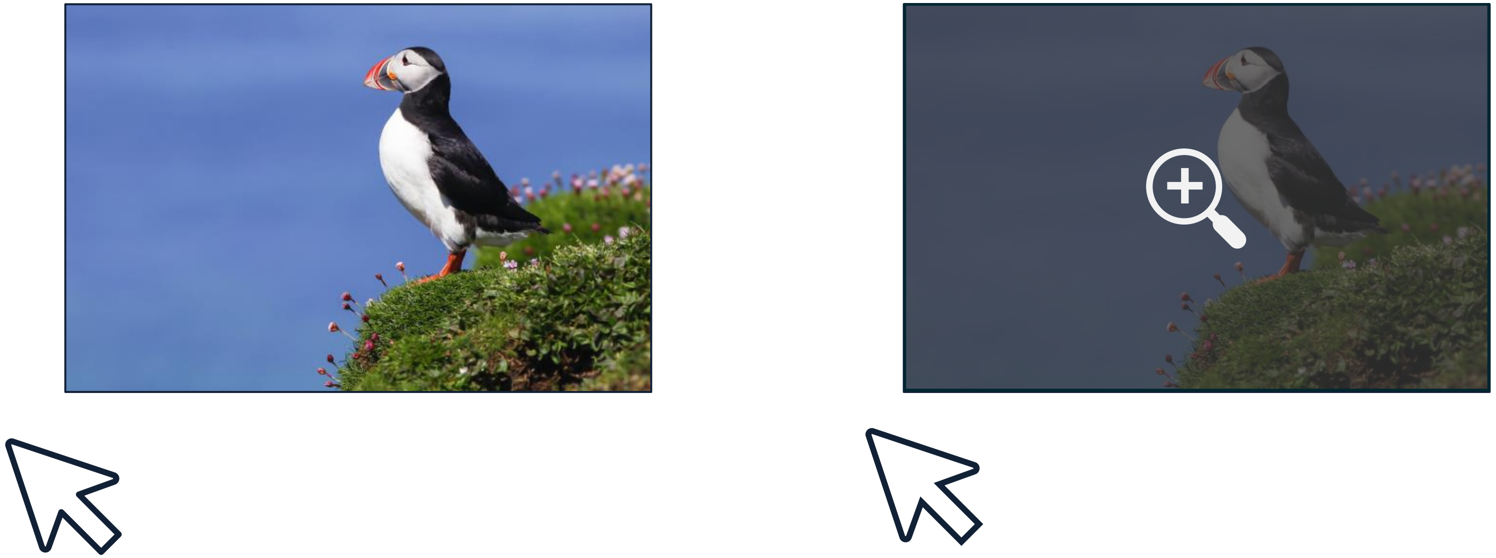
- Software Engineering, Ian Sommerville
- Software Engineering: A Practitioner's Approach, Roger S. Pressman
- Engineering Software Products, Ian Sommerville

- Designing the User Interface, Ben Shneiderman
- The design of Everyday Things, Don Norman
- Usability Engineering, Jakob Nielsen

