Designing Interactive Systems I

Gestalt Laws, Information Content, Visibility, Affordances and Signifiers

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

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Review

- What are the four big areas of HCI?
- What are the main components of the CMN Model?
- What are the key numbers from the CMN Model?
- What is Fitts' Law?

User Errors Are Design Errors

- A Big Message of DIS1
- We tend to blame users for mistakes
- But usually it’s the product/user interface design that is to blame
- Computers are nothing special—they have many of the same problems as everyday things (and others because of their flexibility)

In-class Exercise: Your First Design

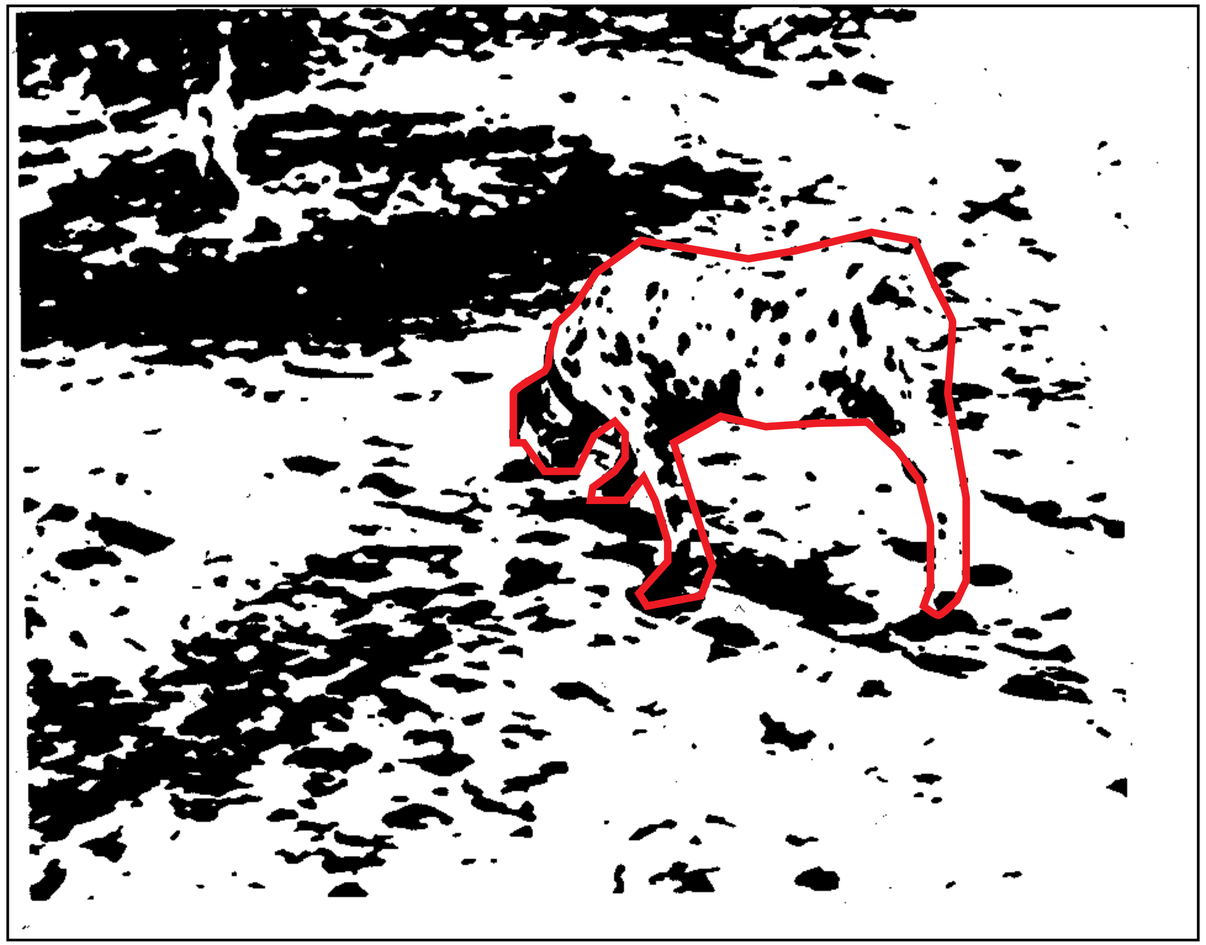
- Sketch a universal remote control for radio, TV, and DVD player
- You have five minutes.

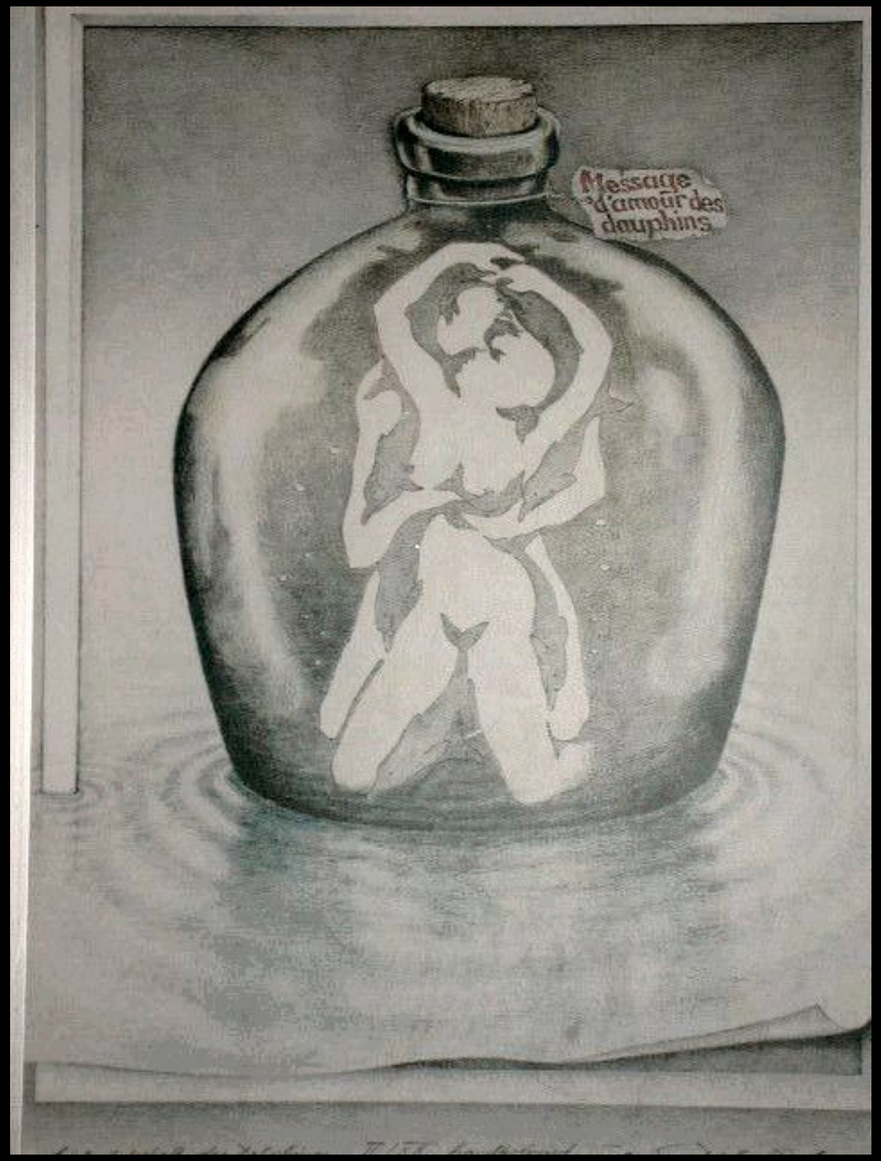
  Get set, ready, go!

Gestalt Laws

In-class Exercise

Our brains are wired to make sense of what we perceive.



