Conceptual Models

CS160: User Interfaces

John Canny

Topics

From Sept. 8 reading:

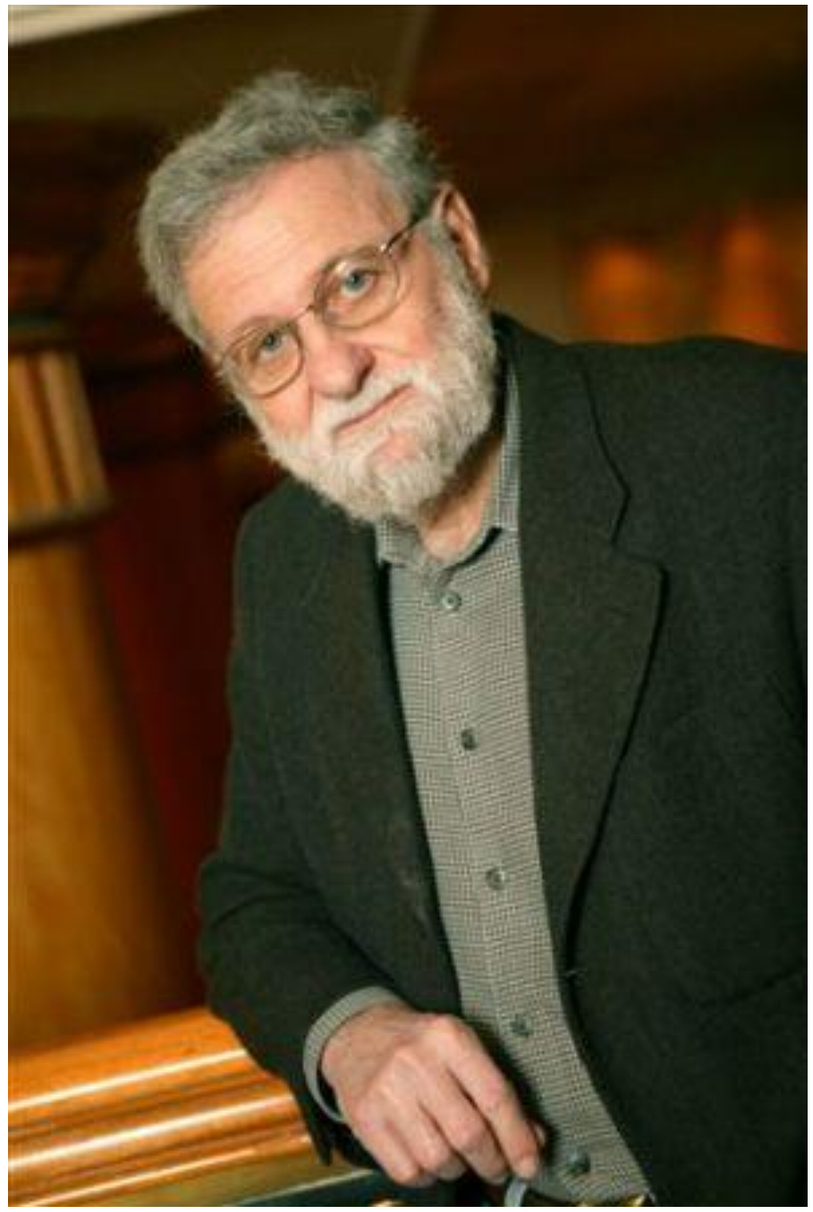
- Affordances
- Conceptual Models
- Design Principles
- Metaphors

Today's reading:

- Cognitive Conscious and Unconscious
- Modes

Affordances

"… the term **affordance** refers to the *perceived* and *actual* properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.



Some affordances "obvious"