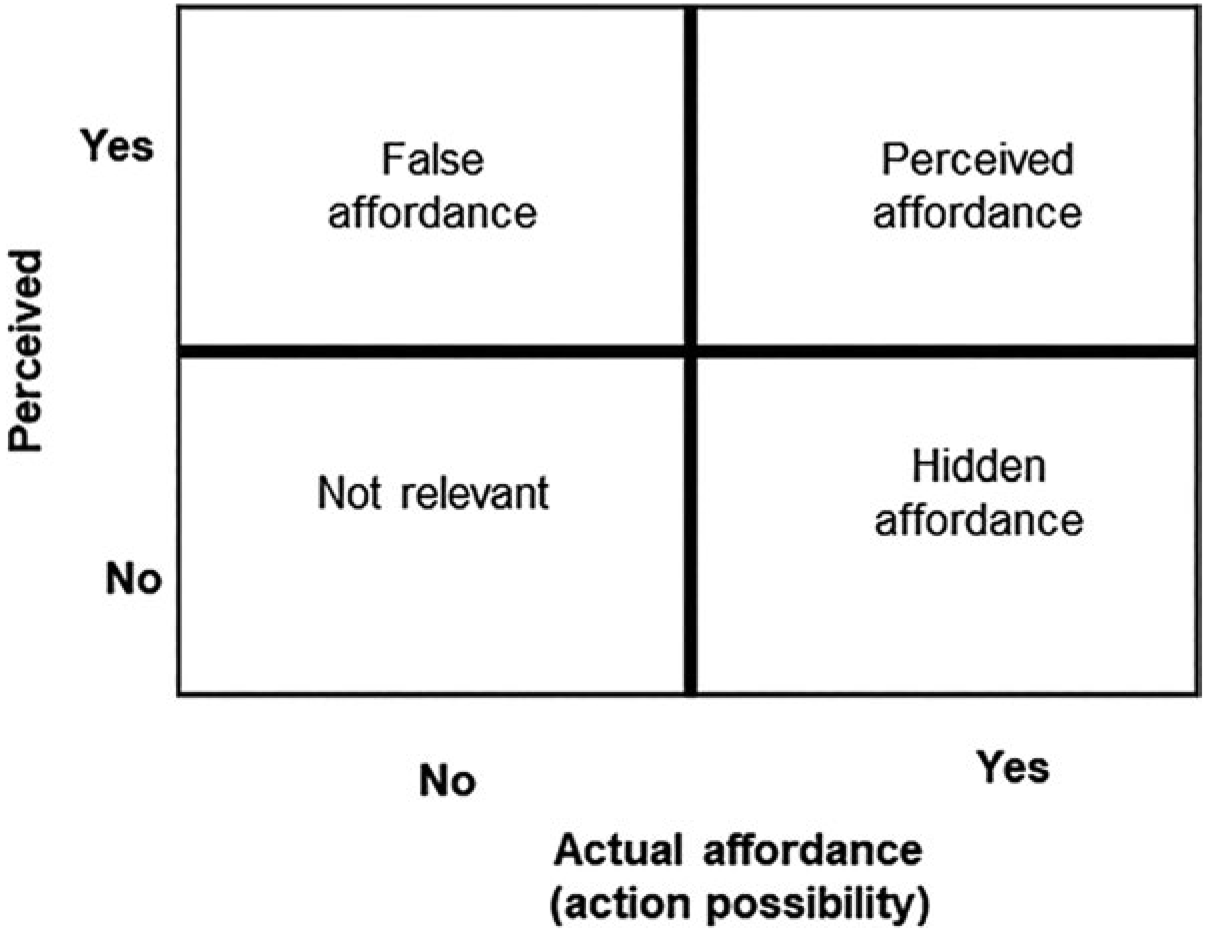
Example available at https://codepen.io/luistar/embed/WNqZBOW?default-tab=result

Hidden Affordances

- Hidden affordances occur when the clues that indicate an items function are not obvious and may not even be displayed until the action is being taken.



Affordances



Perceived	Actual affordance (action possibility): No	Actual affordance (action possibility): Yes
Yes	False affordance	Perceived affordance
No	Not relevant	Hidden affordance