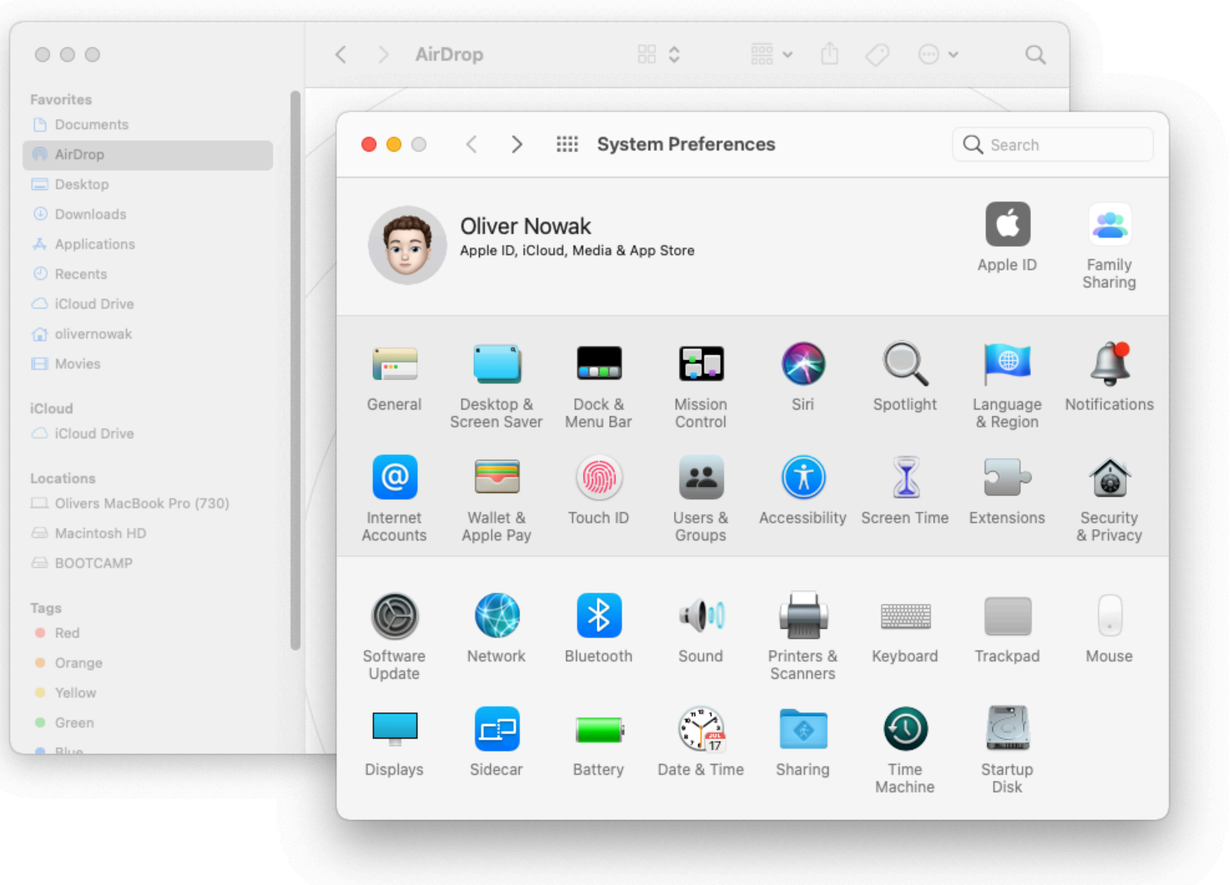


Gestalt Theory

- Köhler, Koffka, Wertheimer (Berliner Schule): *“Gestaltpsychologie”, 1912*
- What do humans perceive as a **group** spatially (or temporally)?
- Basis of order in perception, movement, memory, thinking, learning, and acting
- Overall 100+ Gestalt laws

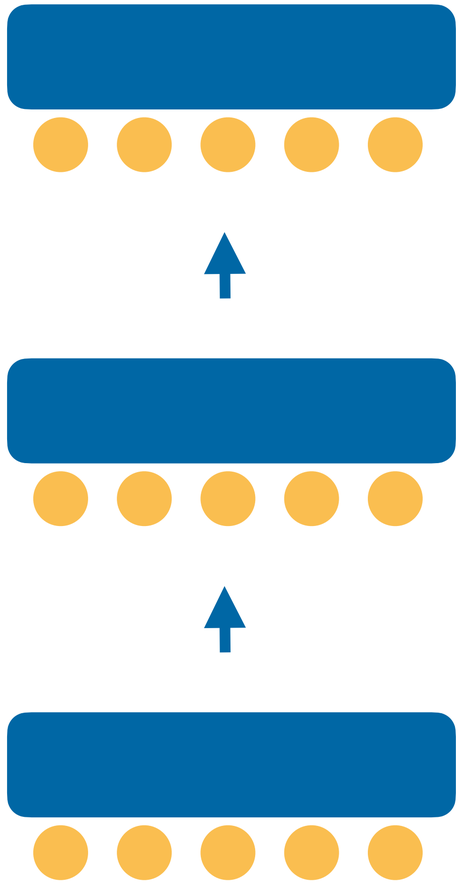
Why Should I Care?

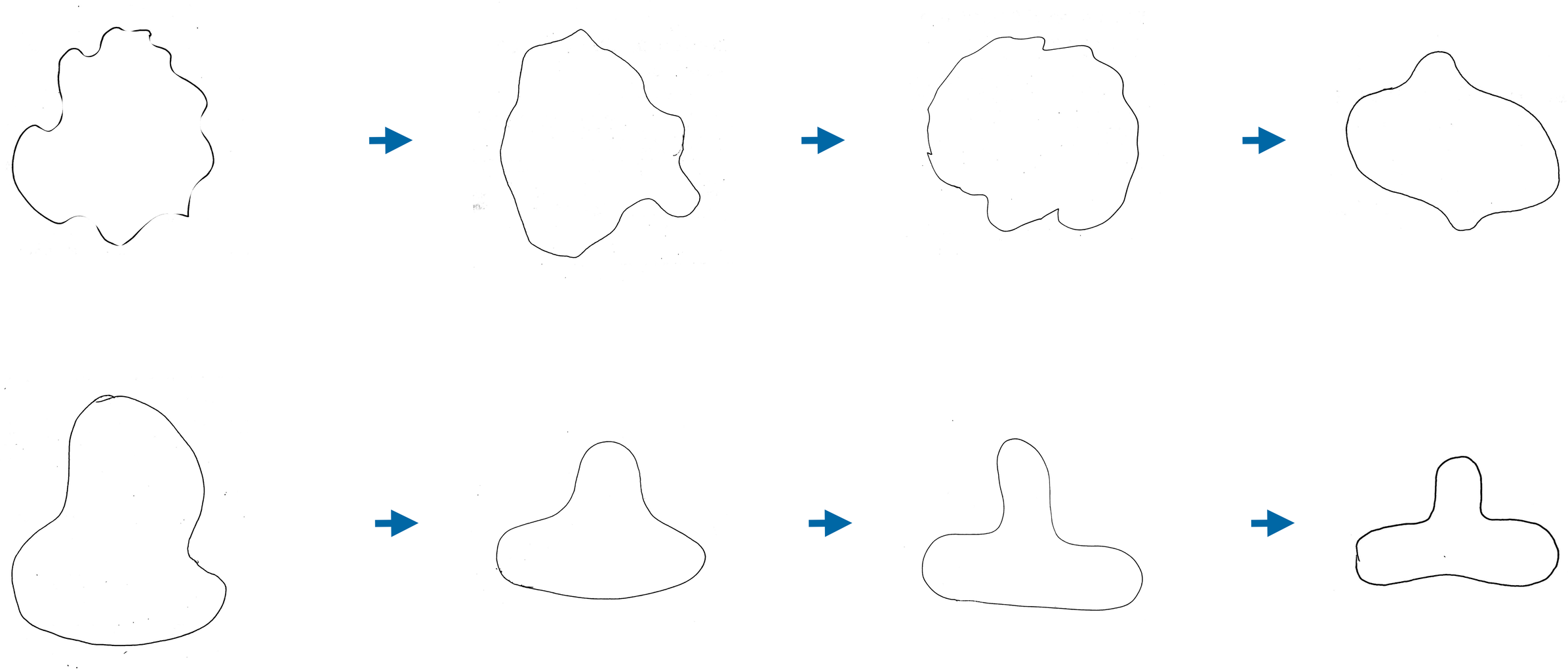
- Simple rules for visual (and auditory) UI design
- Hints how users will react to spatial and temporal order
- Good UIs respect and use Gestalt laws for understandability and intuitiveness



In-class Exercise

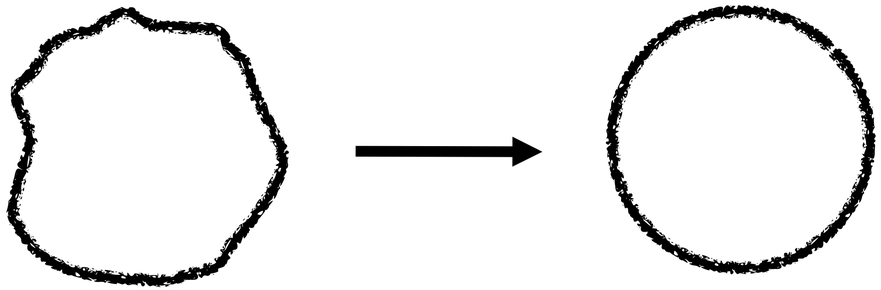
- Take out an empty sheet of paper and a pen
- We will show everyone in the last row a shape on a sheet of paper for a second
- Those students will draw the shape and show it to the row in front of them for a quick second
- And so on … :)



