MONASH University

FIT3175 - Usability

Psychology of User Interaction

Week 2 Lecture P1

Copyright Warning

COVID-19 update

In response to new pandemic orders from the Victorian Government, all on-campus teaching will be moving online until Wednesday 26 January (Australia Day university holiday). A return to campus is planned for Thursday 27 January.

Check the Moodle **Class Streaming** page for Zoom links for your classes.

As always, keep up to date with Ed announcements and Monash COVID-19 news.

https://www.monash.edu/news/coronavirus-updates

Wishing everyone health and safety.

Learning objectives

The Design of Everyday Things

- The relationship between usability and psychology
- Don Norman and "everyday things"

Norman's Principles of Interaction Design

- Key principles
- Principles in-depth
- Examples

Understanding and modelling cognitive processes

- Knowledge in the head and knowledge in the world
- Norman's 7 Stages of Action
- Cognitive processes and memory

The Design of Everyday Things

Before we begin

Be aware that the word **"theory"** has multiple definitions!

General "theory" (n. singular): speculated and often unproven idea.

> ***"My uncle has a theory that there is life on other planets".***

Scientific "theory" (n. singular): substantiated and generally confirmed explanation.

> ***"Einstein's theory of relativity predicts that large objects bend spacetime".***

Scientific "theory" (n. collective): set of formal concepts relating to an area of study.

> ***"Number theory can be used to understand rational numbers."***

Usability theory

When studying how to design HCI many of the underlying principles originate from areas of scientific study.

Cognitive Science

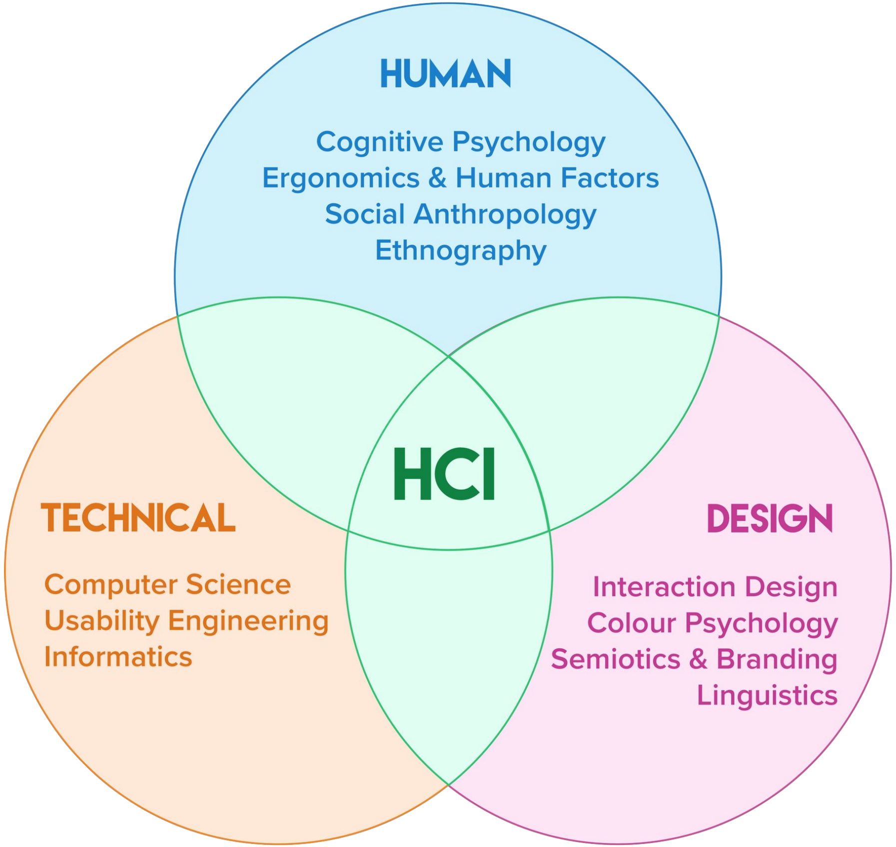
- Psychology

Human Factors

- Ergonomics

Computer Science

- Design and engineering



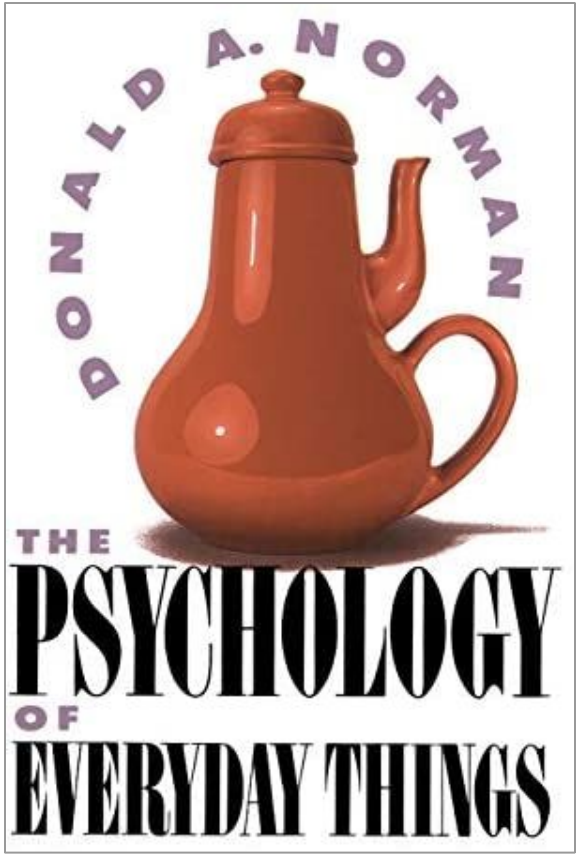
Don Norman

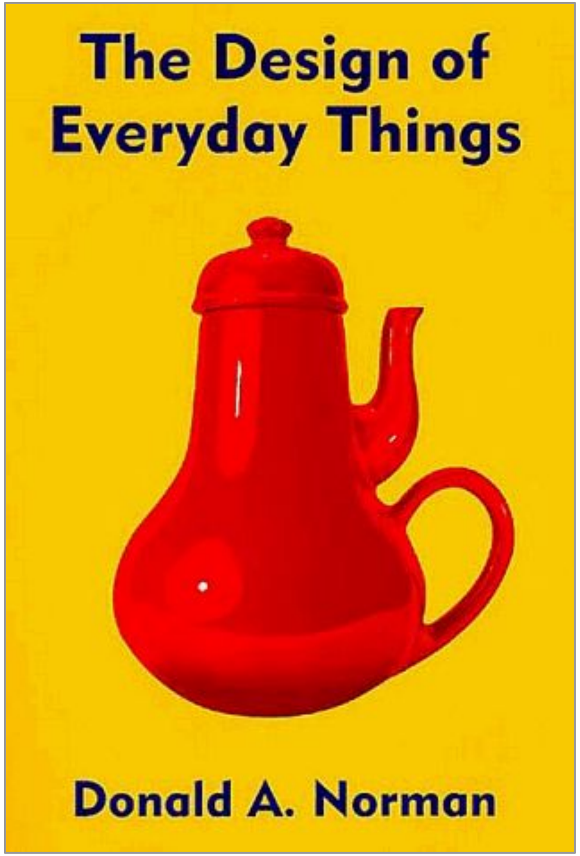
American researcher, professor, and author. Regarded for his expertise in design, usability engineering and cognitive science.