- Knobs afford turning
- Buttons afford pushing
- Glass can be seen through

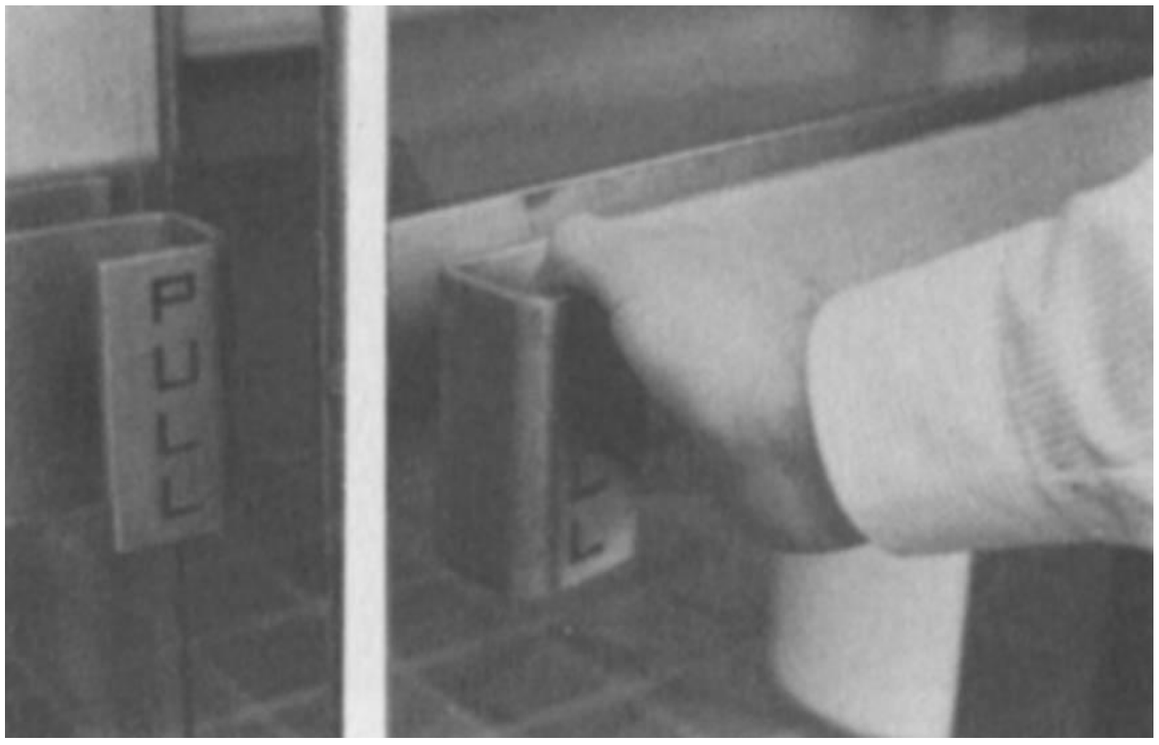
Some affordances learned

- Glass breaks easily
- CDs have only one active side
- iPhone orientation flip

The Design of Everyday Things. 1988. Don Norman

Door Handles

Affordances suggest how to use the object



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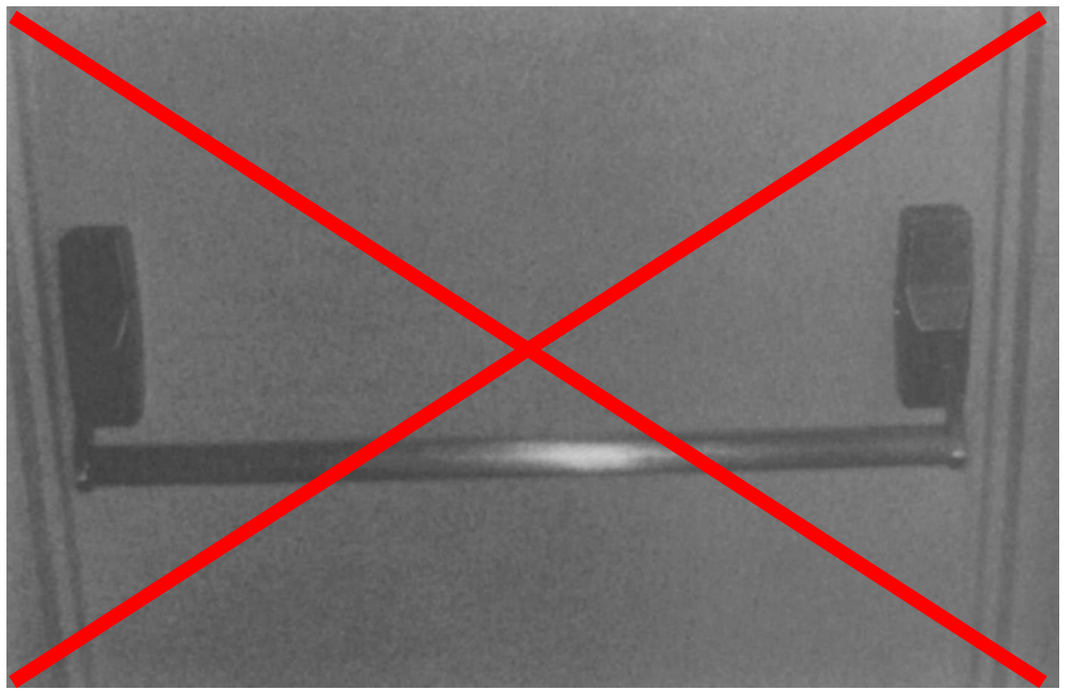
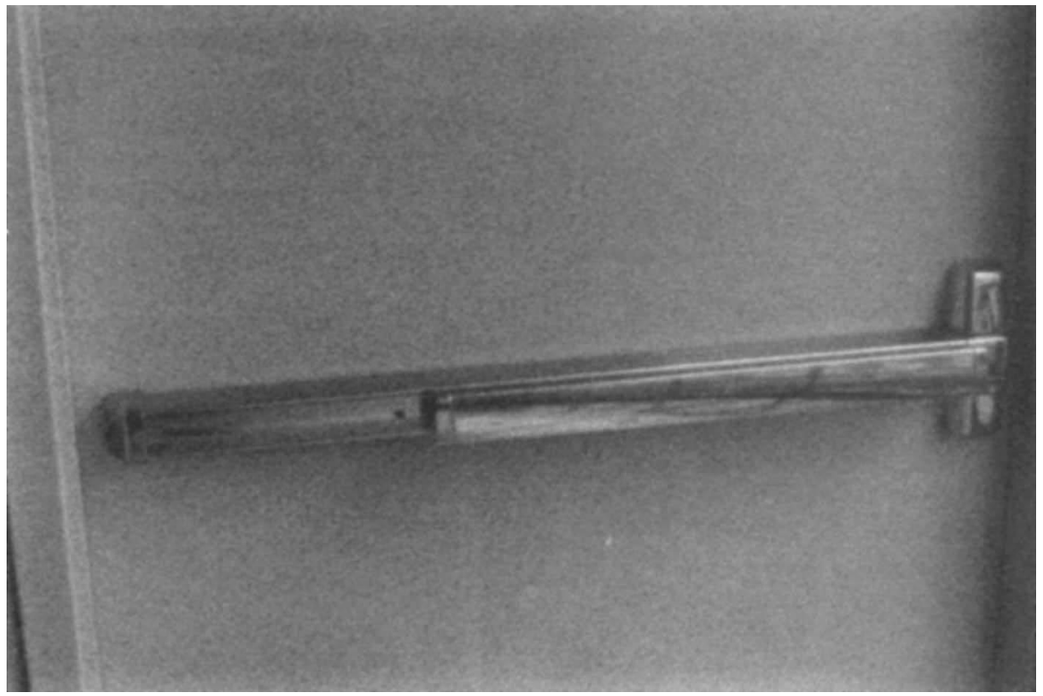




