Designing Interactive Systems I

Knowledge, Feedback, Errors, 7 Principles of Design

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

Review

- What are the Seven Stages of Action?
  - Variations? Gulfs? Design implications?
- What are mappings, natural mappings? Types?
- What are constraints? How do they differ from affordances? Types?

Three Levels of Processing

1. Visceral Level

- Fast, completely subconscious
- Reflex action, impulse
- E.g., vertigo, feeling of warmth and happiness when basking in the sun
- Not exactly ‘emotions’, more like hard-coded responses

https://www.pexels.com/de-de/foto/auto-fahrzeug-chrom-stil-3802508/

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2. Behavioral Level

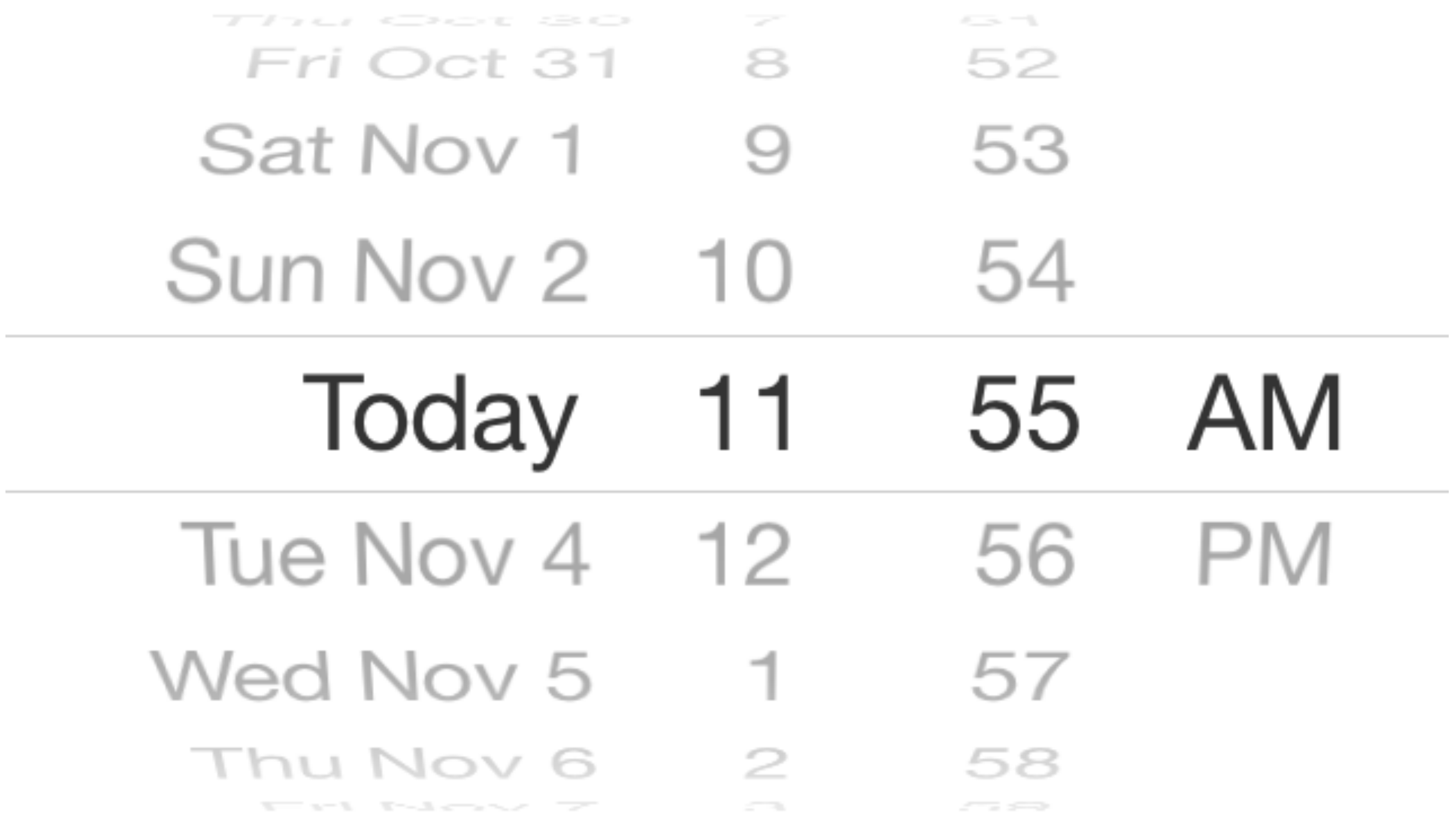
- The level of “classic usability”
- “Learned responses”, triggered by situations matching a pattern
- Mostly subconscious, fast, lower level of emotions
- E.g., sports, walking, etc.
- Behavioral action is associated with an expectation
  - Hope or fear: Am I doing the right set of actions? (feedback)
  - Relief or despair: Did things work out in the way I intended? (conceptual model)