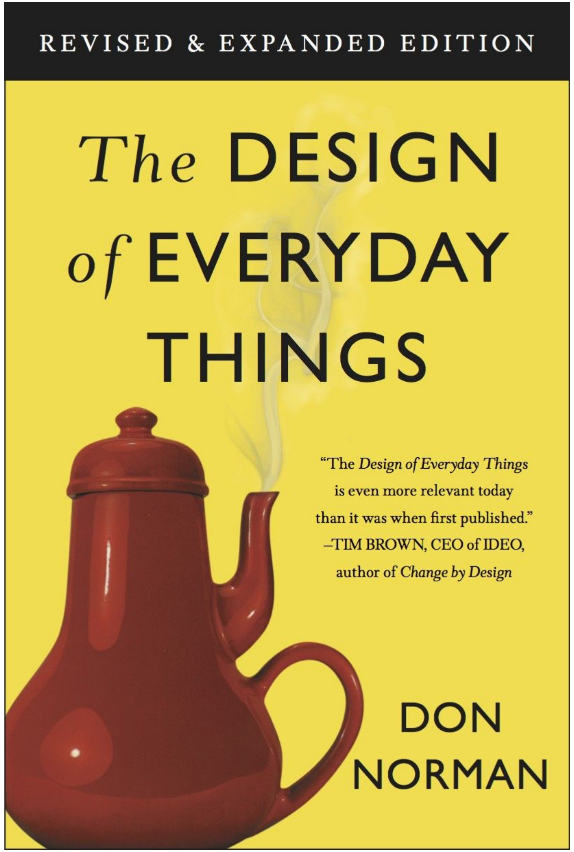
- Professor of Cognitive Science
- Usability Architect, Apple Computer
- Co-founder of Nielsen Norman Group

"When people praise my ideas it is nice to hear, but I don't learn anything. If people disagree, I learn." *- Don Norman*

The Design of Everyday Things







Think about this...

Have you ever encountered a door that was difficult to use?

How did it make you feel?

Norman doors

1. A door where the design tells you to do the opposite of what you're actually supposed to do.
2. A door that gives the wrong signal and needs a sign to correct it.

[It's not you. Bad doors are everywhere.]()

Can you recall any computer interfaces that that have made you feel this way?

https://www.reddit.com/r/WatchPeopleDieInside/comments/jwdya8/

What everyday things can teach us about interfaces

As "users" of the real world, the way we behave is shaped by what we know.

Your **mental model** of how the world works is...

- Shaped by what you observe
- Discovered by conducting experiments
- Validated or refuted by what you experience
- An accumulation of things you know

Our interactions with the world determine what they believe about how it works. The same is true of our interactions with computer interfaces.

https://www.vecteezy.com/vector-art/2242783

Interaction Design Principles

Norman's 7 Principles of Interaction Design

Don Norman proposes fundamental principles of interaction design that fundamental properties of the things we interact with.

- **Discoverability** of system state and available interactions
- **Affordance** of interaction, both real and perceived
- **Constraint** to limit perceived interactions actions to preferred interactions
- **Signifiers** to provide perceptible clues about an interaction
- **Feedback** that informs, validates and refutes an interaction
- **Natural mapping** of an interaction's cause and effect
- **Conceptual model** that is simple for users to understand

Discoverability

Also referred to as **"visibility"**. A user must be able to determine from examining an object what is and is not possible to do with it.

- Available controls and important information required for successful interaction must be **perceptible** by the user.
- Systems should clearly indicate their **status**, especially when the current state creates a context that alters which actions are preferable.
- Where status and controls are not perceptible, users' prior experience and knowledge **(mental model)** must be used to determine possible actions.

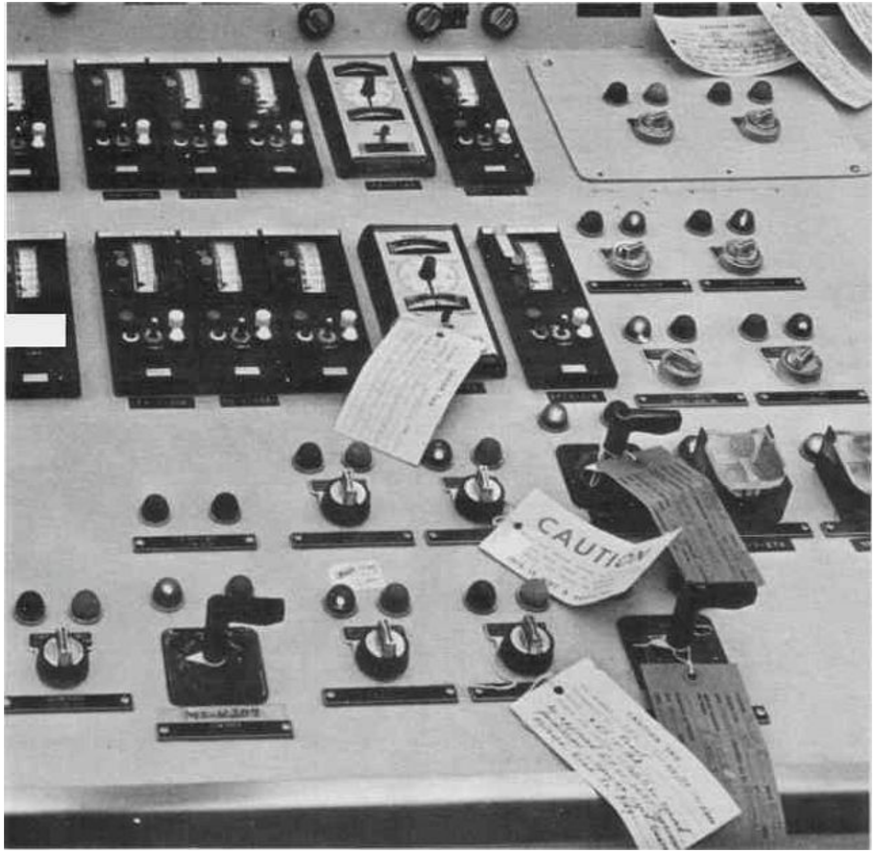
Things not easily seen are less likely to be used - especially in emergencies.

Discoverability: Emergency situations

In 1979, a cooling malfunction at Three Mile Island nuclear power plant caused part of the core to melt in the #2 reactor.

Right: *Control panel of TMI-2, showing maintenance tags that operators testified covered one of the closed emergency feedwater valve indicator lights during the first 8 minutes of the accident.*

Note that discoverability can decrease as the number of options increases.



https://commons.wikimedia.org/wiki/File:TMI-2_control_panel.png

Discoverability: Designing visible actions

A visible interaction makes use of users' senses of perception and prior knowledge.