Affordances

Clues about how object/interface works

Affordances

Clues about how object/interface works

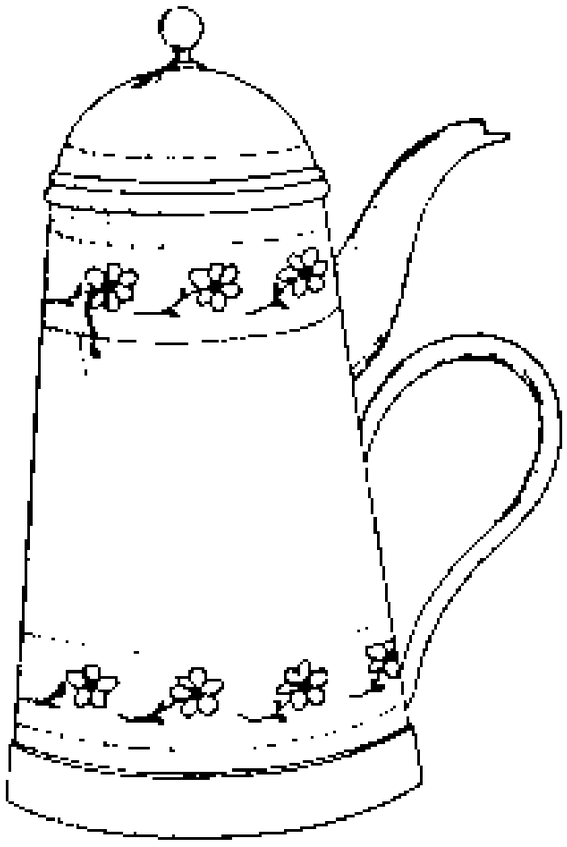
Affordances

- holes for insertion of fingers
- blades for cutting

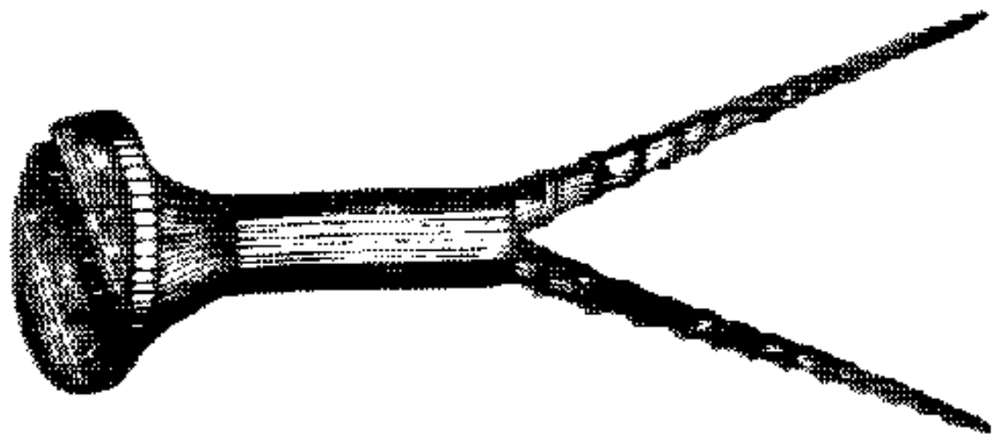
Implications clear for how operating parts work