3. Reflective Level

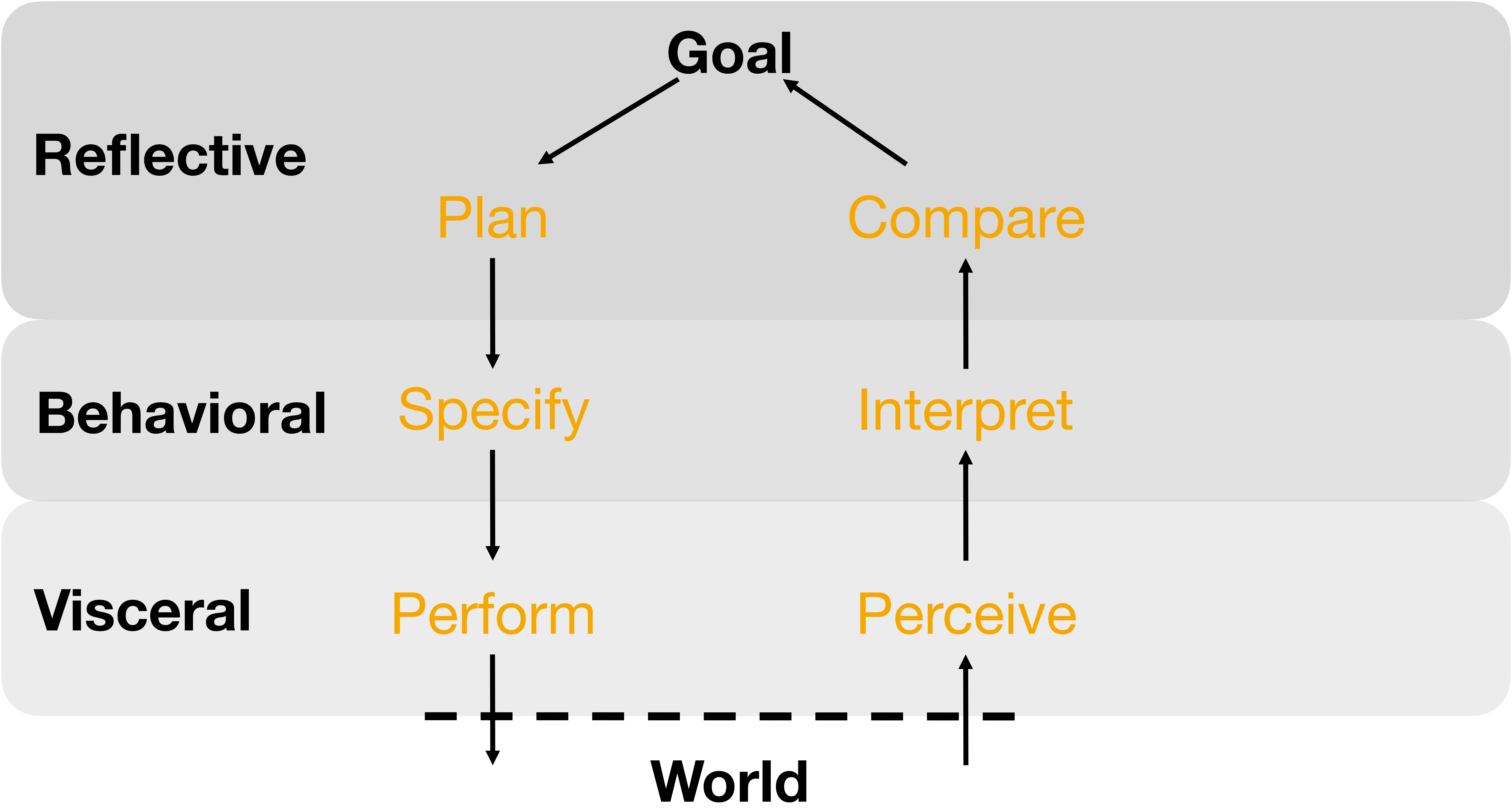
- Conscious thinking about events that have occurred
- Slow, deep thinking
- Highest level of emotions, e.g., guilt, pride, blame, praise
- Retained in memory

Design in Three Levels of Processing

- Visceral design: Make products “feel” great
- Behavioral design: Follow standard cognitive usability rules
- Reflective design: Create something users connect to (e.g., culture, meaning of a product)
- Excellent visceral and reflective design will make users forgive you small usability mistakes