Strive to design interfaces that:

- Clearly indicate current system status
- Clearly present possible and preferred actions
- Direct users' attention to important information
- Selectively hide show controls to balance visibility with complexity
    - Based on context
    - Based on relevance
    - Based on frequency of use
- Provide expectations for the consequences of actions

Affordances

Affordances are physical properties of an object that influence how it is used simply by being physically compatible with users.

Right: *The ergonomics of door hardware automatically guides users to the preferred action.*

The dimensions incorporated into the design improve compatibility with hands and certain actions.

Affordances: Intentional and unintentional

If an action is possible and easy for a user to perform, good affordance is present - regardless of whether the action is an intentional or unintentional part of the design.

What actions does this chair afford?

- Sitting on for comfort
- Standing for height and reach
- Leaning on support
- Folding up for storage
- Rocking on for boredom
- Lifting for **???**

Affordances: Real and perceived

Real affordances use physical compatibility to encourage actions.

What are the physical elements in the design shown to the right that are affordances?

Perceived affordances use virtual design cues to create the appearance of physical compatibility.

What perceived virtual elements are present in the design that suggest affordances?

Constraints

By limiting the actions or range of action that can be performed, users can be guided towards correct and preferred actions.

While constraint is a form of user restriction, when applied correctly they simplify interactions and minimise error

- Reduce reliance on user memory
- Reduce unnecessary interaction that would have not benefit
- Prevent creation of invalid states
- Reduce or prevent occurance of dangerous actions

Constraints can be **physical** limitations or **psychological** suggestions.

Constraints: Physical constraints

Physical constraints implemented in real-world objects redirect physical motion.

Paths and **axes** present a users with predefined linear movement range.

- May implement min/max limits
- May lock to specific steps/intervals

Barriers add friction to, or prevent, certain actions, but may be lenient to other actions

Barriers act as an opposite to affordance.

Constraints: Psychological constraints

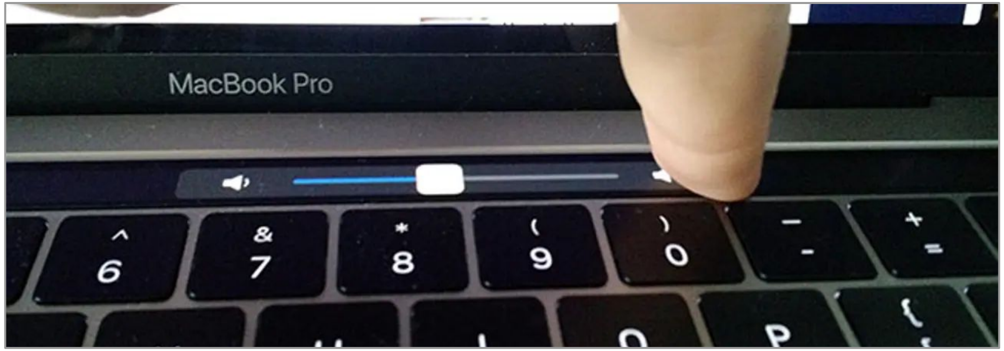
By applying psychological techniques, we help users decide which actions they want to attempt.

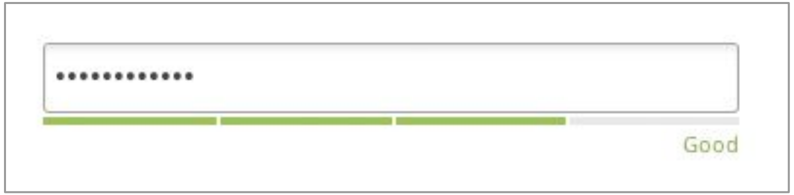
Semantic: Where meaning and context prevent undesirable outcome.

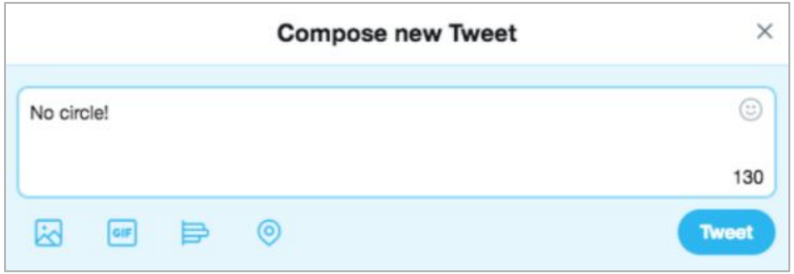
Logical: Where correct actions can be figured out.

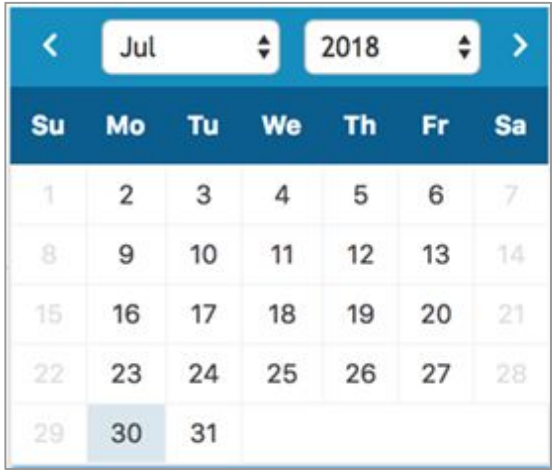
Cultural: Where learned behaviour and convention lead to acceptable actions.

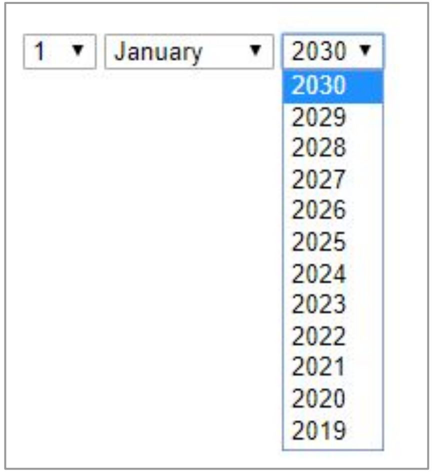
Constraints: Applied to user interfaces











Signifiers

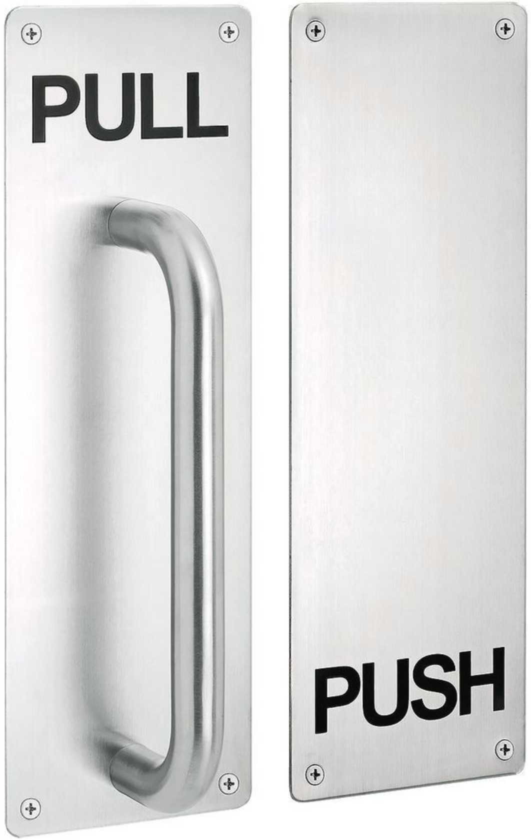
Signifiers are percepticle cues that provide information to users about status, potential actions and possible outcomes. **Signifers can make use of any available senses.**

Correct use of signifiers makes application of other principles easier to detect:

- **Discovery** by making actions easy to find and the effect more obvious.
  - A blinking light next to an area of interest.
- **Affordance** by making physical attributes easy to find.
  - A raised button that invites pressing and with label that says what it does.
- **Constraint** by making limits easy identify and employing psychology.
  - A warning sign or audible alarm.