Design Principles to help us bridge the gulfs

Affordances

Constraints

Feedback

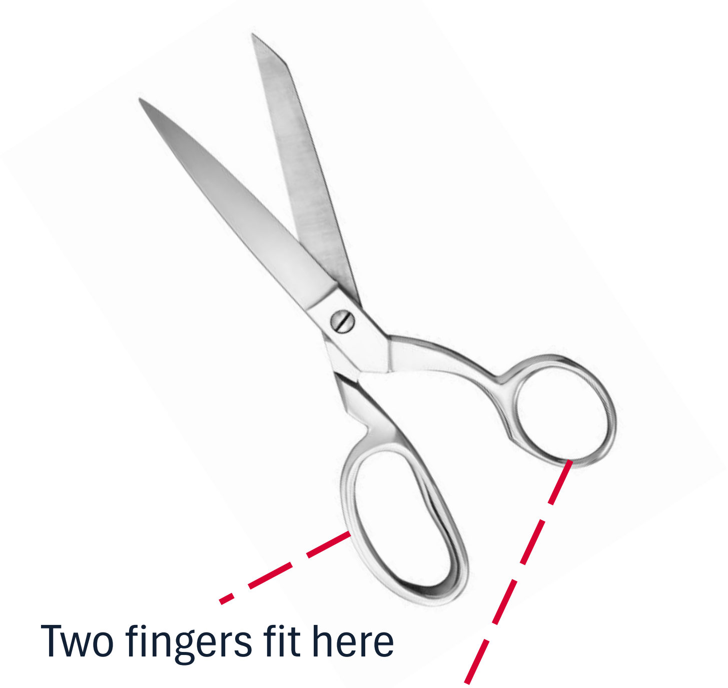
Consistency

Metaphors

Mappings

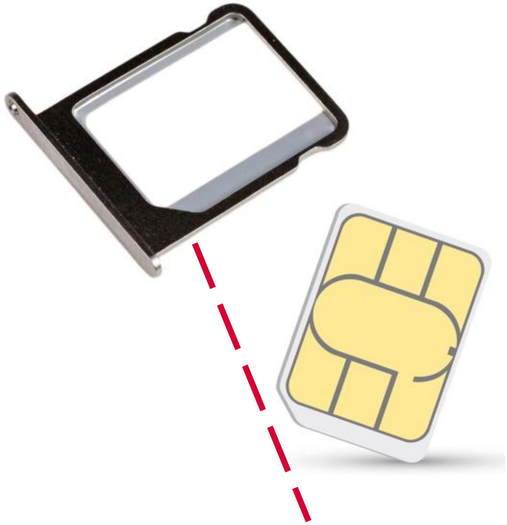
Constraints

- The easiest way to make sure something is easy to use, with few errors, is to make it impossible to do otherwise by constraining user choices