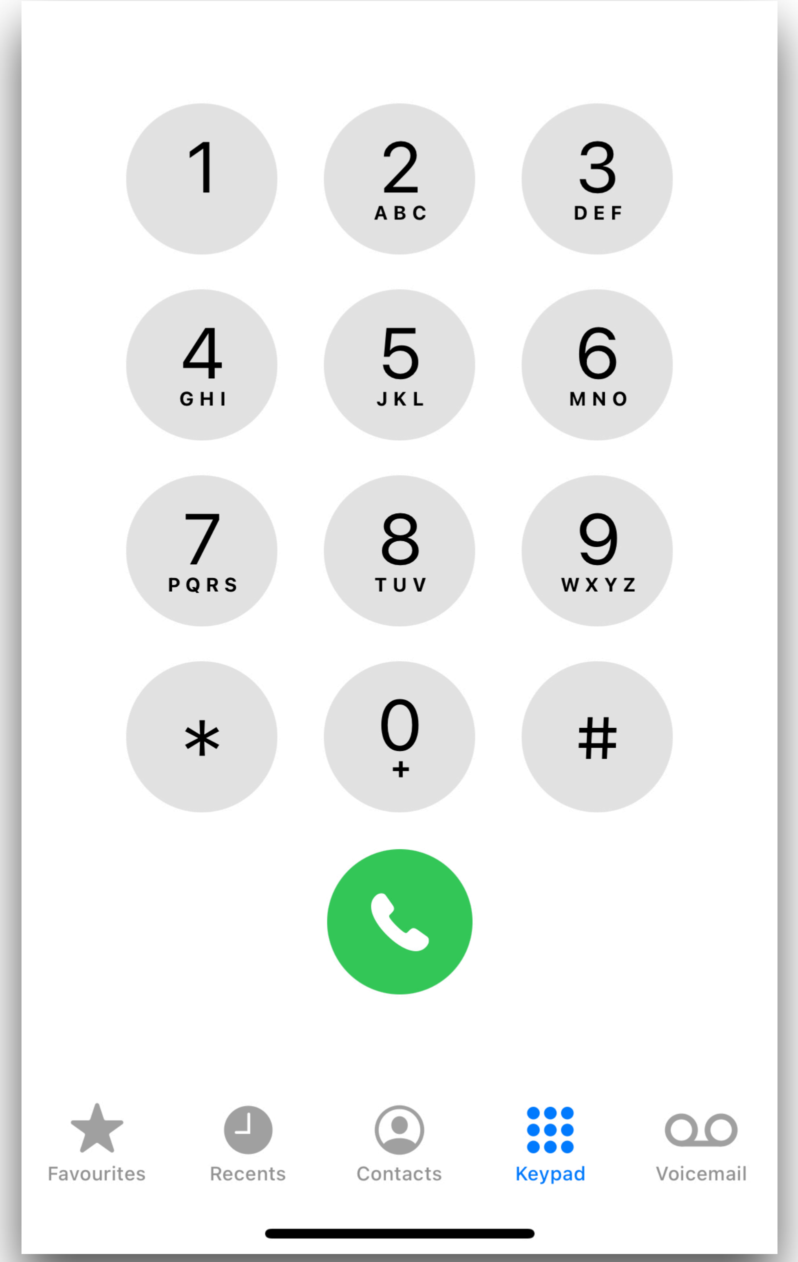


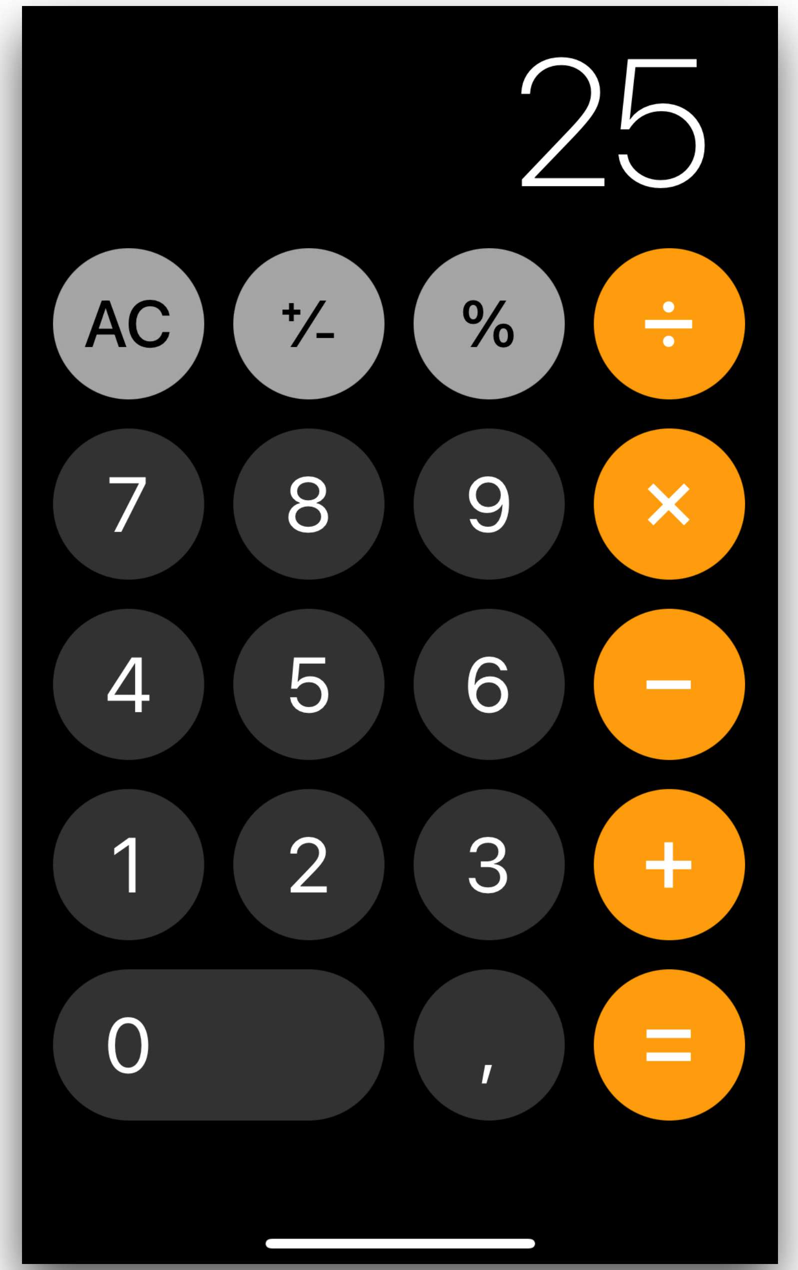
Interplay with the Seven Stages of Action