Signifers can tell us about an interaction **before the interaction has occurred**.

Signifiers: Explicit and implicit

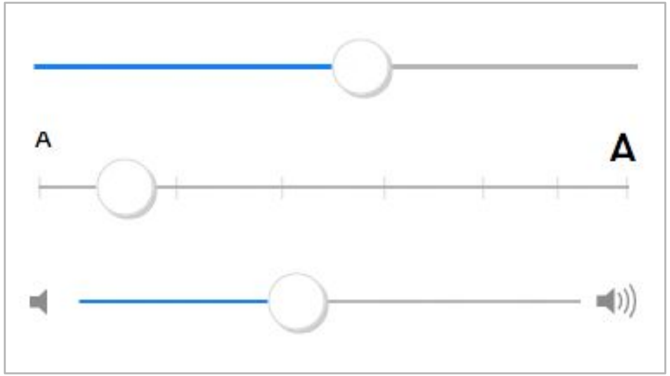


Signifiers... are perceived affordances?

Affordances define the physical actions that can be performed with objects.

Signifiers suggest possible actions in a way that can be perceived.

Signifiers create the perception of affordance!



Right top: *Physical switches and buttons have labels as signifiers. However, visible aspects of affordance also signal potential action.*

Right bottom: *In graphical user interfaces, the visual design of elements provides signals of potential affordance and constraints.*

Signifiers... can create misleading affordance

Design features can send strong signals or affordance when no action is possible.

Left top: *Pizza box with a decorative dotted line incorporated into the artwork design.*

Left bottom: *Late 2010's trend of using bright underlines for decorative text emphasis.*

Feedback

Feedback provides status update information to users about interactions that are in progress or have been completed.

Similar to signifiers, feedback can make use of any available senses that allow users to perceive the feedback.

- Visual changes and messages
- Audible sounds and messages
- Haptic touch feedback

Feedback should be tightly coupled to the relevant interaction.

Feedback... or signifer?

You tap on an app's icon and see the loading screen of the app.

You receive a new message and a notification appears on the screen.

You say "hey google" and your phone makes a chime sound.

A small red dot suddenly appears in the corner of an app icon.

You are typing and each keypress produces a slight vibration.

You press the power button and the screen turns off immediately.

Your phone is in your pocket and you feel it vibrate.

The icon of the back button points towards the left side of the screen.

Natural mappings

Mapping is the correspondence between an input and the effect/output it produces.

- Provided **before** interaction, mapping allows user to reliably predict outcomes.
- Provided **after** interaction, mapping reaffirms that the user caused the outcome.
- **Bad mappings** occur with low correspondence between action and outcome.

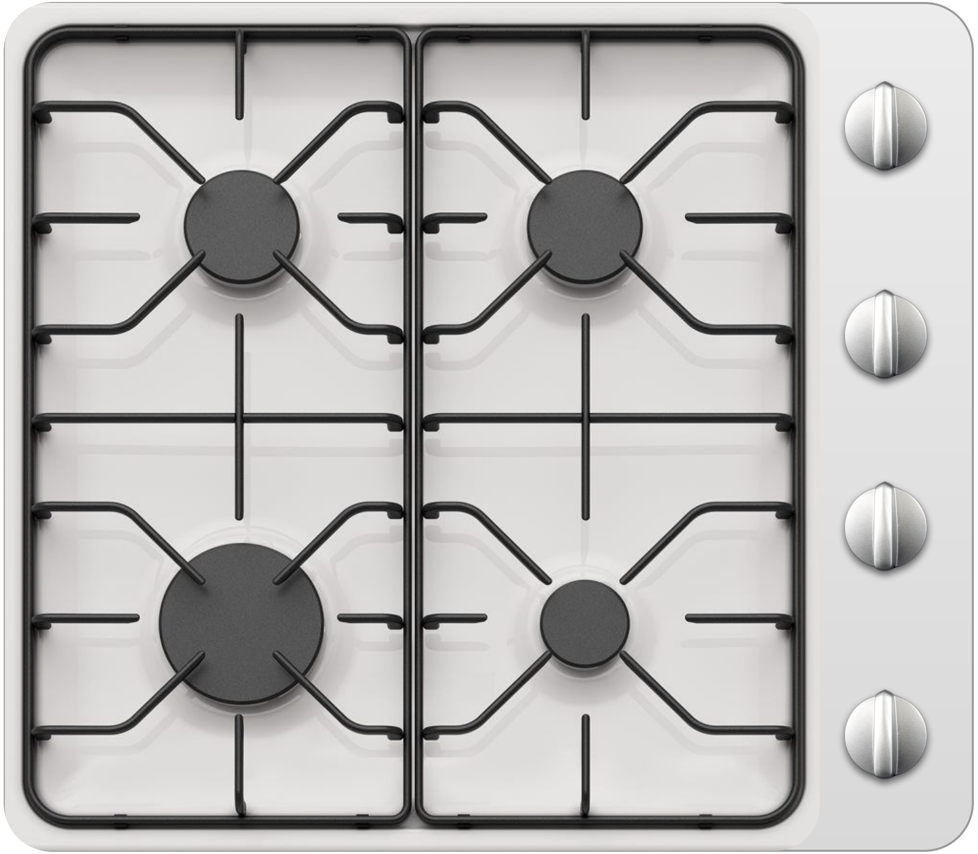
Spatial mapping

- Layout of controls corresponds to the things they control.
- The direction of the action corresponds to the direction of the result.

Temporal mapping

- The result of an action occurs immediately after the action is performed.

Spatial mapping: The "stove problem"



Consider the following fairly typical stovetop design. This arrangement of burners and knobs is found in many kitchens.

Which burner do you think each knob controls?

Why do most people prefer using the bottom-right burner?

Spatial mapping: Best-case scenario

A good spatial mapping makes the relationship between cause and effect as unambiguous as possible.

Norman states that the **best-case** scenario is when controls can incorporated directly into the things they control.

Right: *This stove top shows a perfect best-case spatial mapping.*

What is the problem with this design?