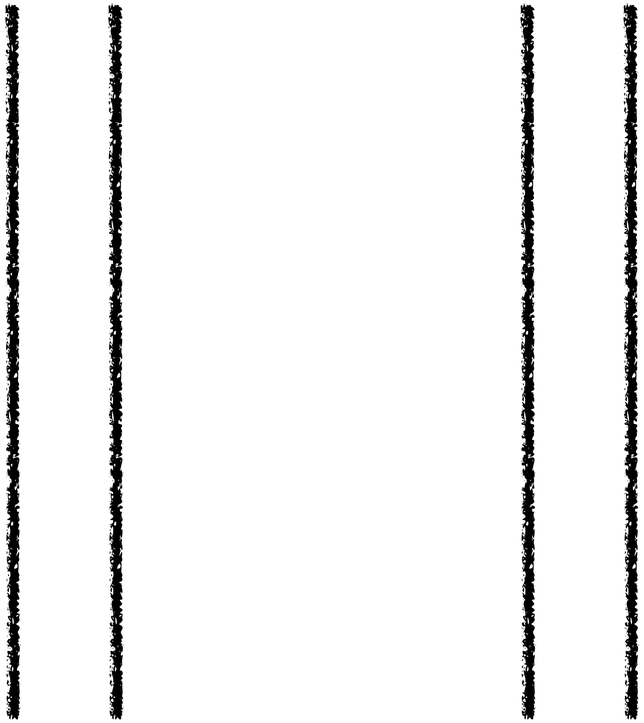


Law 1: Good Shape

- Perception has tendency towards remembering things as “good” / clear / simple shapes
- “Cognitive compression algorithm”!
- Easier shape ⇒ easier to remember

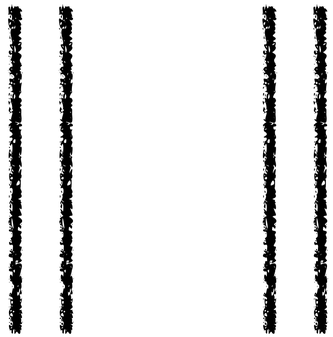


In-class Exercise: Gestalt Laws



Law 2: Proximity

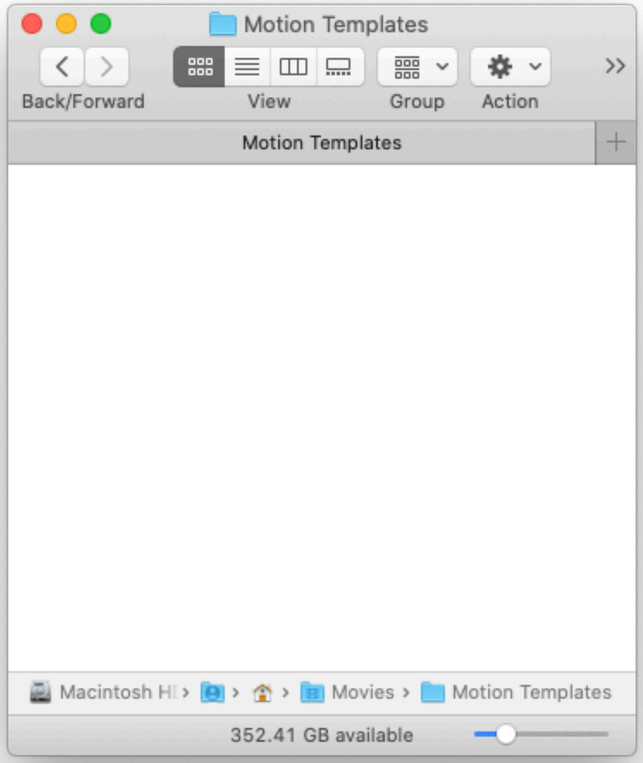
- Objects near each other are perceived as a group
- Advantage: allows for order by position only, without other aides
- Helps you keep your interface simple

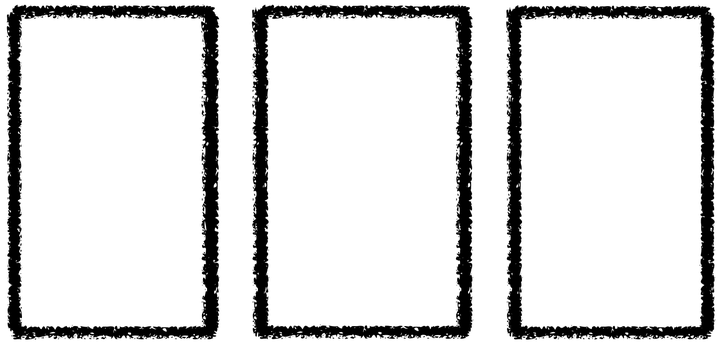


Law 3: Closure

- Closed lines appear as shapes, and thus as belonging together

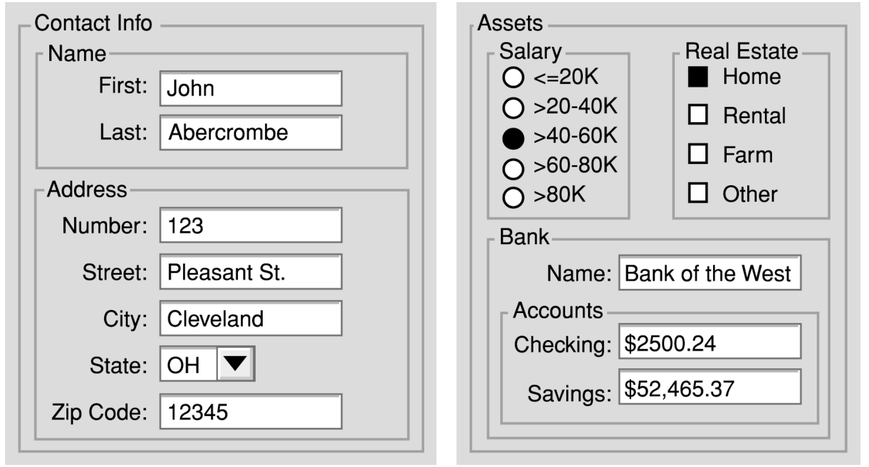
- Foundation of window metaphor



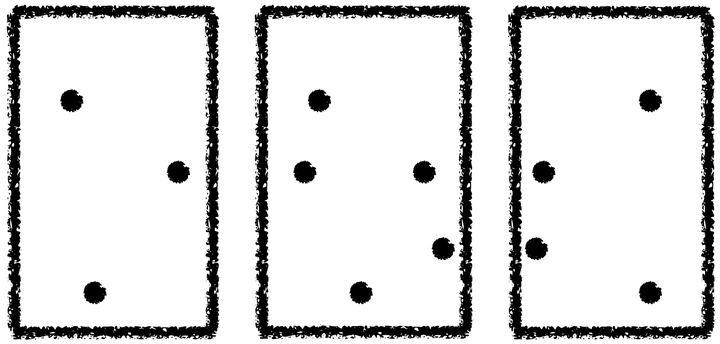


Law 4: Common Region

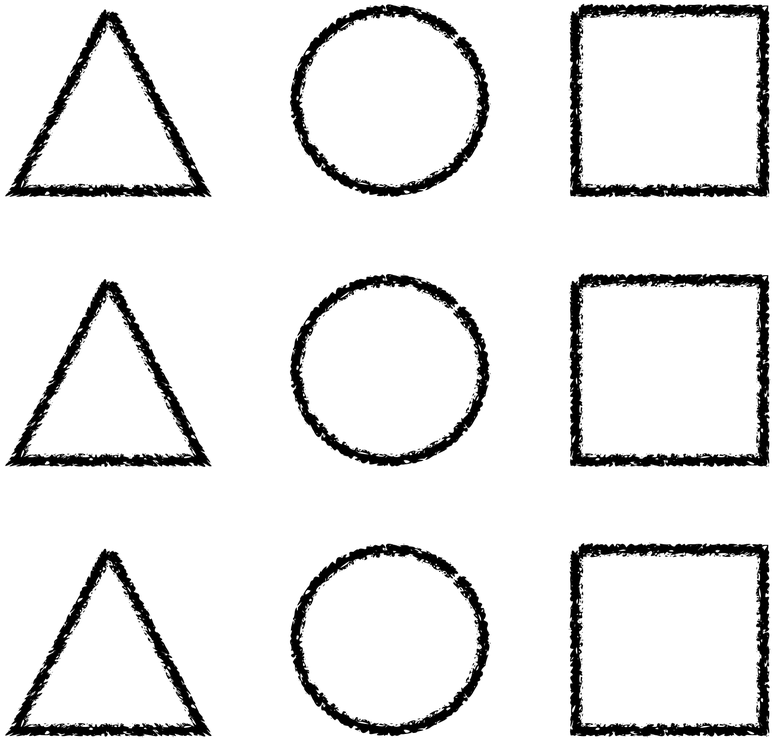
- Objects in a bounded area or region appear as belonging together
- Also basic element of window metaphor
- But: Don’t overdo it



Too many boxes
(from Johnson: *GUI Bloopers*)

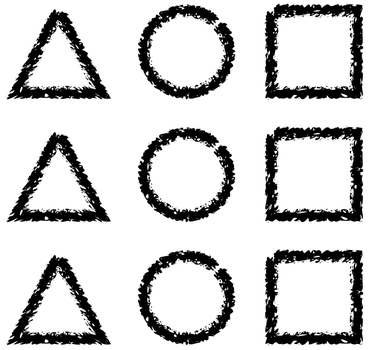


In-class Exercise: Gestalt Laws



Law 5: Similarity

- Similar shapes appear as belonging together
- Different objects have higher information content (i.e., cognitive effort)
  - This can be a good thing or a bad thing
- **Similar** is not necessarily **constant**
  - Linearity, “elegant curve”,…