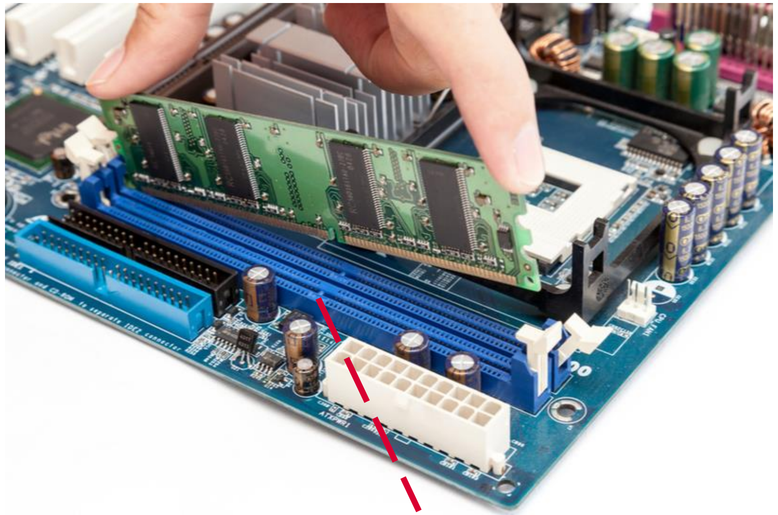


Two fingers fit here

Only one finger fits here

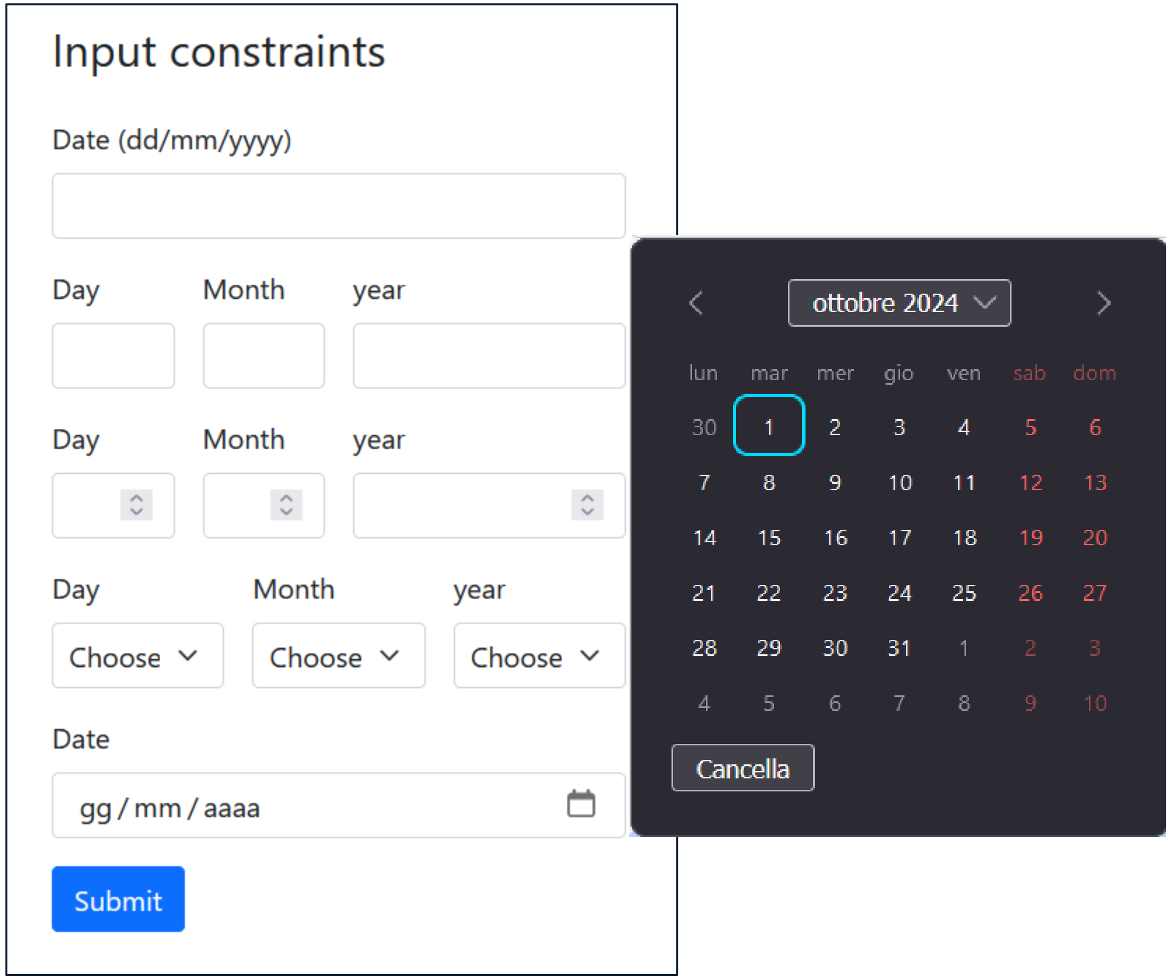


Only one way the nano-sim can fit in the tray



The dent in the DIMM RAM blocks and motherboard slots is not centered. The blocks can only fit in one way

Constraints in UI



Input constraints

Date (dd/mm/yyyy)

Day Month year

Day Month year

Day Month year

Date

gg / mm / aaaa

lun	mar	mer	gio	ven	sab	dom
30	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	1	2	3
4	5	6	7	8	9	10