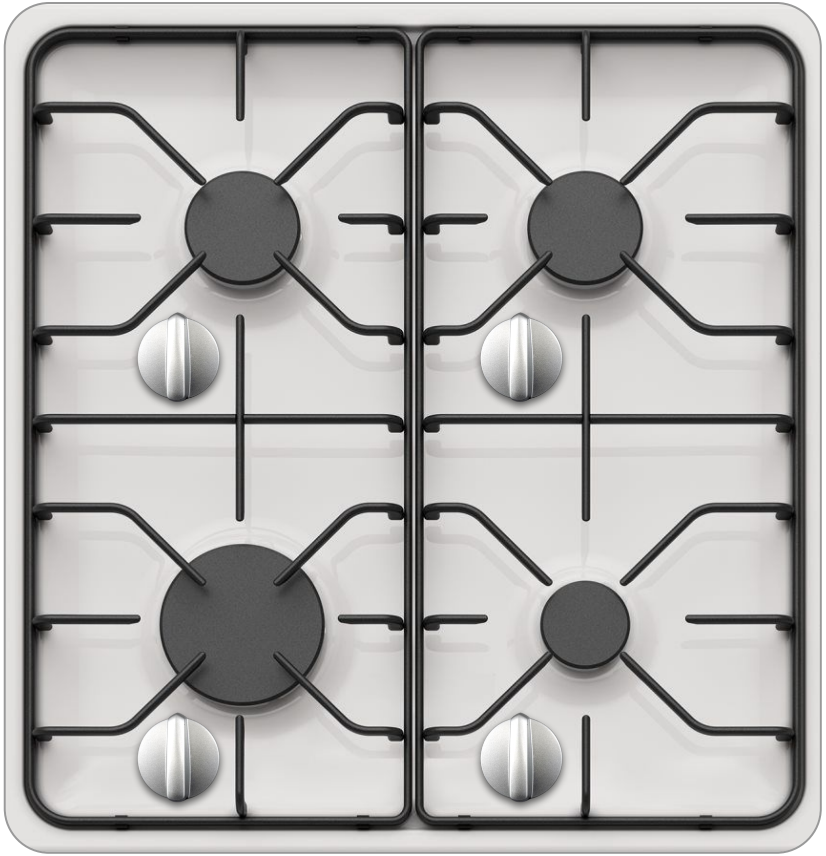
Spatial mapping: Second-best mapping

Where the best-case scenario is not practical, Norman defines a **second-best** mapping.

Controls can be placed immediately next to the things they control.

Right: *Even though the knobs have been relocated, they still retain the same spatial layout and good spatial proximity.*

Is this compromise a feasible design?

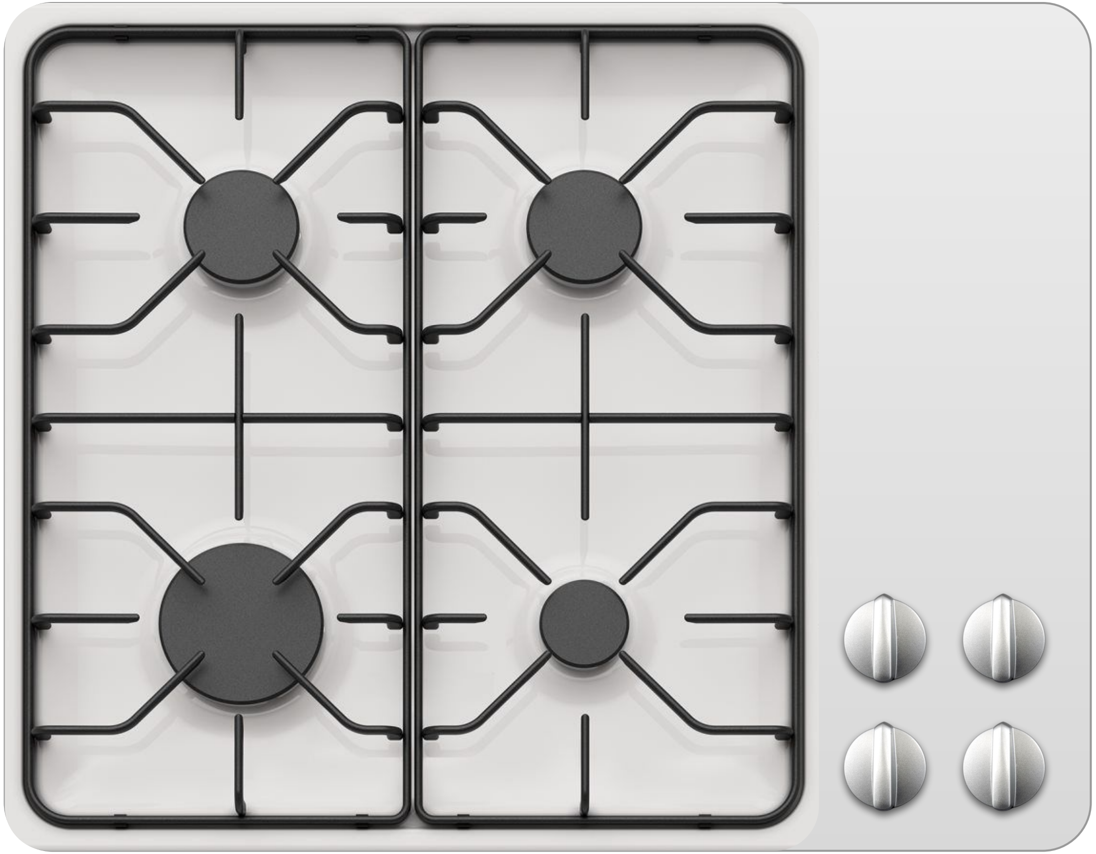


Spatial mapping: Third-best mapping

A **third-best** mapping scenario allows controls to be moved, as long as the spatial layout is unchanged.

Right: *Keeping the knobs in the same layout allows users to easily figure out what each one controls.*

What are some other solutions to this problem?



Conceptual model

Norman specifically notes that the **conceptual model** of a design should be consistent with the user's **mental model**.

But what is a conceptual model?

- A mental representation of how an object or system is intended to work.
    - Highly based in the designer's understanding of the design.
    - Something a new user may need to learn.
    - Something a user tests through experience.
- A conceptual model that is **familiar** requires less learning from the user
- A conceptual model that is **compelling** creates engaging experiences that are quick and enjoyable to learn from.

Conceptual model: Communicating the model

A good conceptual model can leverage a user's prior knowledge and experiences - their **mental model** - to make interactions feel familiar and engaging.

Consider how you would explain a design to a new user to provide them with an immediate understanding.

Conceptual model: Updating mental models

Think about the ways you form expectations about things before you begin using them - **what do you do?**

- Read specifications
- Read documentation
- Consider other people's experiences
- Watch review videos
- Watch instructional videos
- Compare against similar things

As you do this, your mental model grows. Features become slightly more visible. Signifiers become more meaningful. Conceptual models make more sense.

Conceptual model: Benefits of consistency

Learnability of new experiences improves when the meet our existing expectations.

- We expect things with similar designs to behave in similar ways.
- As we interact with a design, we build a **mental model** of how it works.
- Consistency allows **transfer of knowledge** from existing mental models to fit a new contexts.