Bad button design in xrn

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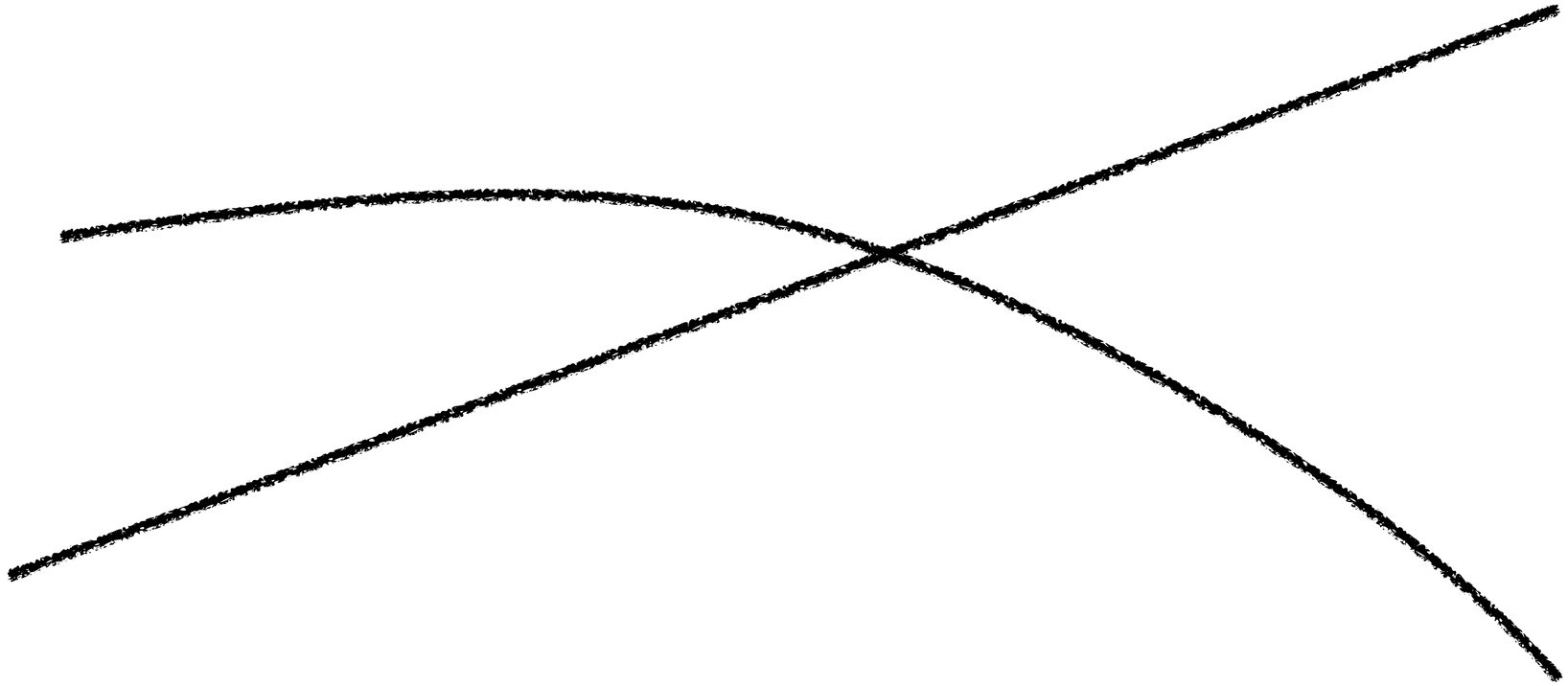
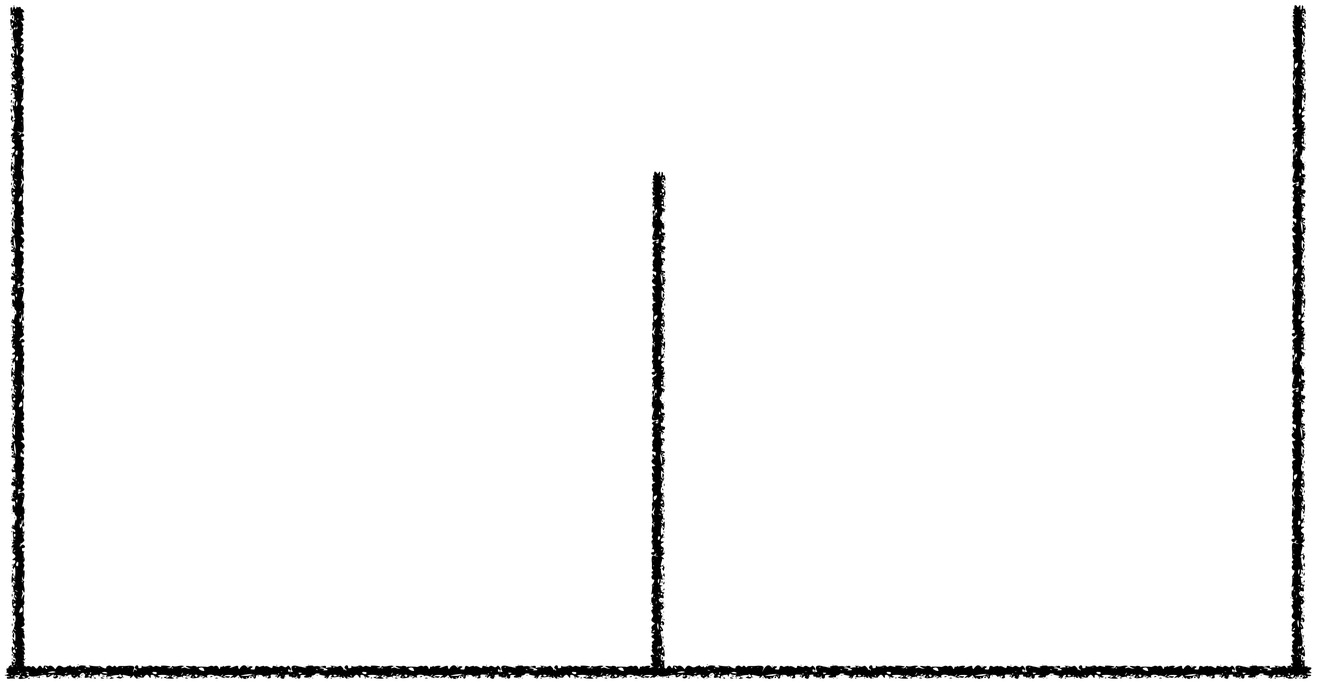
In-class Exercise: Gestalt Laws



Law 6: Continuity

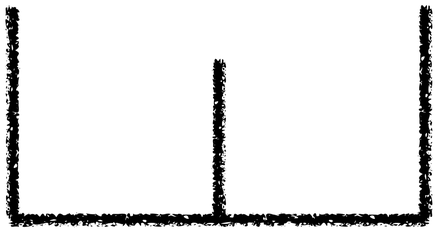
- A.k.a. “Law of the Good Curve”
- Continuous shapes appear as belonging together

In-class Exercise: Gestalt Laws

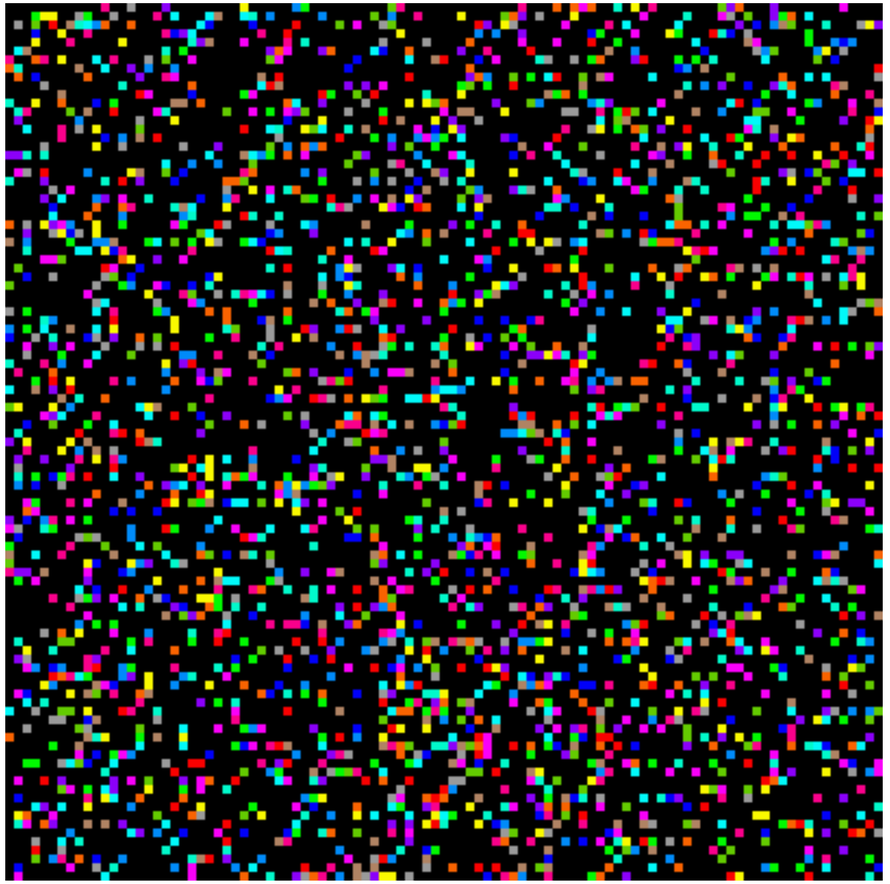


Law 7: Experience

- We tend to “file” new things into categories we already know
- Uses existing knowledge, thereby saving learning effort and memory
- Foundation for the success of metaphors in UI design
  - Analog to real-world models
  - E.g., desktop metaphor