Design Principles to help us bridge the gulfs

Affordances

Constraints

Feedback

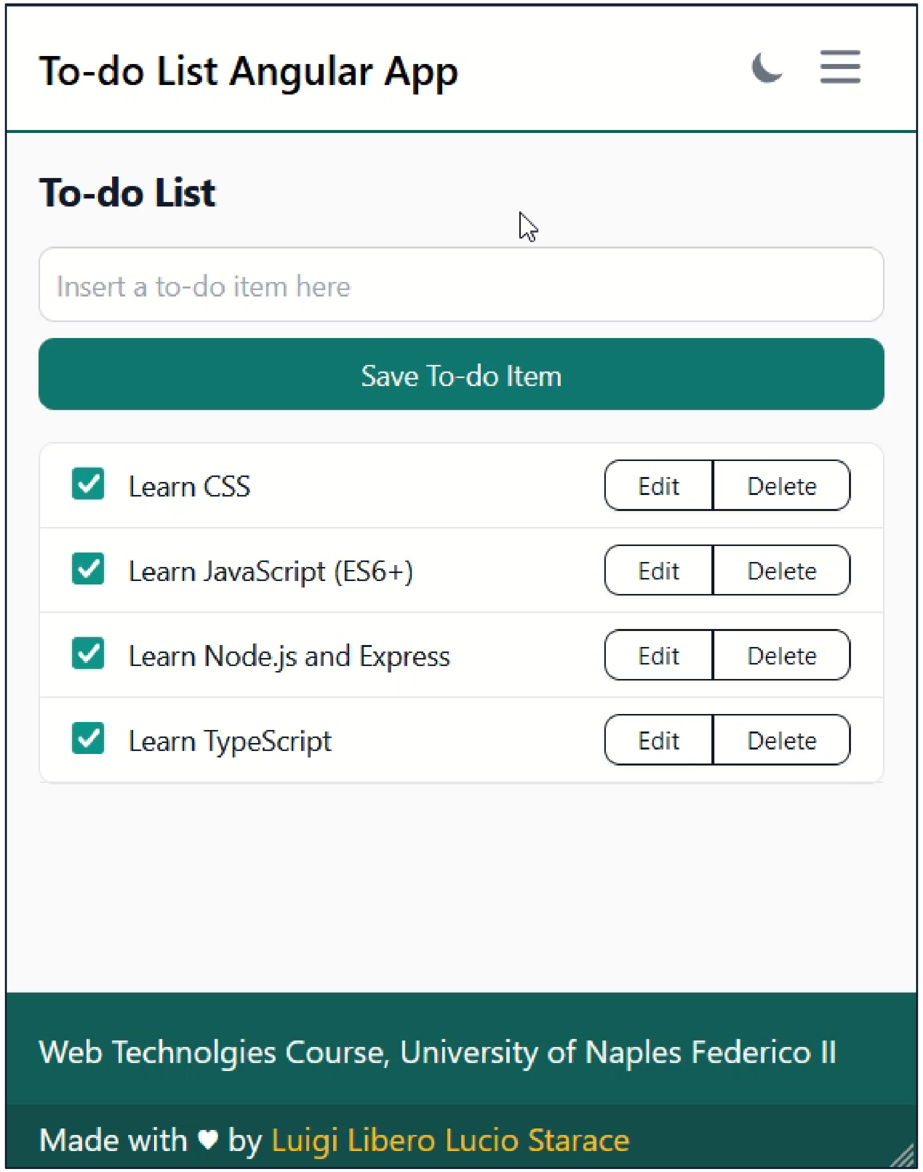
Consistency

Metaphors

Mappings

Feedback

- Every action with relevant side-effects should be explicitly confirmed by the system
- Feedback should be **immediate** and **informative**
- Preferably **non-distractive** and **unobtrusive**