Affordances

Clues about how object/interface works or doesn't



Teapot



Screw

Dependencies

Affordances suggest how to use the object

Can be dependent on the

- Experience
- Knowledge
- Culture

Cultural Dependencies

Affordances suggest how to use the object

Can be dependent on the

- Experience
- Knowledge
- Culture
  - Switches (US down=off, UK down=on)
  - red = danger, green = go

Can make an action easy/difficult

Perceived Affordances

Affordances suggest how to use the object

Can be dependent on the
- Experience
- Knowledge
- Culture of the actor

Can make an action easy/difficult

Affordances may be *perceived* without actually existing

Game controller affordances

Wii remote, roughly flashlight sized, easy to grip the right way.

Roughly the diameter of a tennis racket/ baseball bat/golf club

“Trigger” button underneath falls under the index finger.

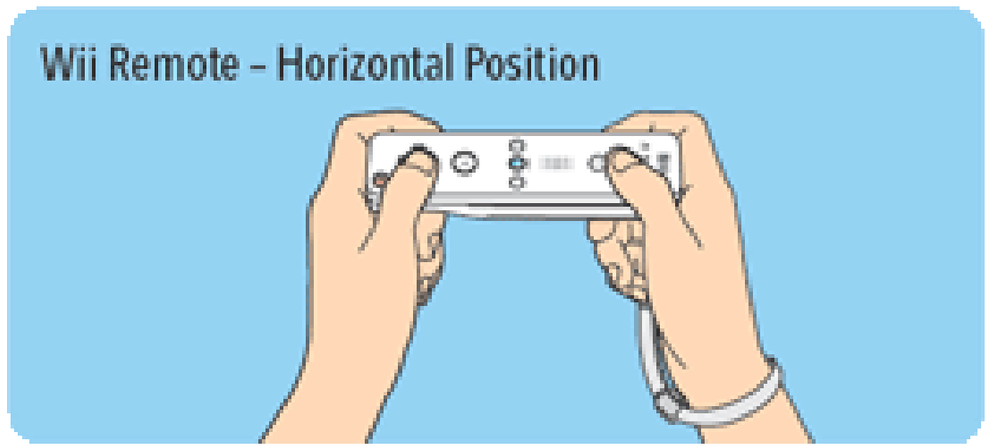
Most-used buttons are thumb- or index-finger operated.

Game controller affordances

But the Wii remote also supports two-handed use.

In this position, the main select “A” button falls under the left hand. The right hand button replaces it.

Main select doesn’t work in older Nintendo games. This takes some getting used to…



Screen-Based Interfaces

Physical affordances

- Screen, pointing device, physical buttons, keyboard
- These afford touching, pointing, looking, clicking on every pixel

Screen-Based Interfaces

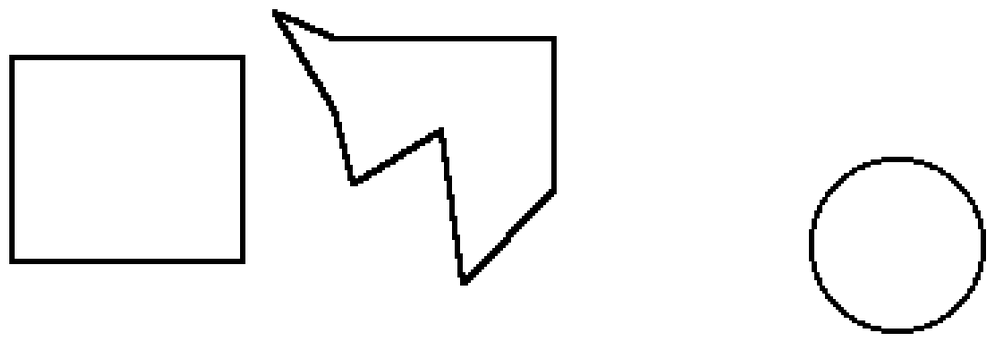
Physical affordances

- Screen, pointing device, selection buttons, keyboard
- These afford touching, pointing, looking, clicking on every pixel