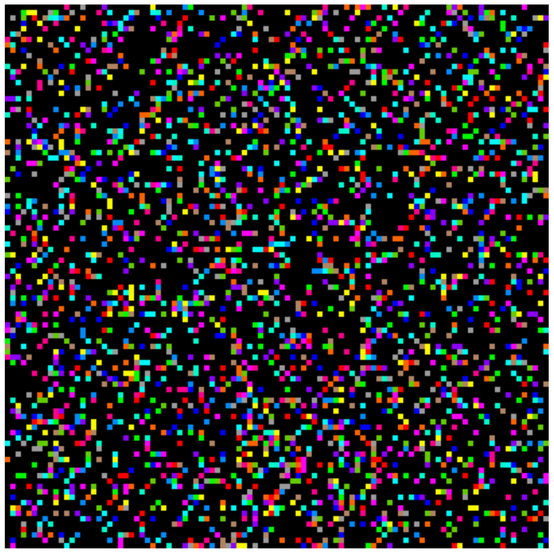


In-class Exercise: Gestalt Laws

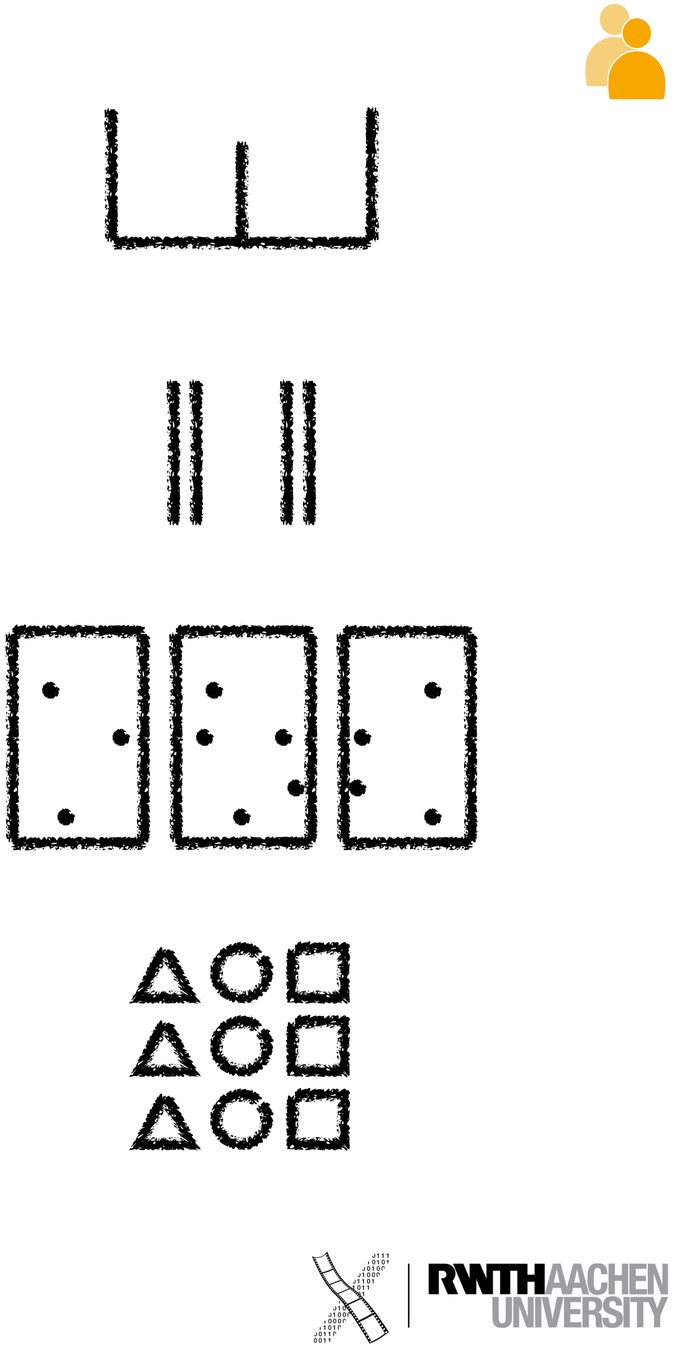


Law 7: Common Fate

- A.k.a. “Law of Common Movement”
- Animated objects within a static environment appear as a group
- By-Law: Animation has a very strong effect in UI design
  - Here: Synchronous animation groups the items



Blinking text is perceived as a group



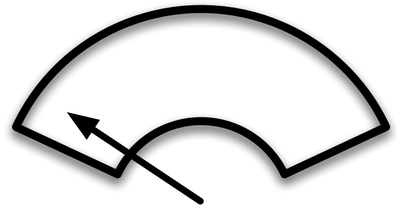
Information Content

Information Content in UIs

- Basic unit of information: **bit**
- Toggle button:
  - 2 states: ☐ ☑ ⇒ $\log_2(2) = 1$ bit
- Single digit:
  - 10 states: 0…9 ⇒ $\log_2(10) \approx 3.3$ bits
- Single letter, upper- and lowercase, U.S.:
  - 52 states: a…z | A…Z ⇒ $\log_2(52) \approx 5.7$ bits

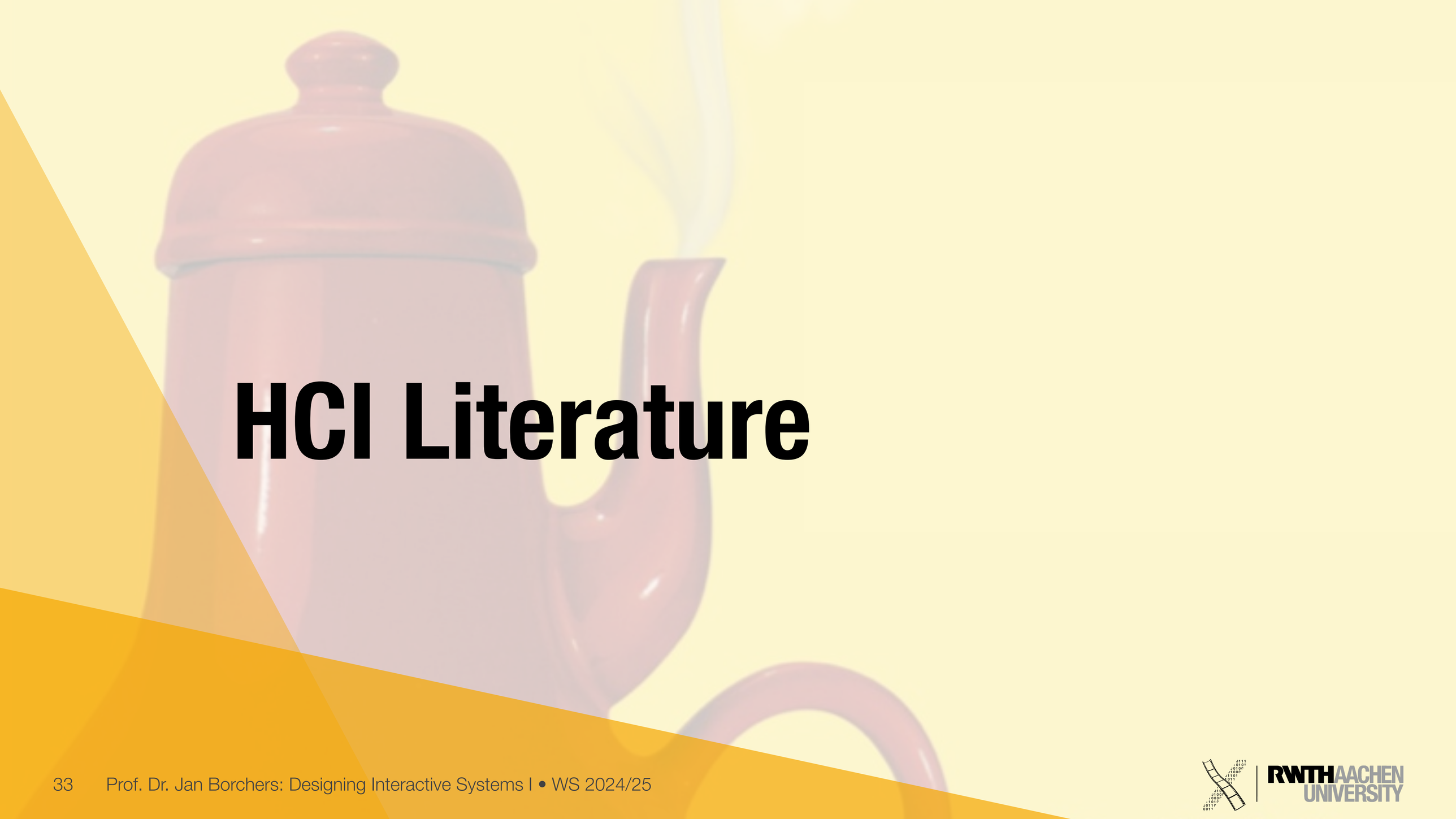
Information Content in UIs

- Analog scales (reading = estimate)
  - Unmarked scale (experiment)
    - 3 bits (8 different positions differentiable)
  - Audio pitch, volume, salt content
    - Pitch 2.5 bits (But: with perfect pitch 5–6 bits)
    - Volume 2 bits
    - Saltiness 1.8 bits



Analog or Digital?