To-do List Angular App

To-do List

Insert a to-do item here

Save To-do Item

☑ Learn CSS — Edit | Delete

☑ Learn JavaScript (ES6+) — Edit | Delete

☑ Learn Node.js and Express — Edit | Delete

☑ Learn TypeScript — Edit | Delete

Web Technolgies Course, University of Naples Federico II

Made with ♥ by Luigi Libero Lucio Starace

Design Principles to help us bridge the gulfs

- Affordances
- Constraints
- Feedback
- Consistency
- Metaphors
- Mappings

Consistency

- Interfaces should be consistent in meaningful ways
  - Within the application itself (**internal consistency**)
  - With other external applications (**external consistency**)
- Consistency helps users brige the gulfs of evaluation and execution
  - E.g.: if all actions are confirmed using a toast message in the upper right corner (as in the To-do List App we've seen a few slides back), it's easier for users to tell what status the system is in. If confirmation messages were different for each action…

Design Principles to help us bridge the gulfs

Affordances

Constraints

Feedback

Consistency

Metaphors

Mappings

Metaphors

Can be useful in UI to suggest an existing mental model and exploit specific knowledge that users already have in different domains

- Horseless carriages, wireless phones…
- Desktop metaphor
  - Not an attempt to simulate an actual desktop, but aims at leverage the knowledge users have of files, documents, folders, trash cans, …