Physical affordances of screens often unused

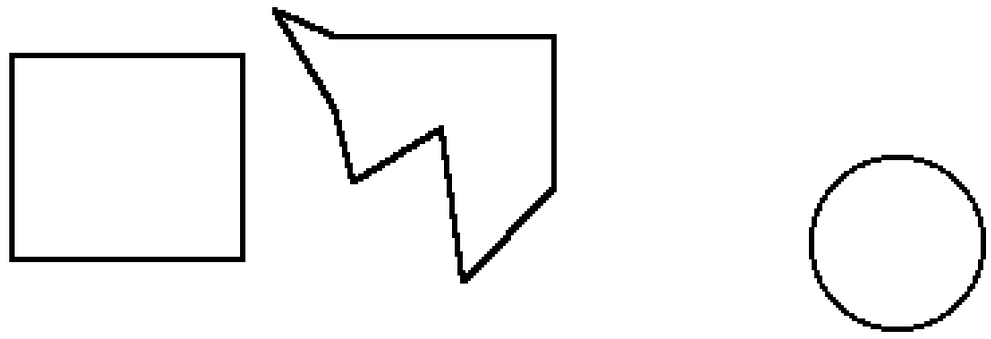
- Screen affords touching, but many screens are *not* touch sensitive

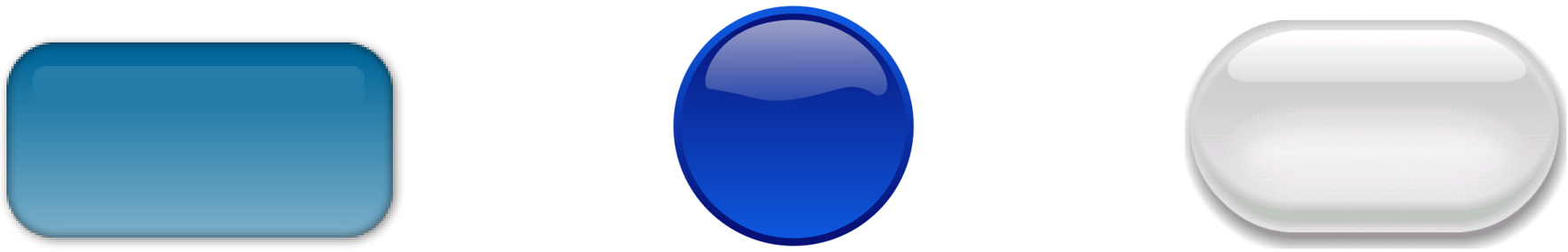
Designer Controls Perceived Affordances



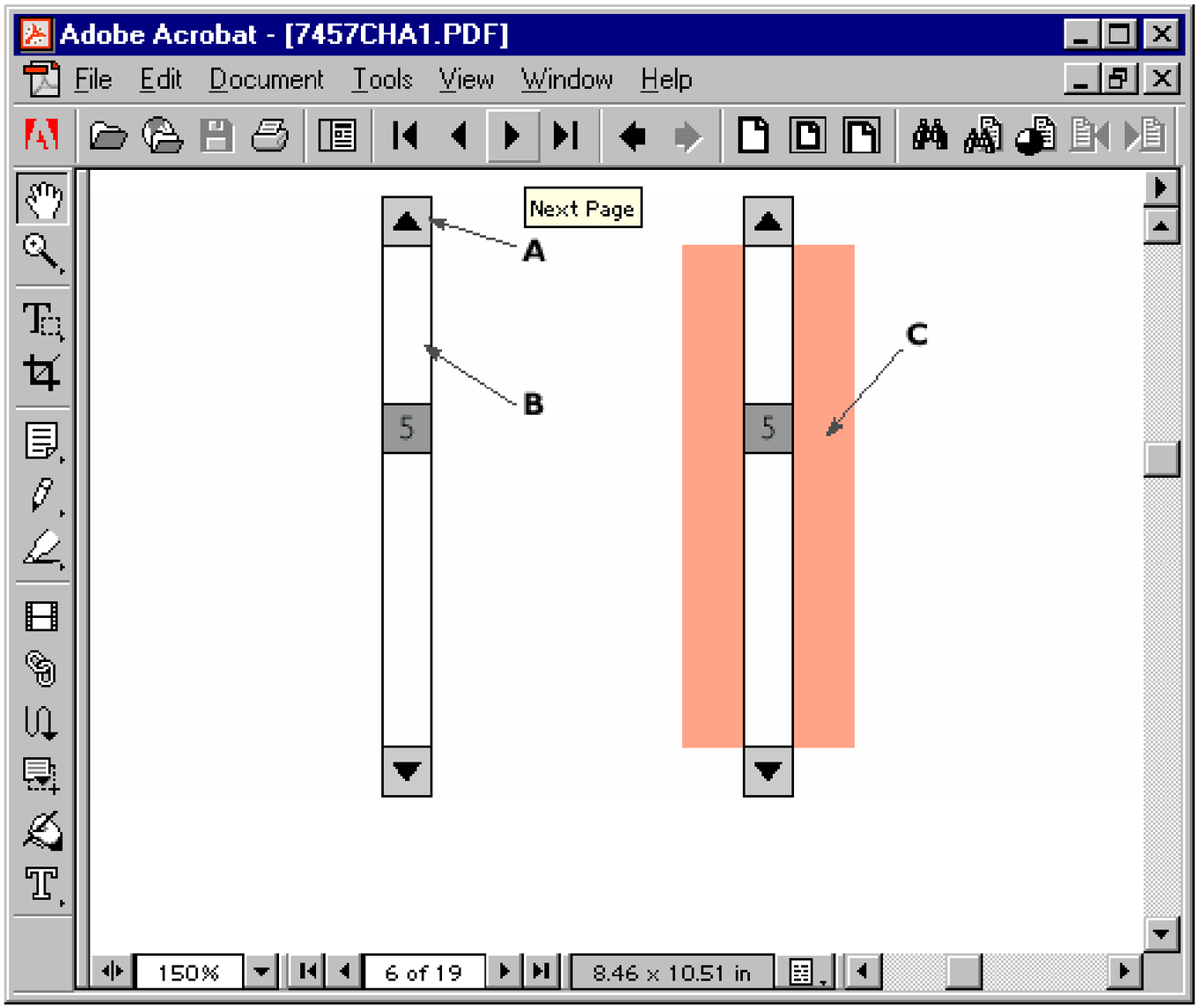
What are the affordances of these graphical objects?