Right: *Consistency in worldwide signage.*

Modelling the Cognitive Process

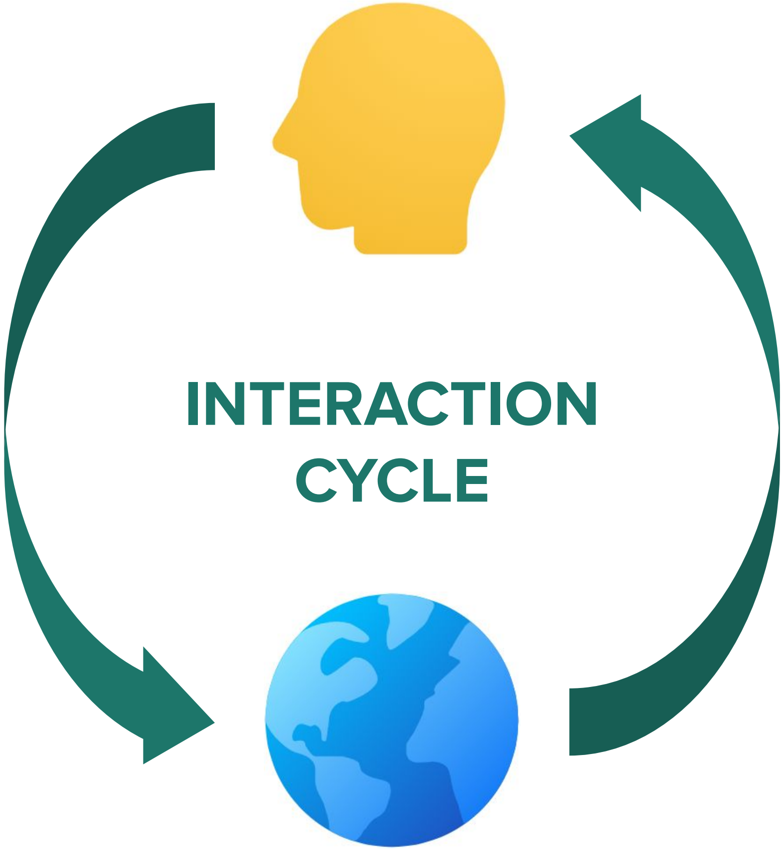
Knowledge in the head vs knowledge in the world

This describes where the sum of information required for interaction originates from.

Knowledge in the head	Knowledge in the world
Learned discoverability	Perceptible discoverability
Psychological constraints	Affordances
Meaning of signifiers	Physical constraints
Meaning of feedback	Signifers
Conceptual model	Feedback
Mental model (inherited from the world)	Mappings

Designs that apply **knowledge in the world** requires less conscious learning to use.

Human cognition: The user vs. the world

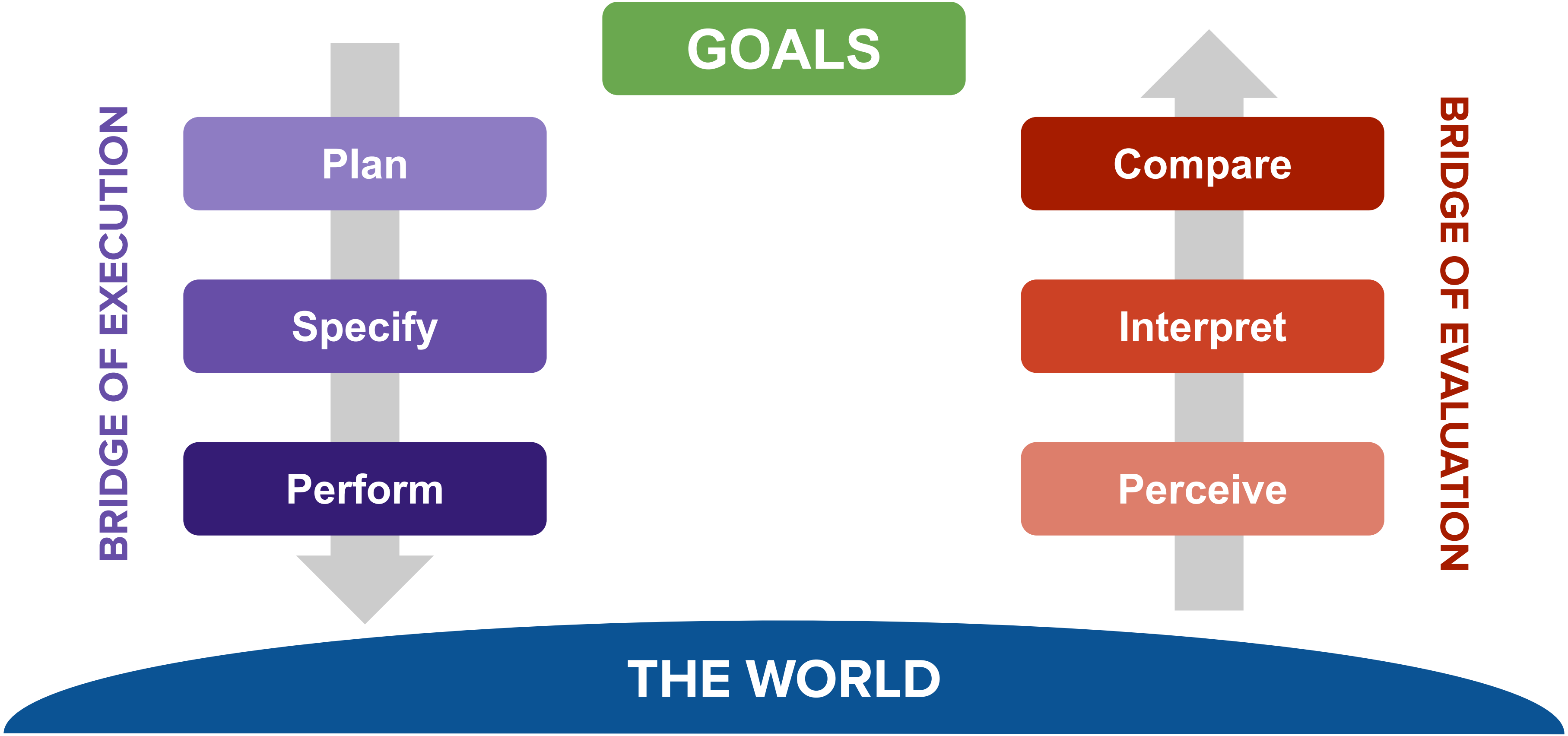


Interaction is a cognitive process where a user make use of both knowledge in the head and word.

- We observe the world to determine what actions are possible.
- We plan and execute actions
- We observe the world to see what changes our actions produced

Understanding the process allows us to troubleshoot interaction design issues.