Design Principles to help us bridge the gulfs

Affordances

Constraints

Feedback

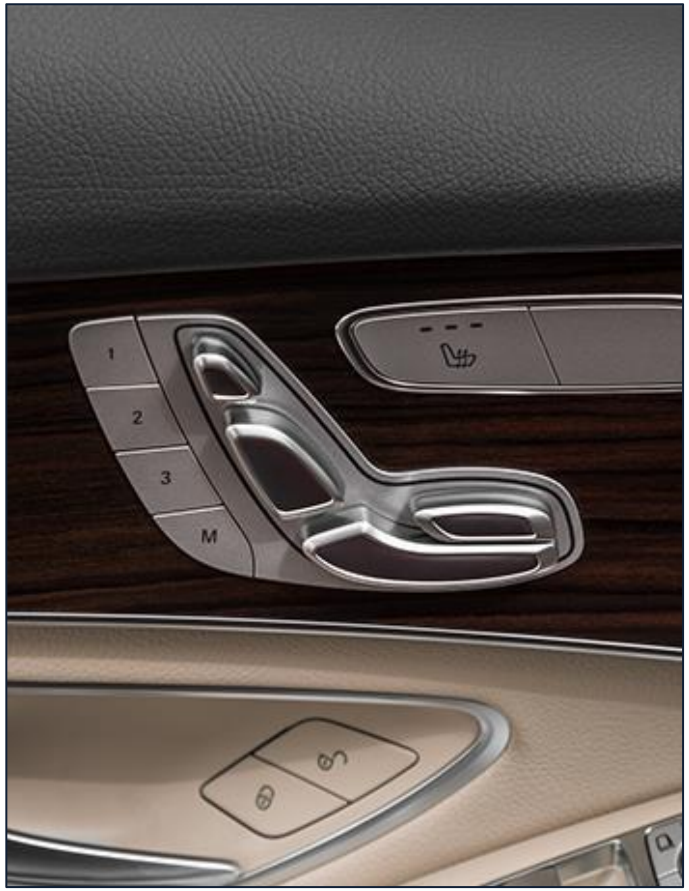
Consistency

Metaphors

Mappings

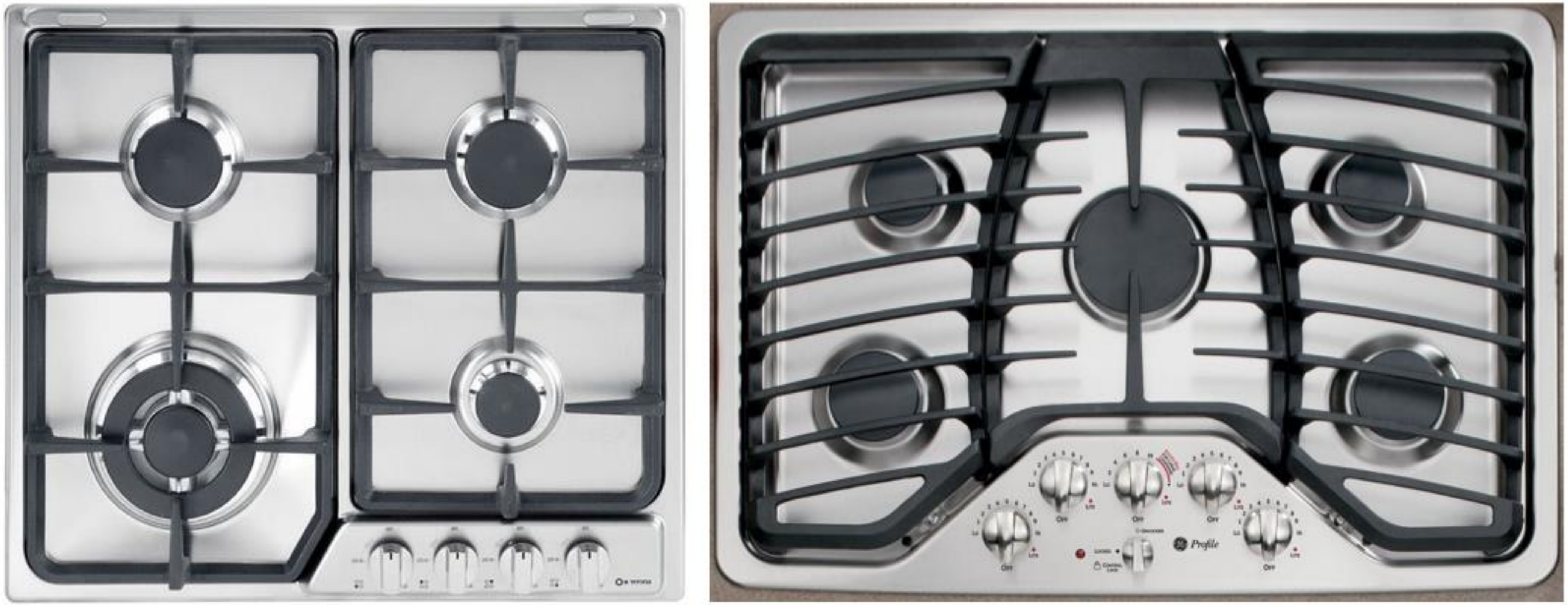
Mappings

- A mapping is a correspondence between an interface and the corresponding action in the world
- Effective (natural) mappings can minimize cognitive steps to transform an action into effect, or speed-up the process of transforming perception into comprehension
- Natural mappings can also reduce memory load