Do Graphical Objects Afford Clicking?





- Graphical design emphasizes affordances
- Does user recognize object as a button to be clicked?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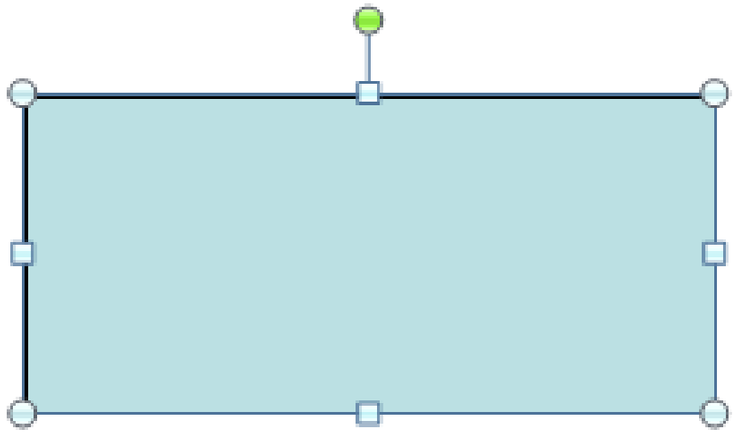
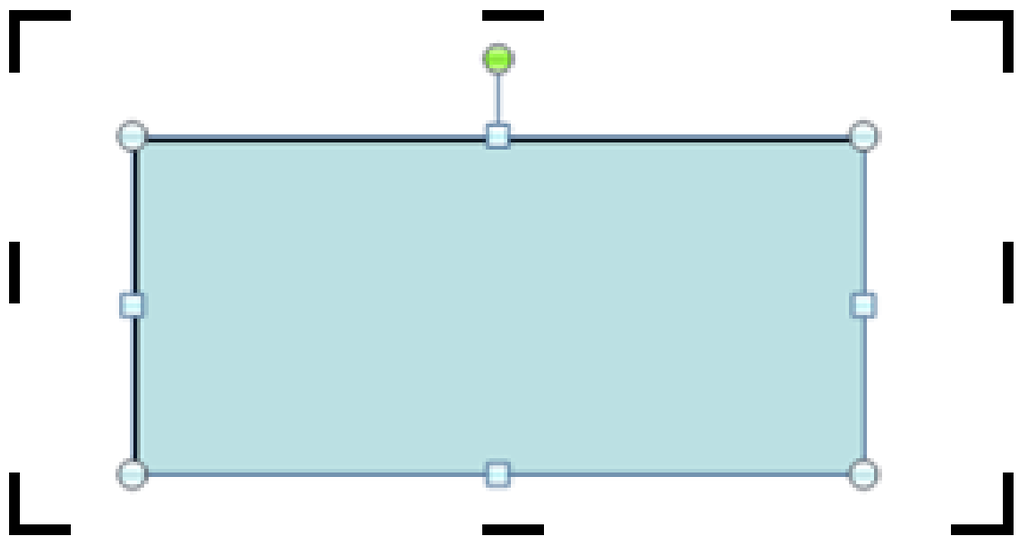
Widget Affordances