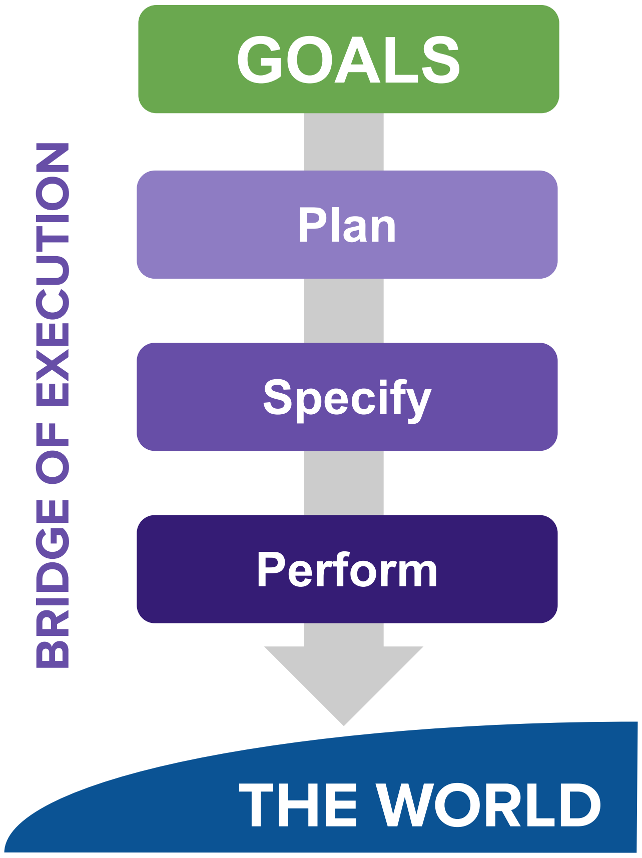
Norman's 7 Stages of Action



Bridge of execution

We can bridge gaps between goals and the world.

1. **Goals: Form a goal, a desired outcome**
   "I've written an email, now I want to send it".
2. **Plan: Choose from the possible actions**
   "Click on the send button"
3. **Specify: Construct an action sequence**
   "Move the mouse to the button, click it"
4. **Perform: Attempt to execute the actions**



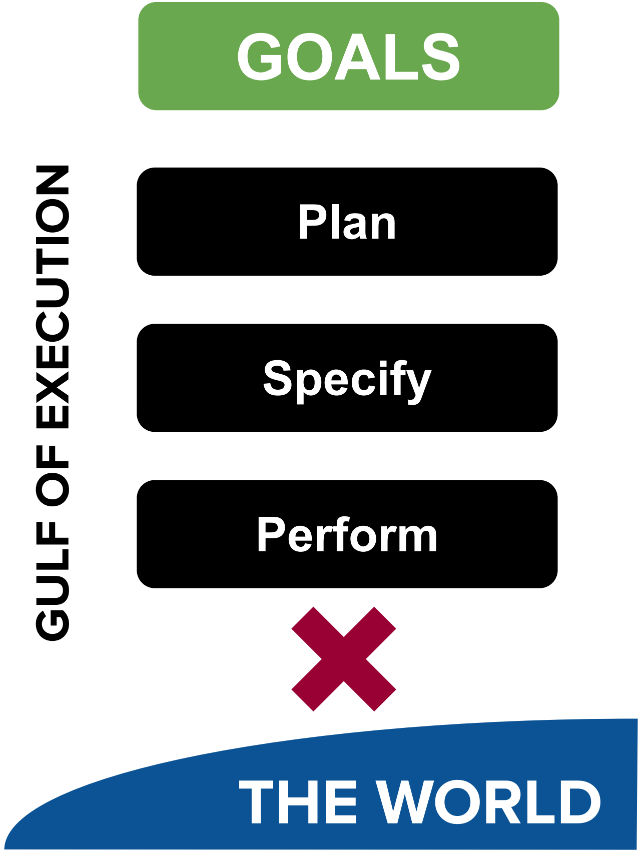
Gulf of execution

Users encounter gulfs of execution whenever they try to figure out how something operates.

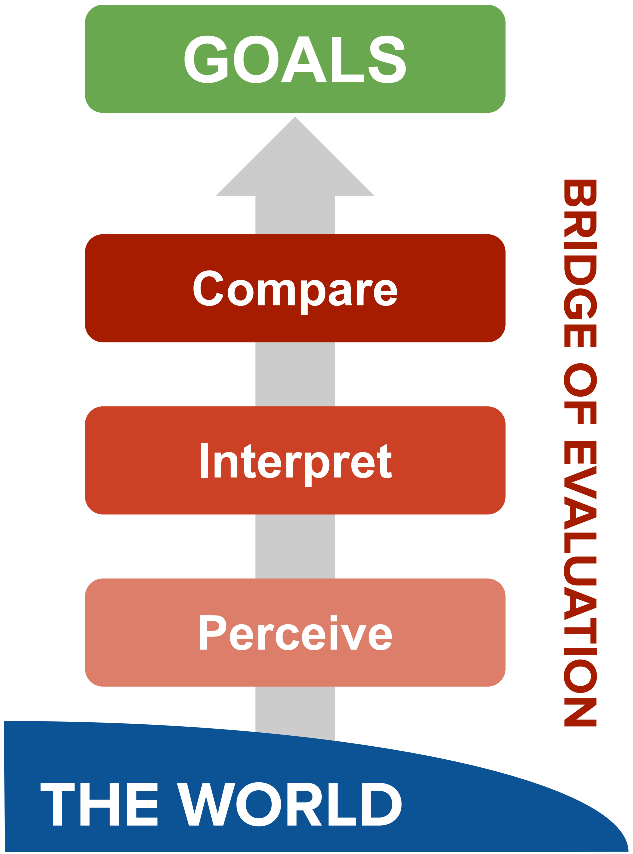
> ***"I can't find any way to send the email"***
>
> ***"The send button looks like its disabled"***
>
> ***"The send button small and hard to click"***

The gulfs can be both major and minor, conscious or subconscious.

If the gulf cannot be bridged, the cycle breaks.



Bridge of evaluation



4. **Goals: Establish the next goal**

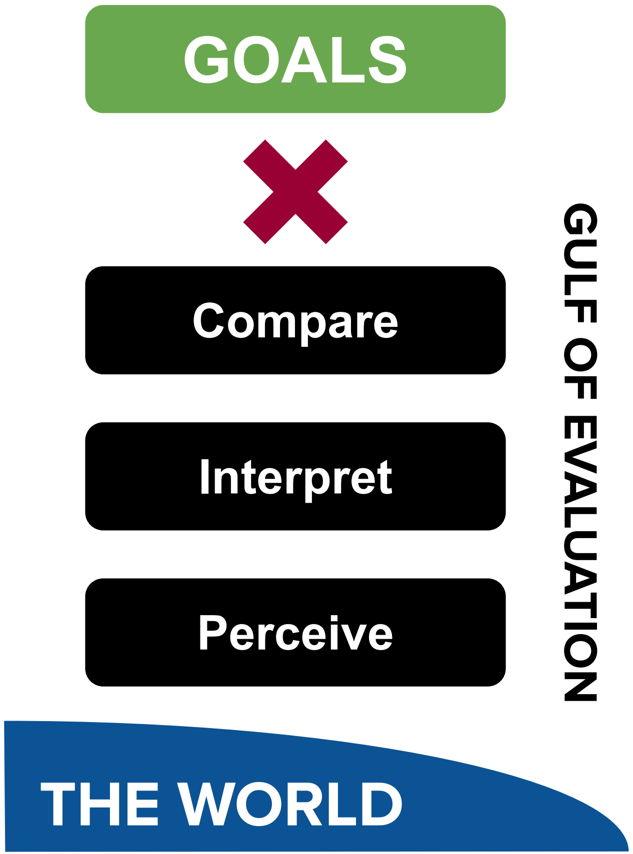
3. **Compare: Did the outcome match the goal?**
   "I think that worked!"