Seat controls in a Mercedes GLC

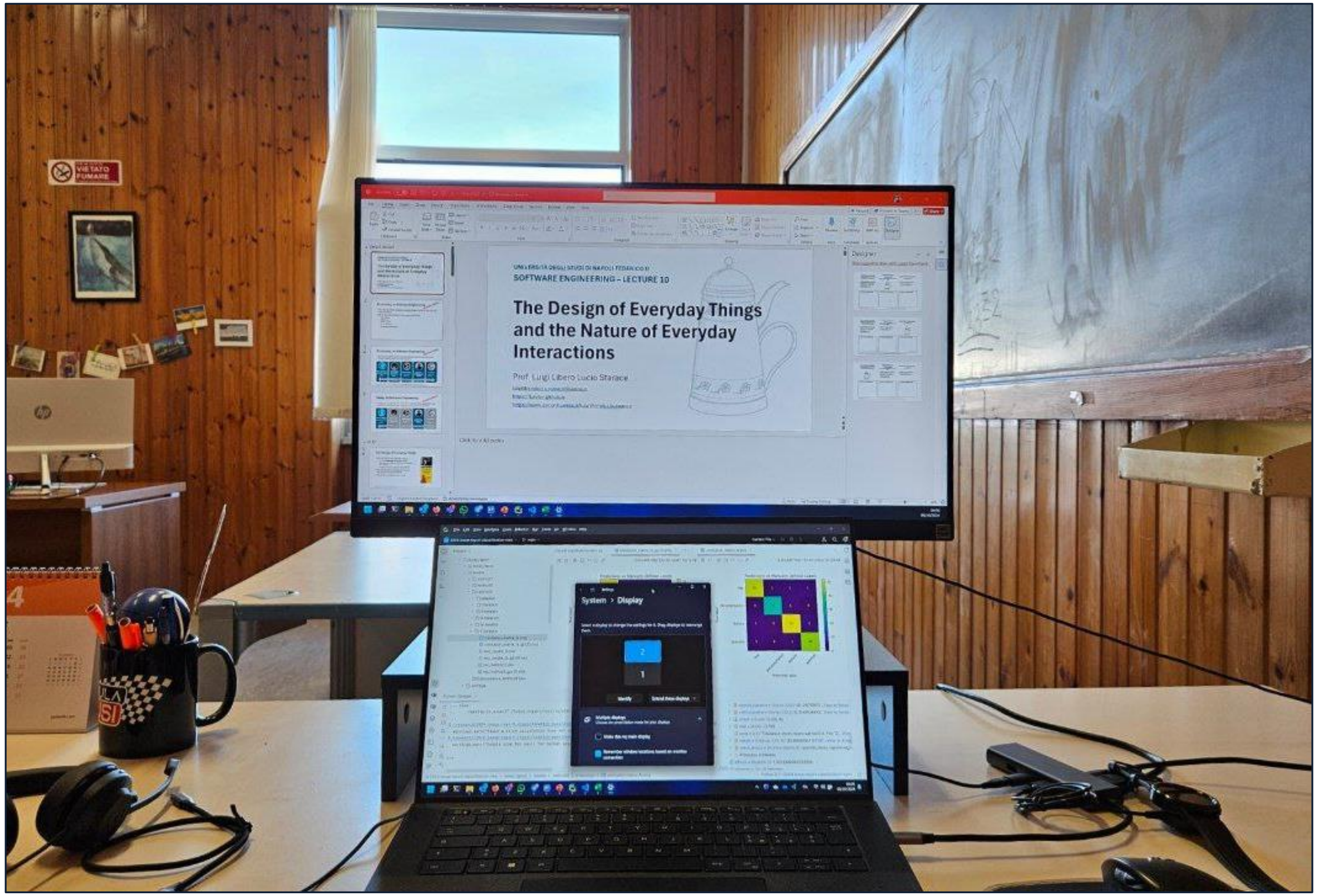
Mappings



https://www.nngroup.com/articles/natural-mappings/

Mappings

Mappings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SOFTWARE ENGINEERING – LECTURE 10
The Design of Everyday Things and the Nature of Everyday Interactions
Prof. Luigi Libero Lucio Starace
System > Display
2
1

Norman’s Guidelines for bridging the gulfs

- ***Visibility***. By looking, the user can tell the state of the device and the alternatives for action.
- ***A good conceptual model***. The designer provides a good conceptual model for the user, with consistency in the presentation of operations and results and a coherent, consistent system image.
- ***Good mappings***. It is possible to determine the relationships between actions and results, between the controls and their effects, and between the system state and what is visible.
- ***Feedback***. The user receives full and continuous feedback about the results of actions.

Features of Good Design

- Has **affordances** (makes operations visible)
- Offers obvious **mappings** (makes the relationship between the actual action of the device and the action of the user obvious)
- Provides **feedback** on the user’s action
- Provides a good **mental model** of the underlying behavior of the system
    - A mental model is the internal representation a user has of how a system or interface works.
    - A **good mental model** enables users to predict how the interface will behave and helps them interact effectively with it.
- Provides **constraints** (to prevent errors)