Knowledge in the World and in the Head

- Experiment:
  - Write down the digit layout of a telephone and a calculator keyboard






OQO

Knowledge in the World and in the Head

- Much knowledge is not in the head but in the world
- Despite less-than-perfect knowledge, precise behavior is possible—how?
- Behavior is determined by combination of knowledge in the world and in the head
- High precision of knowledge in the head is unnecessary
  - We only need the knowledge to be precise enough to distinguish the right behavior from the others possible
- Example: What is on the front and the back of the German 1 cent coin?

More Reasons Why This Works

- **Physical constraints** are in effect
  - They limit the actions possible
  - Example: What can be moved/combined/ manipulated how when repairing your toaster?

- **Cultural constraints** are in effect
  - Social rules are learned once and are then applicable in many situations
  - Example: What to do upon entering a restaurant?
  - But: Cultural differences!

Knowledge in the Head & Constraints

- Traveling poets were able to recite poems with thousands of lines
  - Story works as semantic constraint
  - Rhyme works as "linguistic constraint"
- Constraints limit the amount of knowledge that needs to be learned
- Humans can minimize the amount/precision/depth of information to remember by arranging their environment and copying people's behavior
  - This can even help people cover missing abilities (dyslexia) or mental disabilities

Example: Typing

- Exercise:
  - What kind of knowledge do beginners/intermediate/expert typists use?
- Beginner: Knowledge in the world (keyboard labeling)
- Intermediate: Knowledge in the world (peripheral vision, feeling keys) and in the head (knowing location of important keys by heart)
- Expert: All knowledge in the head, no eye contact to keyboard necessary anymore (cost/benefit tradeoff)

Example: City Map

- Exercise:
  - Try to write down exactly how to get from your home to the main university building
- Result:
  - Nobody has a perfect street/building map in their head; often entire parts are forgotten in route descriptions
  - Nevertheless we can get from A to B safely
  - Why? Signage and constraints (e.g., street numbers) supply external knowledge