- Example: speedometer in the car
- Analog displays (scales, …)
  - Quick estimate possible, range limits visible
  - Easy to detect trends
  - But: reading time increases linearly with number of significant digits
- Digital displays (digits, …)
  - Reading time ~ constant up to 3–4 digits
  - But: hard to estimate quickly, trends hard to detect, limits invisible without external labeling



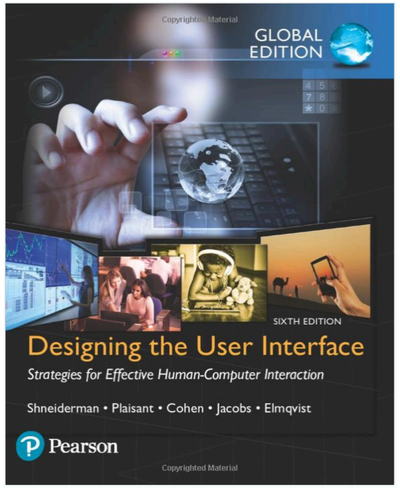
HCI Literature

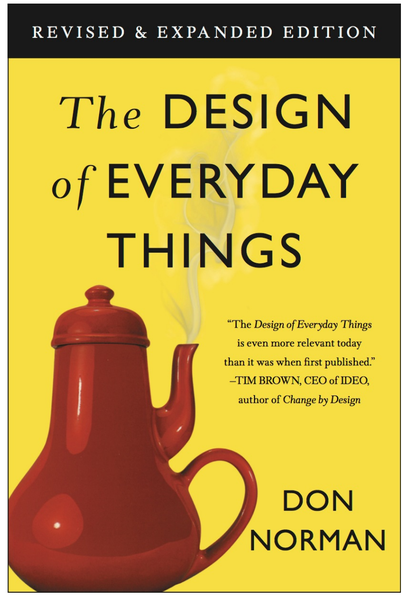
HCI Literature Sources: Conferences+Journals

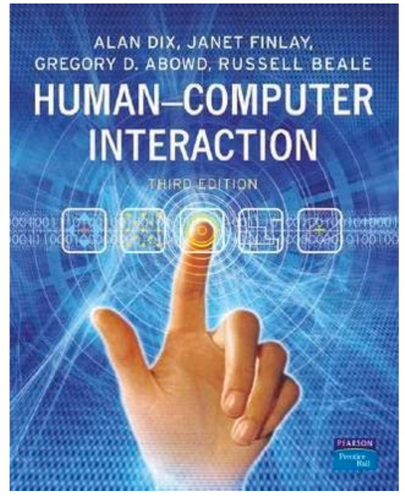
- Conferences
  - **CHI** (main), UIST (technical), DIS (design), MobileHCI, INTERACT (Euro-Asian), CSCW (group work), TEI (Tangibles), Ubicomp, ACM Multimedia,…
- Journals
  - TOCHI (archival), Interactions (magazine), PUC (Ubicomp)
- Find them online
  - ACM Digital Library (dl.acm.org)
  - Full access from RWTH network

HCI Literature Sources: Books

- Norman ’13: Design of Everyday Things (Revised & Expanded Edition) — *required reading*
  - Affordances, mappings, constraints
- Dix ’04: Human-Computer Interaction
  - Very good general textbook
- Shneiderman ’18: Designing the User Interface (6th edition)
  - Technology, interviews
- Nielsen ’93: Usability Engineering (prototyping)
  - How to bring usability to the business
- More on https://hci.rwth-aachen.de/hcibooks







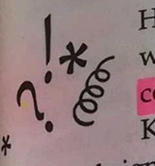
A Note on Active Reading

- Highlight 1–2 key points per page
- Scribble brief summaries, ‘!’ marks, crazy associations, project ideas,… in margins
- Put sticky notes with keywords onto pages you keep referring back to
- Type short bullet-point summaries of each chapter
- Make sure you can tell your copy of the book apart from 10ft
- Increases value of the book for you many times

called *inside-out*.

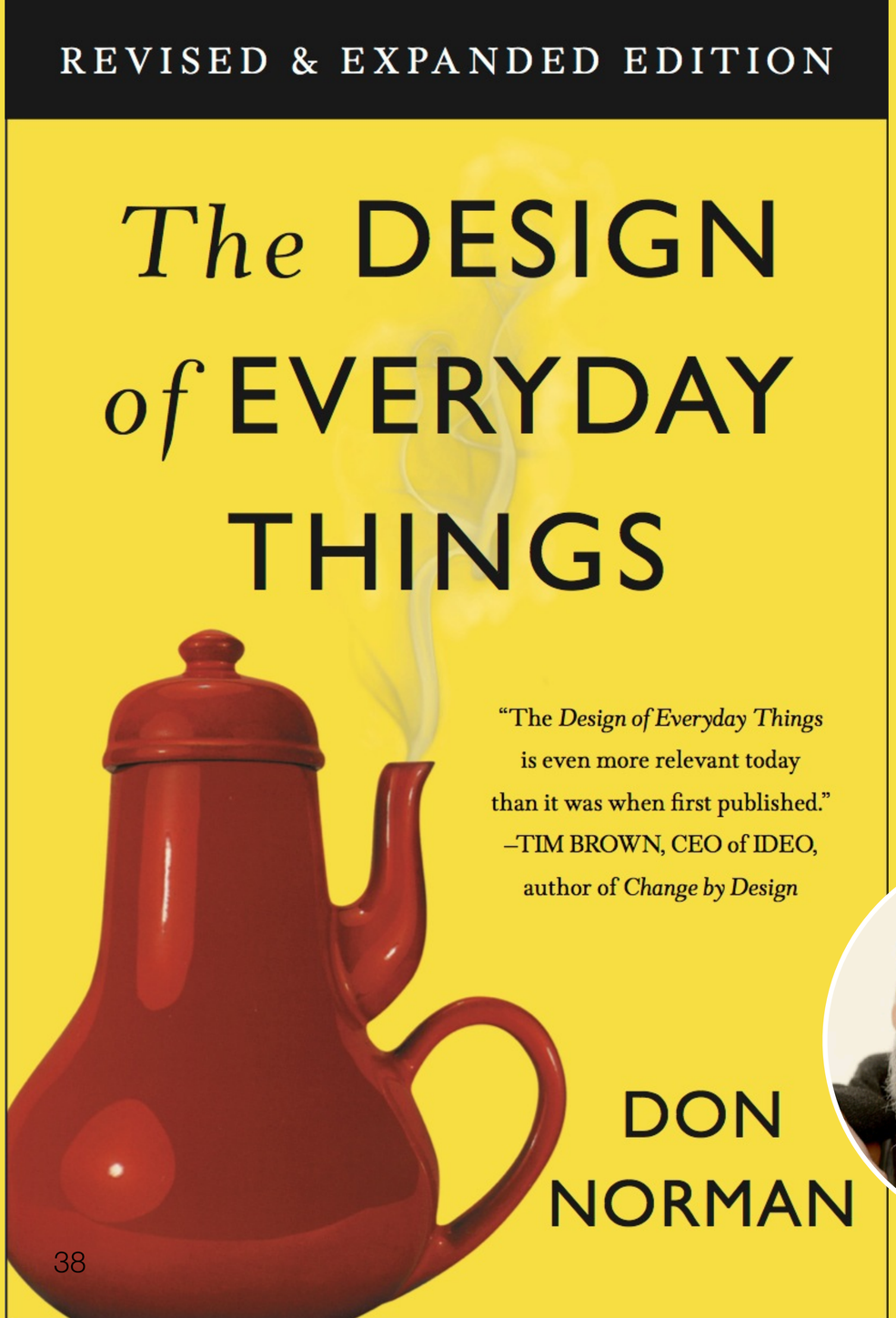
In all these cases, every point of view is correct. It all depends upon what you consider to be moving. What does all this mean for design? What is natural depends upon point of view, the culture of metaphor, and therefore, the culture. The design difficulties occur when there is a switch in metaphors. Airplane pilots have to undergo training and testing before they are allowed to switch from one set of instruments (those with an outside-in metaphor, for example) to the other (those with the inside-out metaphor). When countries decided to switch which side of the road cars would drive on, the temporary confusion that resulted was dangerous. (Most places that switched moved from left-side driving to right-side, but a few, notably Okinawa, Samoa, and East Timor, switched from right to left.) In all these cases of convention switches, people eventually adjusted. It is possible to break convention and switch metaphors, but expect a period of confusion until people adapt to the new system.