Well-designed widgets have clear affordances

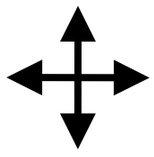
e.g. resize handles:



crop handles:



motion arrows



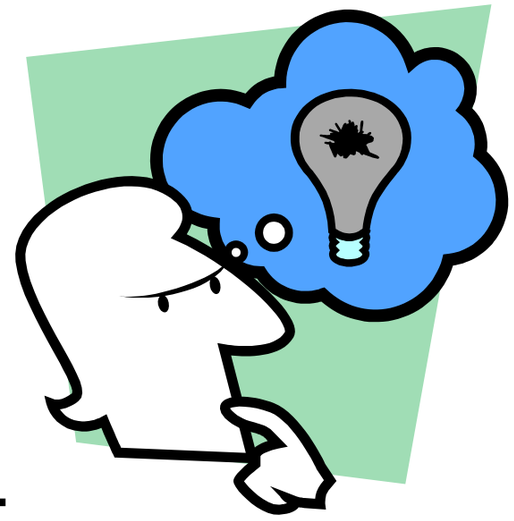
Conceptual Models

Mental Representations

Users' understanding of how interface works

People have preconceived models

- Infix vs. postfix calculators
- Delete file by dragging into trash can

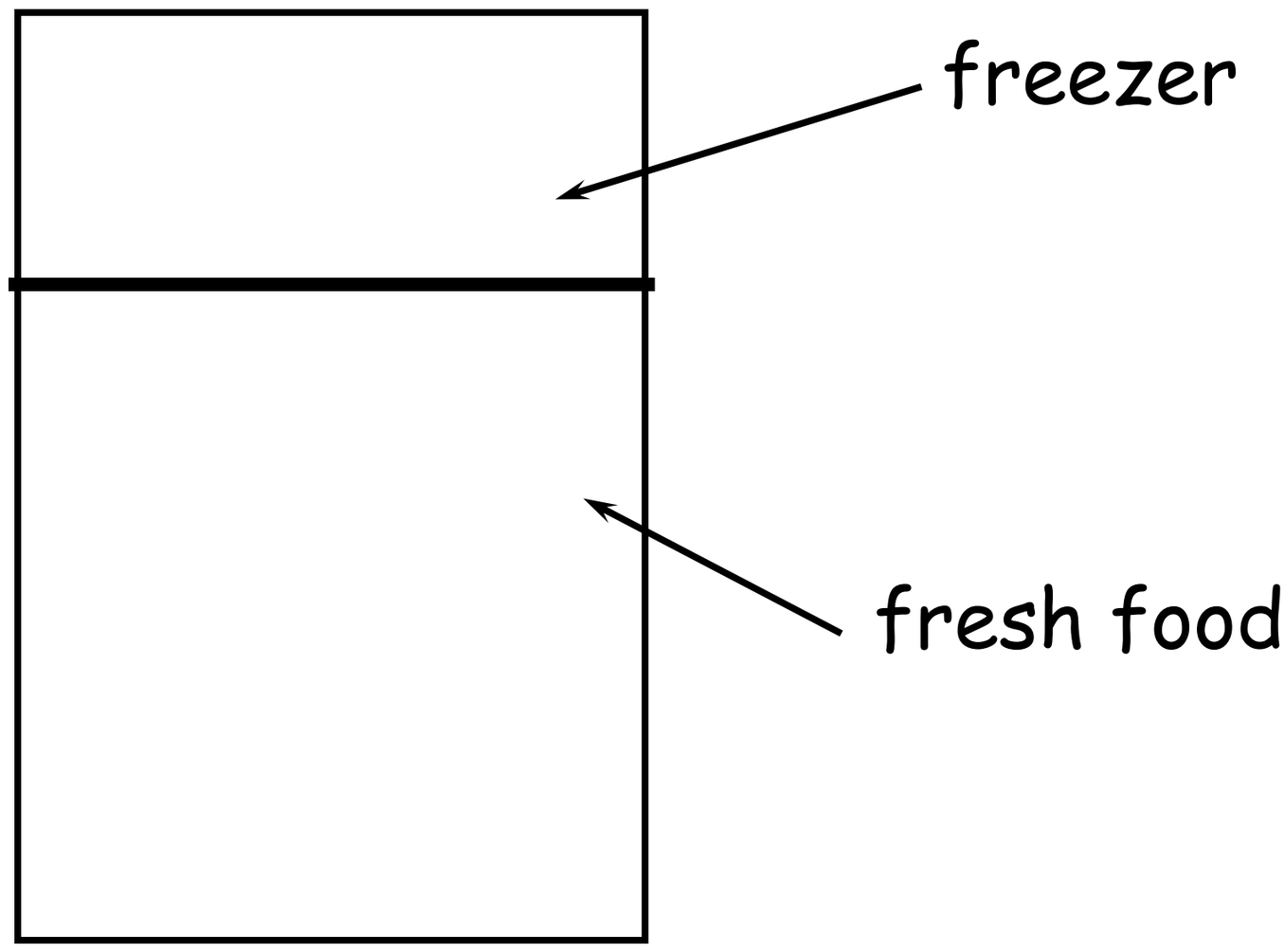


Changing mental models can be difficult

Interfaces Must Communicate Model

Online help / documentation useful (but shouldn't be necessary)