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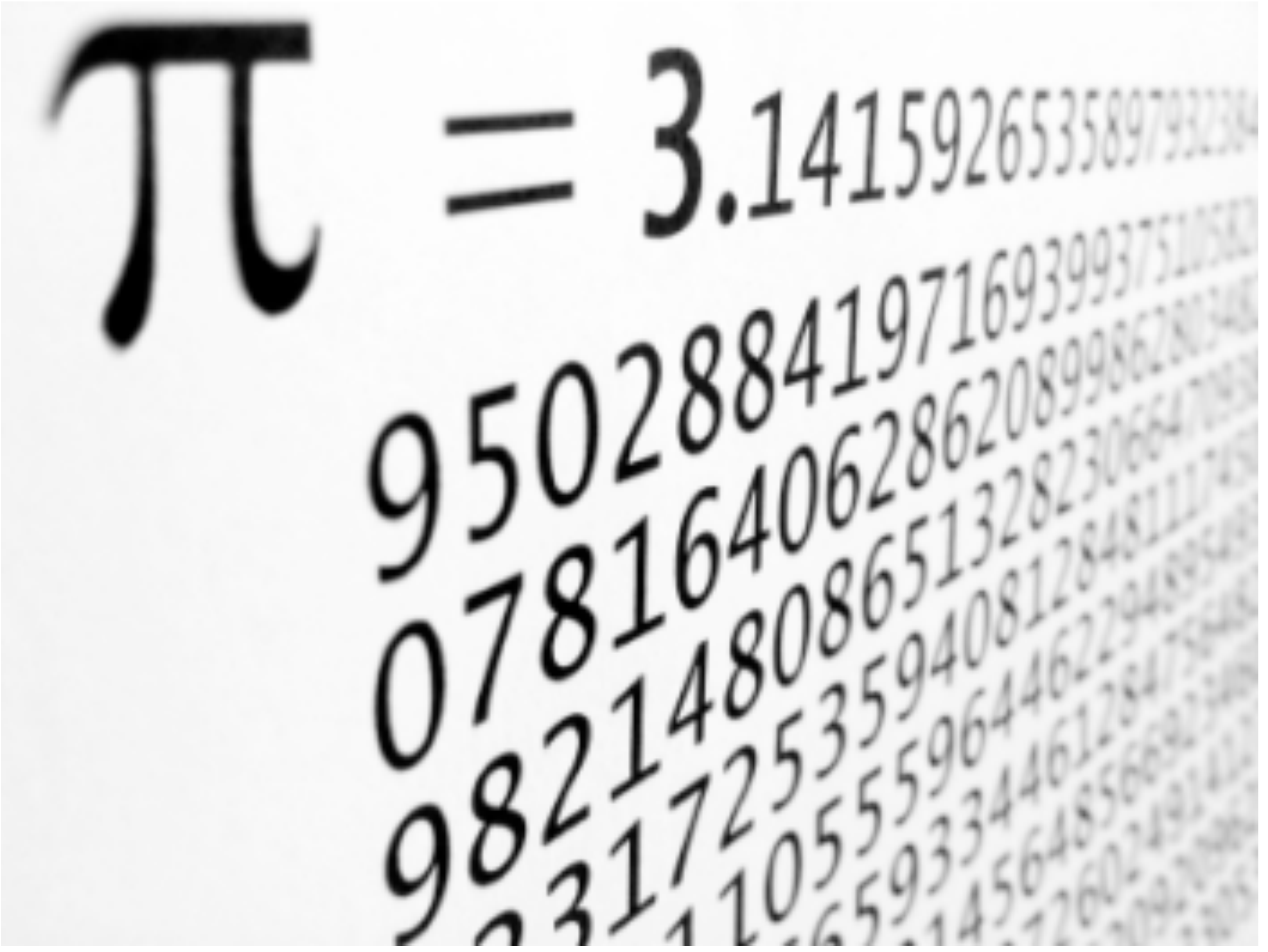
Types of Knowledge

- Declarative knowledge (“what”)
  - Facts (Bonn is southeast of Aachen)
  - Rules (stop at red traffic lights)
  - Easy to write down and teach (not learn!)
- Procedural knowledge (“how”)
  - How to play an instrument
  - Hard to write down, subconscious
  - Hard to teach, best by demo/training
- Design can easily convey **declarative** knowledge

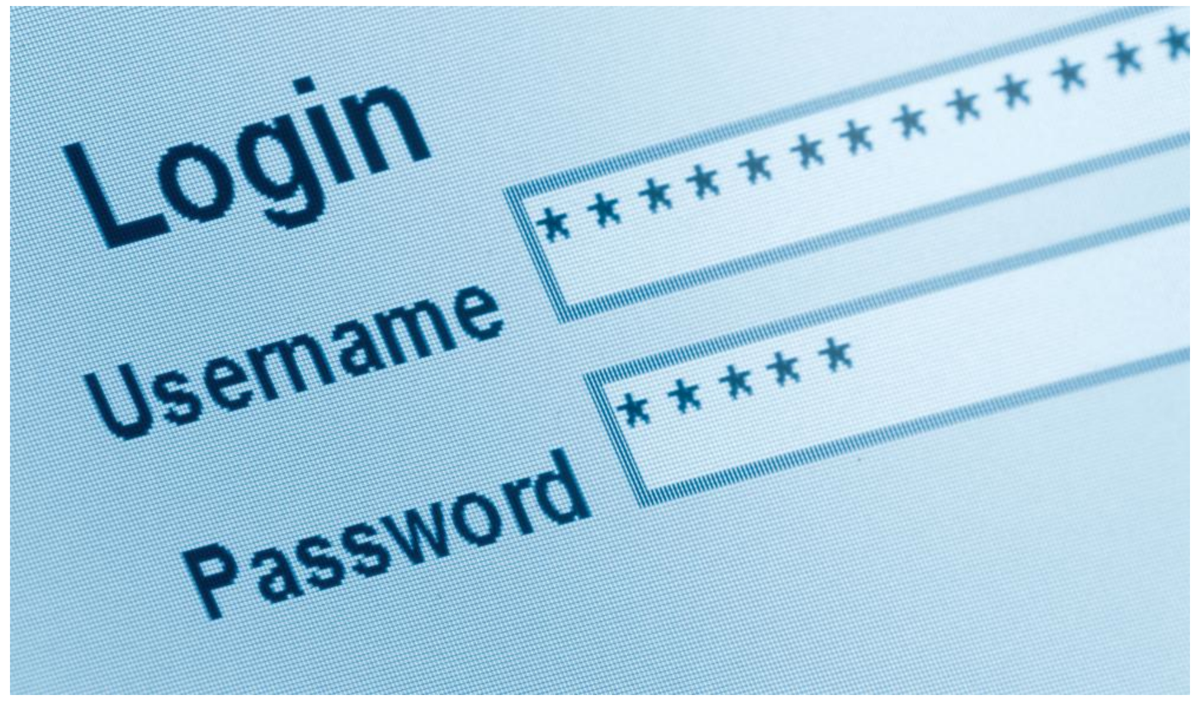
How Much Can We Remember?