2. **Interpret: Make sense of the perception**
   "Gmail says has the message has been sent"

1. **Perceive: What happened in the world?**
   "Did anything change after I clicked?"

We can also bridge the gap of evaluation.

Gulf of evaluation



Users encounter gulfs of evaluation whenever they try to figure out what happens after an interaction.

"I received an error message instead"

"Something unexpected changed"

"I moved my mouse by nothing happened"

To resolve these problems a user may need to establish a new goal or choose a different action.

If the gulf cannot be bridged, the cycle breaks.

Cognitive Process

When users interact with a system/product it involves a number of cognitive processes

Cognitive processes include:

- **Perception** - processing sensory input as stimuli
- **Attention** - choosing and concentrating on relevant stimuli
- **Recognition** - matching stimuli to information in memory
- **Memory** - encoding, storing and retrieving information
- **Learning** - Understanding and connecting information
- **Reflection** - Reasoning and problem solving

Memory

Sensory memory

- Very short (about milliseconds) - information is forgotten almost immediately
- Can be transferred to short-term memory using conscious attention.

Short-term (or working) memory

- Holds a small amount of information for a short period of time
- Used when learning new things
- Can be transferred to long-term memory via repetition.

Long-term memory

- Storage of past experiences and knowledge
- These memories form out mental models of how things work.

Cognitive Load

Cognitive load is the amount of effort being used to perform a task. For example, requiring effort in any of the different types of cognitive process:

- **Perception** - Requiring users to notice nearly imperceptible feedback.
- **Attention** - Cluttering a design with many different interface elements.
- **Recognition** - Implementing signifiers that don't align with mental models.
- **Memory** - Requiring information to be re-entered unnecessarily.
- **Learning** - Expecting users to be experts at things they do infrequently.
- **Reflection** - Not providing time for users to think about the interactions.

External cognition

Cognitive load can be minimised by implementing **external representations and aids** that augment a human's normal internal cognitive processes.

Externalising

- Transforming knowledge into external representations
- e.g. making a shopping list, using a calendar or diary

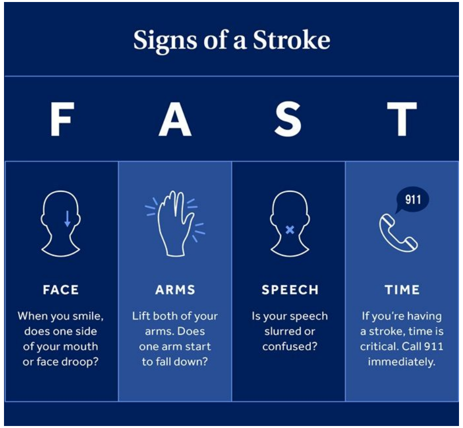
Computational offloading

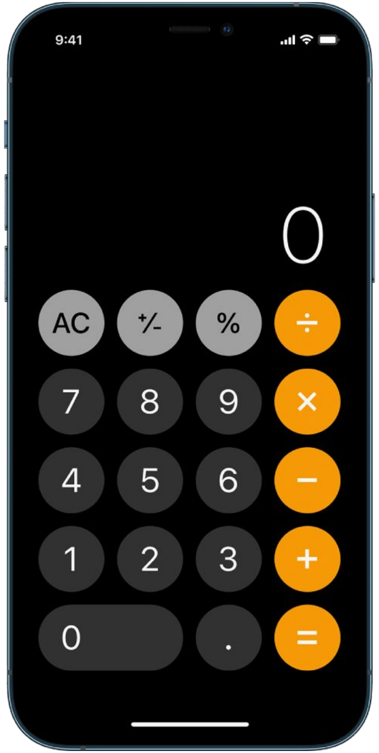
- Using tools for cognitive problem solving - e.g. a calculator

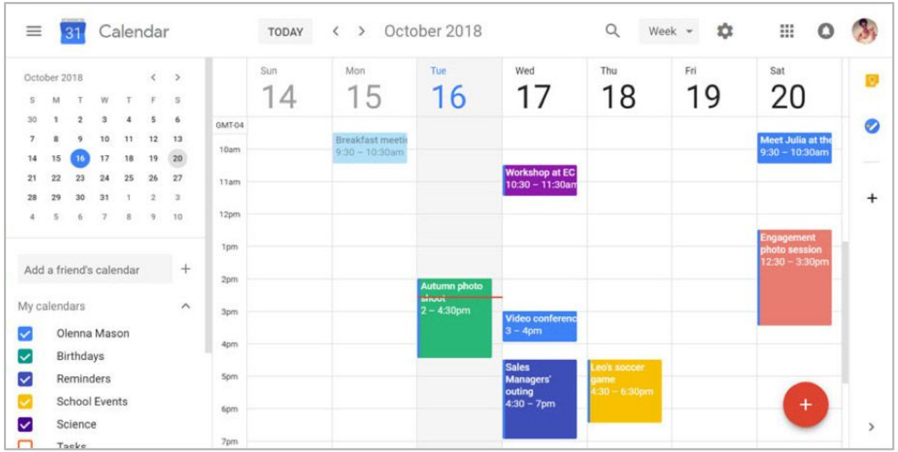
Annotating and cognitive tracing

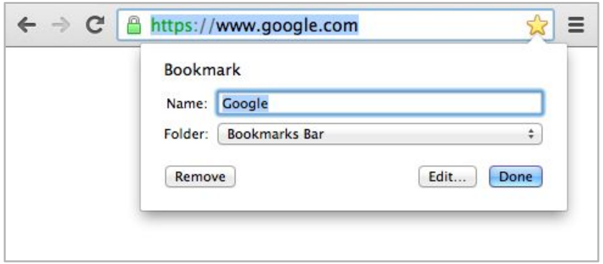
- Annotating - modifying information representation - e.g. underlining words
- Cognitive tracing - restructuring information - e.g. sorting a list of items

Examples of external representations and aids









Interfaces that we design should aim to reduce cognitive effort - **not increase it!**

"Whenever you see hand-lettered signs pasted on doors, switches, or products, trying to explain how to work them, what to do and what not to do, you are also looking at poor design."

- *Don Norman*

The 3 Ways Good Design Makes You Happy (2009)

TED

"Ideas worth spreading"

http://www.ted.com

In this talk from 2003, design critic Don Norman turns his incisive eye toward beauty, fun, pleasure and emotion, as he looks at design that makes people happy. He names the three emotional cues that a well-designed product must hit to succeed.

https://www.youtube.com/watch?v=RlQEoJaLQRA

Next session

- User interfaces and 8 Golden Rules
- Storyboards, journey maps and low-fidelity prototyping

Reminders

- **Stage A submission this week (Due Fri 14 January)**
  - Upload to be completed by 1 group member.
- **Stage B submission next week (Due Tue 18 January)**
  - Individual task - each group member uploads a submission