KNOWING WHAT TO DO: CONSTRAINTS, DISCOVERABILITY, AND FEEDBACK



How do we determine how to operate something that we have never seen before? We have no choice but to combine knowledge in the world with that in the head. Knowledge in the world includes perceived affordances and signifiers, the mappings between the parts that appear to be controls or places to manipulate and the resulting actions, and the physical constraints that limit what can be done. Knowledge in the head includes conceptual models; cultural, semantic, and logical constraints on behavior; and analogies between the current situation and previous experiences with other situations. Chapter 3 was devoted to a discussion of how we acquire knowledge and use it. There, the major emphasis was upon the knowledge in the head. This chapter focuses upon the knowledge in the world: how designers can provide the critical information that allows people to know what to do, even when experiencing an unfamiliar device or situation.

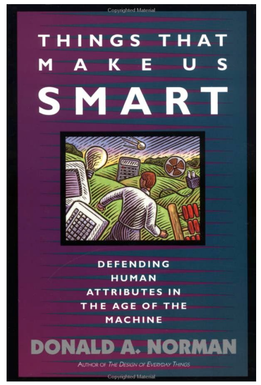
Let me illustrate with an example: building a motorcycle from a Lego set (a children's construction toy). The Lego motorcycle shown in Figure 4.1 has fifteen pieces, some rather specialized. Of those fifteen pieces, only two pairs are alike—two rectangles with the word *police* on them, and the two hands of

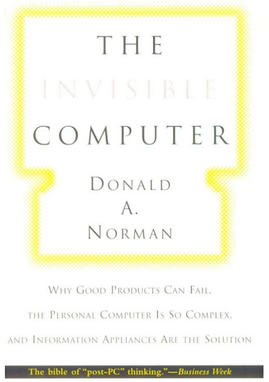


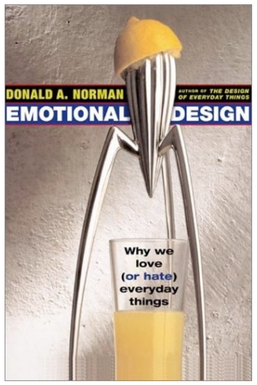
- Originally published as “The Psychology of Everyday Things” (POET) in 1988
- One of the ‘bibles’ for HCI; revised in 2013
- Introduced the concept of affordances to HCI in general

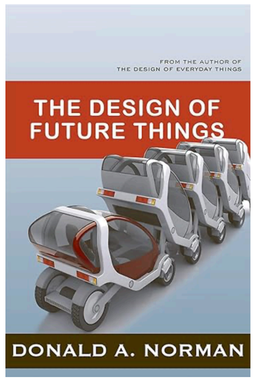
Other Books by Donald A. Norman

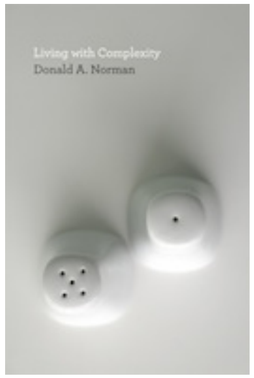
- Things That Make Us Smart: Defending Human Attributes in the Age of the Machine (1994)
- The Invisible Computer: Why Good Products Can Fail, the Personal Computer Is So Complex and Information Appliances Are the Solution (1998)
- Emotional Design: Why We Love (Or Hate) Everyday Things (2004)
- The Design of Future Things: Automation in our homes and automobiles and why it is done so badly (2007)
- Living with Complexity (2011)
- Design for a Better World (2023)
- ...

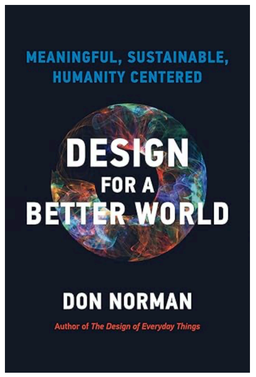






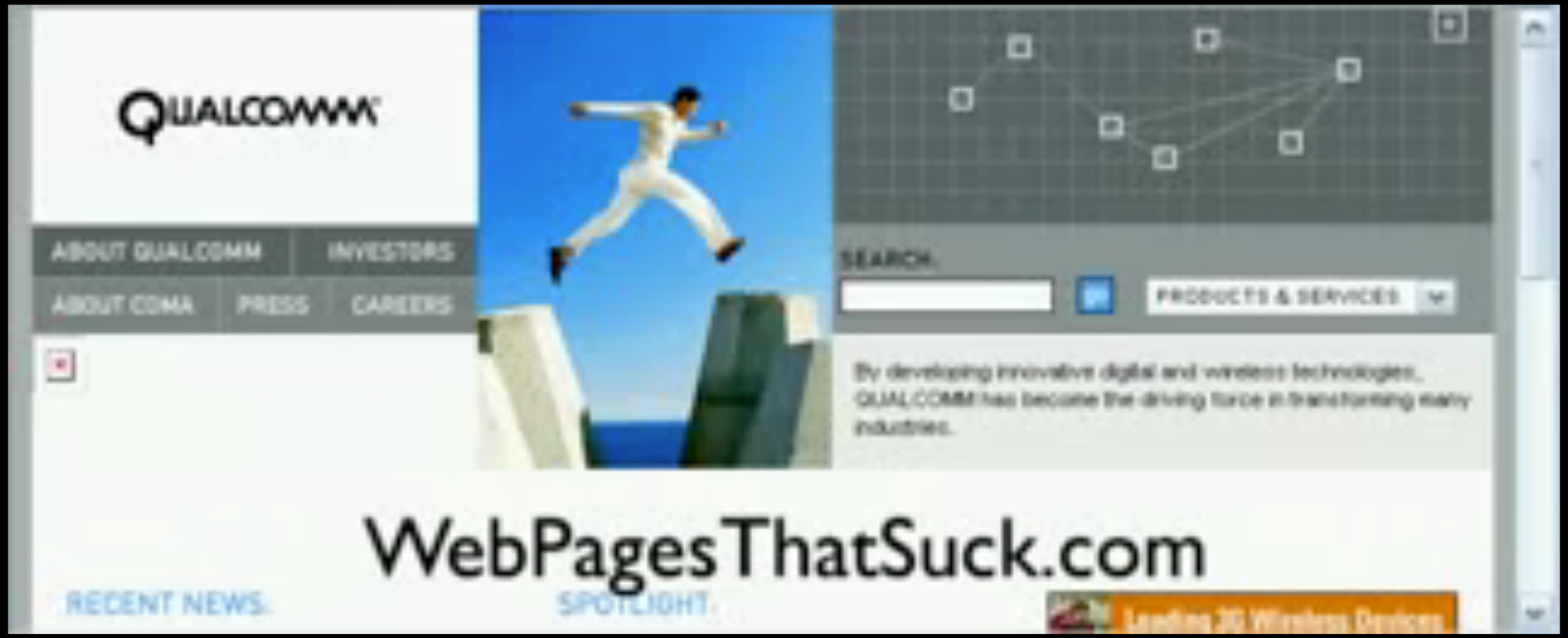






Visibility

“Mystery Meat Navigation”



http://www.webpagesthatsuck.com/

Visibility

- The mind is excellent at noticing and interpreting clues in the world, rationalizing, explaining cause and effect
- Much everyday knowledge is in the world, not in the head
- So visibility is one of the most important aspects in design
- Ideally, natural clues are made visible, requiring no conscious thought: natural design
- Just the right things have to be visible:
  Excess is as bad as lack of visible clues

Swedish Hair Dryer

Improving the Swedish Hair Dryer

- Detach scale (labels) and control
- Provide at-a-glance overview of possible settings (What Can I do?)
- Design control knob to show how it can be operated (e.g., pushed)
- Make current setting of control against scale easy to determine (Where Am I?)
- Use natural ordering of settings (0 < I < II)
- These all work for a new product—but design for use
  - One-handed operation, labels must not wear off, water-resistant controls, voltage settings,…
- Apply the First Rule of UI Design: **Keep It Simple**

https://www.artnews.com/wp-content/uploads/2021/07/51tG4W-zbFL._SL1000_.jpg

Visibility & Superstitions

- Coincidence and lack of visibility can cause false causalities (thinking your action had a bad or no effect).
- They lead to superstition and loss of control.
- Example: Multiple clicks because system doesn’t respond—and then the chaos when it does…

Market Constraints

- Better UIs are not automatically business goals
- Consumers have to prioritize usability before industry changes (it's happening gradually)
- Goal of this class: Turn you into nitpickers that notice bad (and good) UIs everywhere.

How do you check your voicemail?

RWTH University Phones

- More phone issues
  - Tone dialing doesn’t work, have to dial “* * 8” to activate
  - Missed calls are hard to retrieve, and numbers disappear after looking at them once
  - Etc. …
- Mobile phones (“network features”) are not much better (e.g., blocking caller ID)

British Rail Shelters

- British Rail shelters with glass walls were being vandalized routinely
  - Glass suggests (“affords”) being broken
- After replacing them with equally strong plywood, the demolishing stopped
  - Wood suggests/affords stability and support
- However, now they were being scribbled upon…
  - Smooth, even surfaces “afford” drawing!