- Random unconnected facts: little
  - “Press Ctrl-Alt-Delete to log on”
  - Not learnable per se, only via associations
  - Example: First 1,000 digits of π
  - If your recipe fails, you are lost
- Connected facts: more
  - Using associations
  - Example: motor bike directional indicator



The Daily Struggle

- Exercise:
  - How many online accounts with passwords do you have?
  - How many of these can you remember the passwords to?
  - For how many of them do you use the same password?
- Credit cards, bank accounts with bank codes, number plates, phone numbers/addresses/birthdays/age of friends, clothing sizes,…
- As the password requirements become more complex, the system becomes less secure, why?
  - We tend to move these things from the head into the world



Knowledge in the World: Characteristics

- Nothing to remember
- But: only there while you see it
- Especially difficult with things that are not very important to you
- Solution: Reminders
    - Paper agenda vs. PDA
    - Signal vs. message

Comparing Knowledge in the World and in the Head

- In the world:
  - Available as soon as visible
  - No learning needed
  - Low efficiency (interpreting needed)
  - High initial usability
  - Aesthetics difficult with much to display
- Remember: **Natural mappings** can save both learning and labeling

- In the head:
  - Less available
  - Less suitable for beginners
  - Harder to learn
  - But efficient
  - Invisible (less labels)

Decision Structures

- To reduce chance of error, use either shallow or narrow decision trees
  - Shallow: No planning required, e.g., ice cream parlor menu
  - Narrow: No deep thinking required, e.g., cook book instructions, start your car, motorway exits
- Wide and deep structures:
  - Games like chess, etc.
  - Designed to occupy the mind
- Subconscious thought is effortless, associative, pattern-matching
- Conscious thought is slow, serial, demanding

Feedback

Feedback

- Feedback communicates to the user the current system state, success or failure of actions, and results of actions
- Good feedback:
  - Immediate
  - Informative and clear
  - The right amount
  - Prioritized

Sound

- Exercise:
  - Listen to everyday objects and their acoustic feedback (or think about it if not readily available in class)
- Examples: Pen cap, hard drive, bike lock, car door, telephone, software
- Sound is a unique information channel
  - Omnidirectional: blessing and curse
- But: Use it to convey **meaning** if possible!
- More on sound in DIS 2

Visibility and Feedback

- Invisible On/Off switch on the rear
- VCRs without on-screen programming required lengthy programming instructions without much visible feedback
- A good display is great to improve visibility, and therefore often usability
- This becomes more feasible as technology progresses (Augmented Reality/Ubicomp)

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rear door handle
0504 JMB

Feedforward

- Feedforward is to execution as feedback is to evaluation
- Information that helps you know what you can do
- Uses signifiers, constraints, and mappings
- Visual, but also haptic
  - Example: feeling keys before typing eyes-free on real vs. onscreen keyboard

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Human Errors

Errors

- People make errors using everyday objects all the time
- Often blame themselves (untypical!)
- Often caused by taught helplessness
  - E.g., maths classes
- May lead to learned helplessness
  - Conspiracy of silence, depression
- Not only “dumb folk” have misconceptions of everyday life, and often those “wrong” models work better for everyday life
  - E.g., thermostats

Mistakes

- Result of conscious decision/thinking
- Often major events
- Reasons: Wrong goal, wrong plan, leaping to wrong conclusions, false causalities
- Hard to detect

Classes of Mistakes

- Memory-lapse: memory fails during goal-setting, planning, or evaluation
  - E.g., a mechanical failure because the mechanic was distracted while troubleshooting
- Knowledge-based: wrong evaluation of the situation because of incomplete knowledge
  - E.g., reporting the weight of an item in pounds instead of kilograms
- Rule-based: correct evaluation of the situation, but wrong course of action
  - E.g., blocking night club attendees from an emergency exit assuming they are avoiding payment

Slips

- Most everyday errors
- Small things going wrong
- Goal formed, but execution messed up
- Usually easy to discover
- Occur mostly in skilled behavior
- Often caused by lack of attention, busy, tired, stressed, bored, more important things to do,…
- We can only do one conscious thing at once
  - Jef Raskin, The Humane Interface: Walking and eating and solving a maths problem

Classes of Slips

- Action-based: the wrong action is performed
  - E.g., pouring a cup of coffee and milk and placing the cup in the fridge
  - Types: capture slips, description-similarity slips, mode errors

- Memory-lapse: memory fails, and the intended action is not done or its results not evaluated
  - E.g., forgetting to lock the door when leaving the house

Action-based Slips

- Capture slips
  - Two action sequences with similar initial but different later sequence
  - The sequence well practiced “captures” the unfamiliar one
  - Driving to work on a Sunday
  - Pocketing a borrowed pen

Action-based Slips

- Description-Similarity slip
  - Intention not described in enough detail, fitting 2 different action sequences
  - Often occurs if similar objects are physically close to each other (e.g., switches)
  - E.g., throwing t-shirt into toilet instead of laundry basket
  - Putting a lid onto the obviously wrong container
  - Pouring orange juice into your coffee pot

Action-based Slips

- Mode errors
  - Triggering the wrong action because the device is in a different mode than expected
  - Who has seen this in their favorite text editor: “:wq”?
  - Happens whenever devices resort to modes to cope with more functions than controls
  - The most prominent problem in many software user interfaces

Memory-Lapse Slips

- Memory lapses are common causes of errors
- Caused by interruption through other people or devices
- Forgetting to complete action sequence
  - E.g., walking into your bedroom, then wondering what you wanted to do here
- Sometimes because main part of goal is accomplished
  - E.g., ATM card in machine, originals in copier
- Minimize by
  - reducing the number of required steps
  - providing reminders of the steps
  - applying forcing functions

In-Class Exercise: Slips

- Think of three examples of slips that happened to you.
  What type are they?
  - Capture (driving to work)
  - Description-similarity (shirt in toilet)
  - Mode (vi)
  - Memory-lapse (ATM)

Detecting Errors

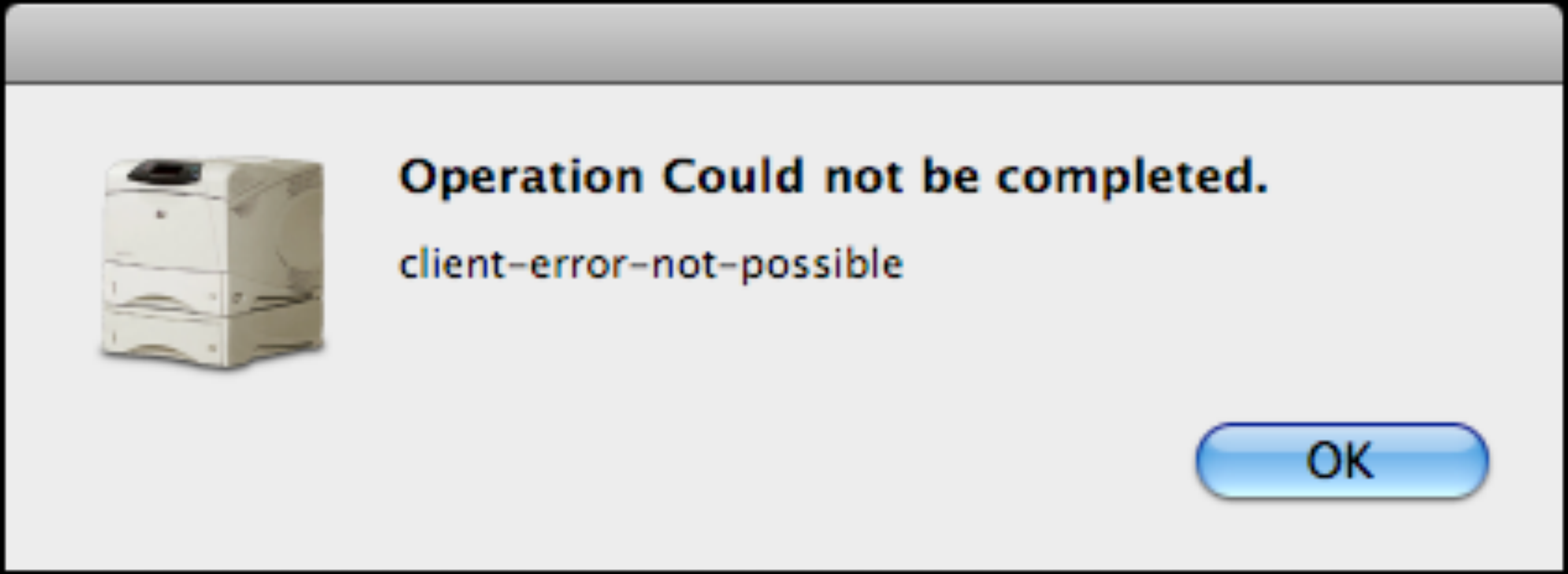
- Detecting slips is easier than mistakes, but requires visible feedback
  - Example: “Adjust the window!”
- Action-based slips are easier to detect that memory-lapses because the feedback is tangible
- Mistakes are hard to detect because nothing signals a wrong goal
- Problem: Finding the right level at which to correct
  - Are we doing this bottom-up?
  - The wrong car key
  - Confirmation is unlikely to catch errors
    - “Remove file blah.txt?”
  - Soft, reversible actions are better (e.g., trashcan), but people begin to rely on it