Affordances

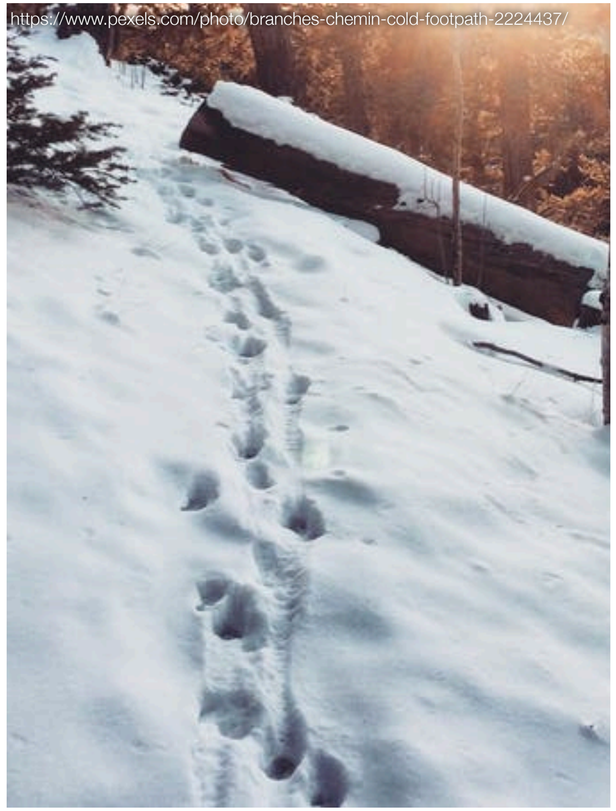
- Model by Norman, after Gibson
  - “...affordances of the environment are what it offers the animal...” [Gibson77]
- Affordances are the actions that an object allows a user to do with it
  - “An affordance is a relationship between the properties of an object and the capabilities of the agent that determine just how the object could possibly be used.” [Norman, 2013]
- Affordances depend on both the object and the user (chair example)
- Affordances can be visible (perceivable) or hidden

Signifiers

- The signaling component of an affordance (i.e., it signifies the affordance)
- Affordances: **what** action?
  Signifiers: **where**?
- More important than affordances for design
- Perceivable affordances are their own signifier — most useable design
- If affordance is not perceivable, signifier must be added

Intentional and Unintentional Signifiers

- Intentional
  - Door signs (any signs)
  - “Click here” buttons
- Unintentional or accidental
  - Footpath in a snow terrain
  - Wind direction from flag
- Either way, users interpret it as strong cue



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

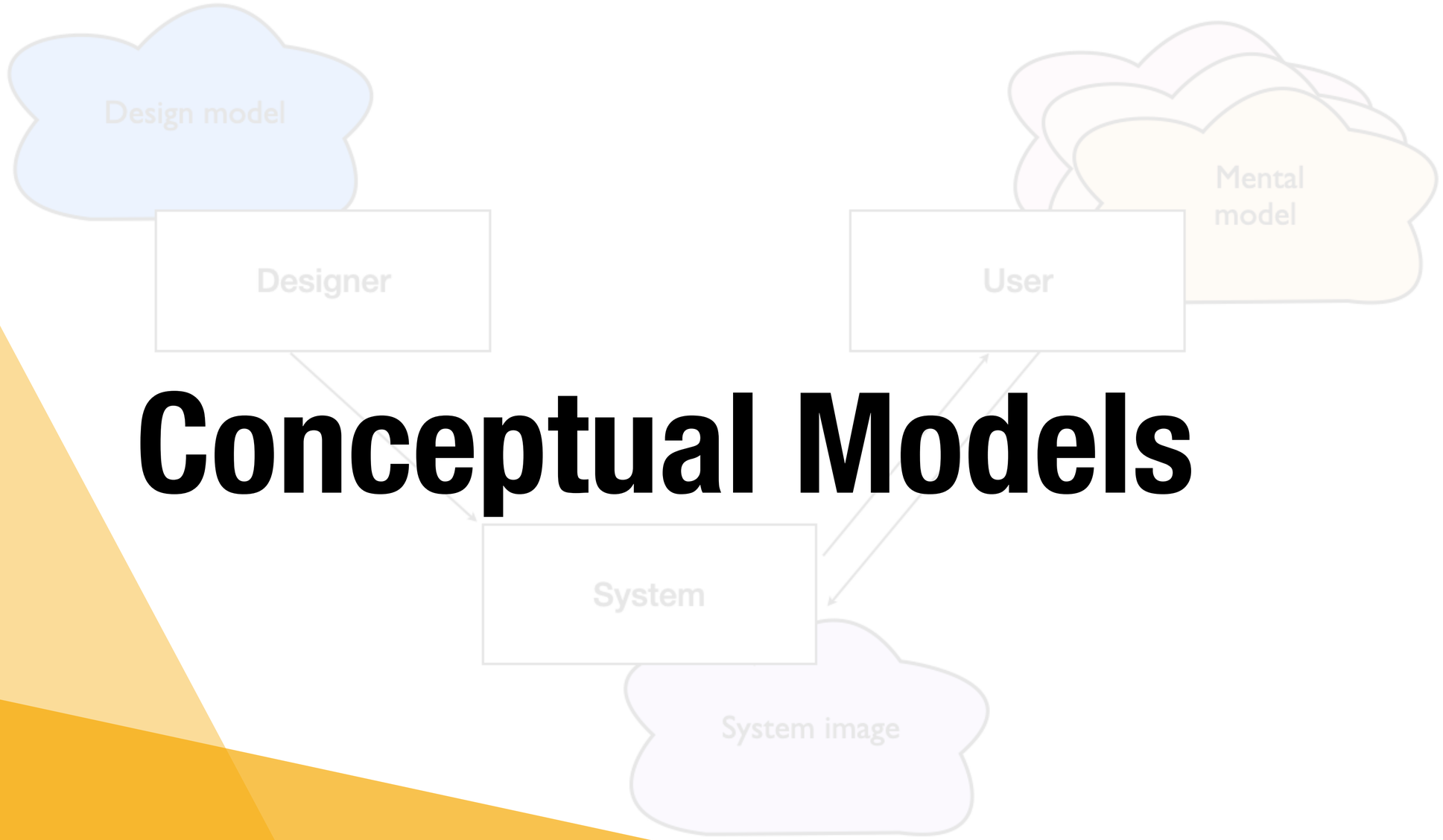
Example: Headlamp

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

D. Norman: The Design of Everyday Things



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

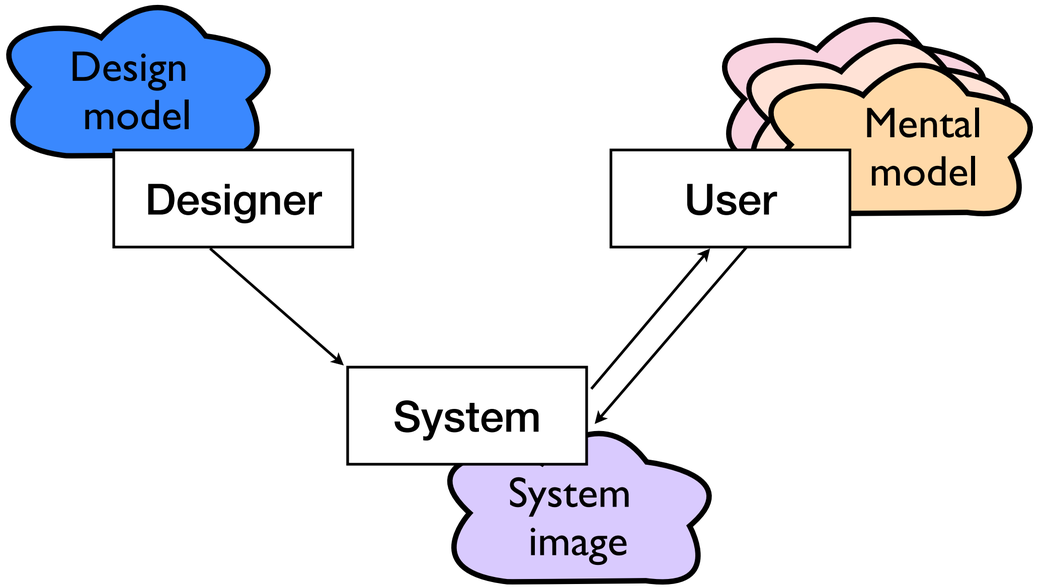
- Humans form a conceptual model of how something works when they encounter it

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!



https://www.pngwing.com/en/free-png-tviug

“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?

What to Do Now

- **Required Reading:** Read Norman's book until page 36 this week
  - You have four weeks to finish the book
  - As of this moment, we are already 12% into the book
- **Recommended Reading:**
  - Dix et al.: Human-Computer Interaction, Chapter 3: "The Interaction"
  - Shneiderman et al.: Designing the User Interface, Chapter 2.4: "Theories"