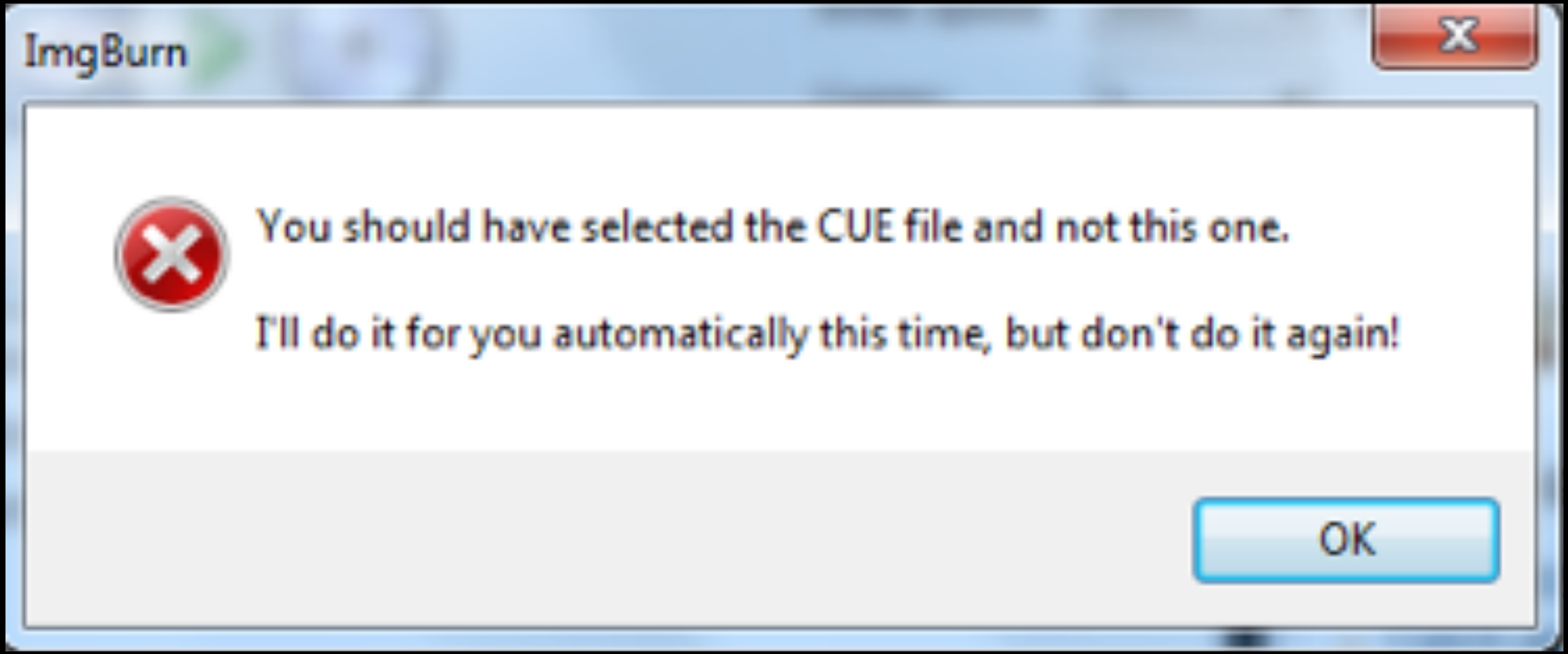
The Paradox of Automation

- When automation works, tasks are done as well or even better than by people
- The paradox is that automation can take over dull and simple tasks, but not complex ones
- When automation doesn't work, the results are unpredictable and could be dangerous, e.g., self-driven cars

Designing for Error

- Assume all possible errors will be made
- Minimize the chance of errors occurring
- Minimize their effect if they are made
- Make them easy to detect
- Make them easy to reverse (undo)
- Watch people using your system (and their slips and mistakes)
- Don’t punish, don’t ignore
- Warning signals are ignored, warning features bypassed if inconvenient


Operation Could not be completed.
client-error-not-possible
OK


ImgBurn
You should have selected the CUE file and not this one.
I'll do it for you automatically this time, but don't do it again!
OK

What to Do Now

- Read Norman's book until page 216