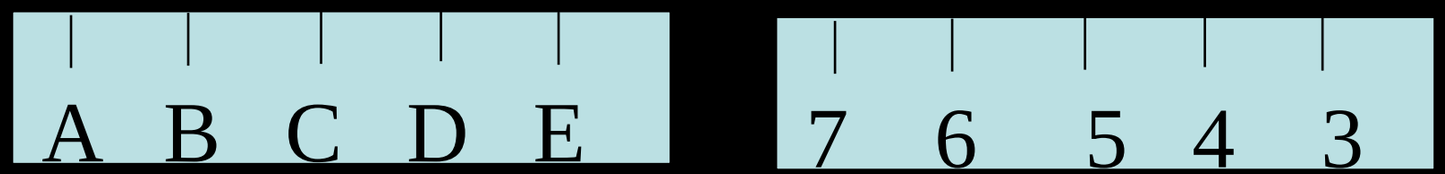
Refrigerator



Problem: freezer too cold, but fresh food just right

Refrigerator Controls

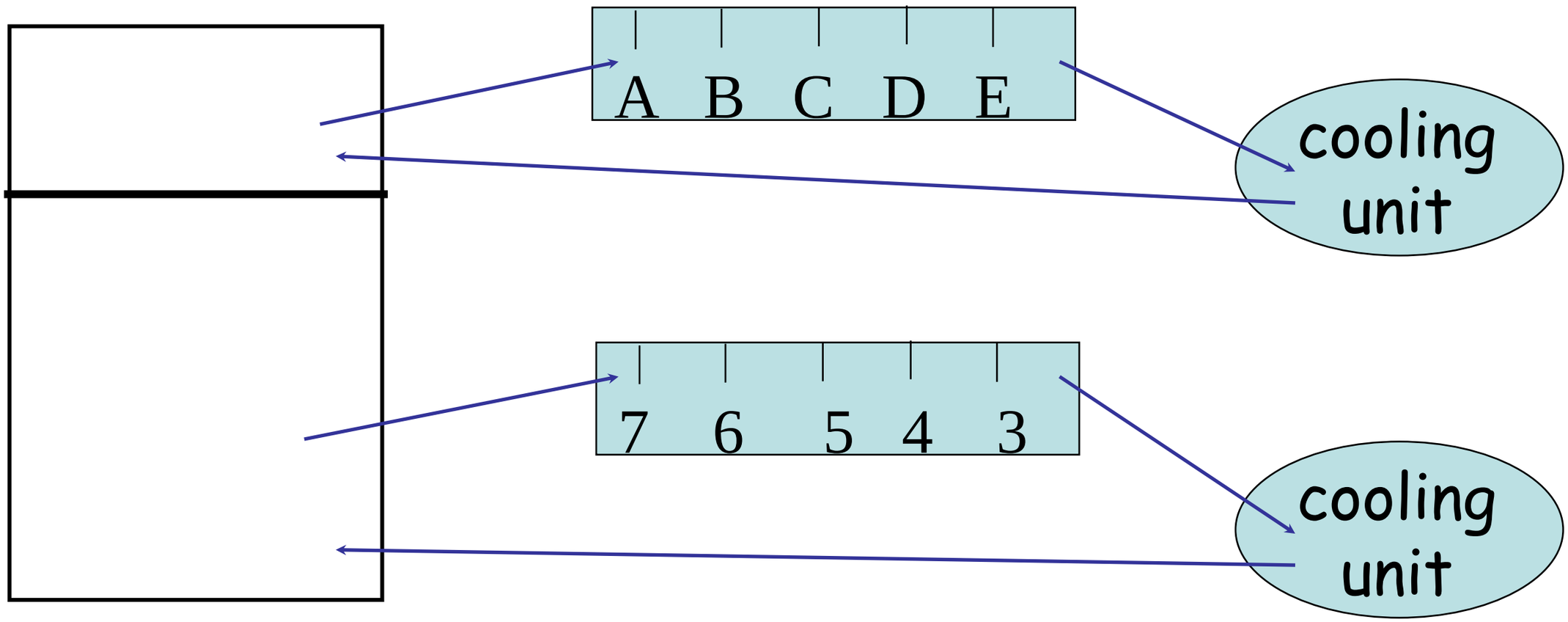
Normal Settings	C and 4
Colder Fresh Food	C and 5-6
Coldest Fresh Food	B and 7
Colder Freezer	D and 6-7
Warmer Fresh Food	C and 3-1
OFF (both)	0



Freezer Fresh Food

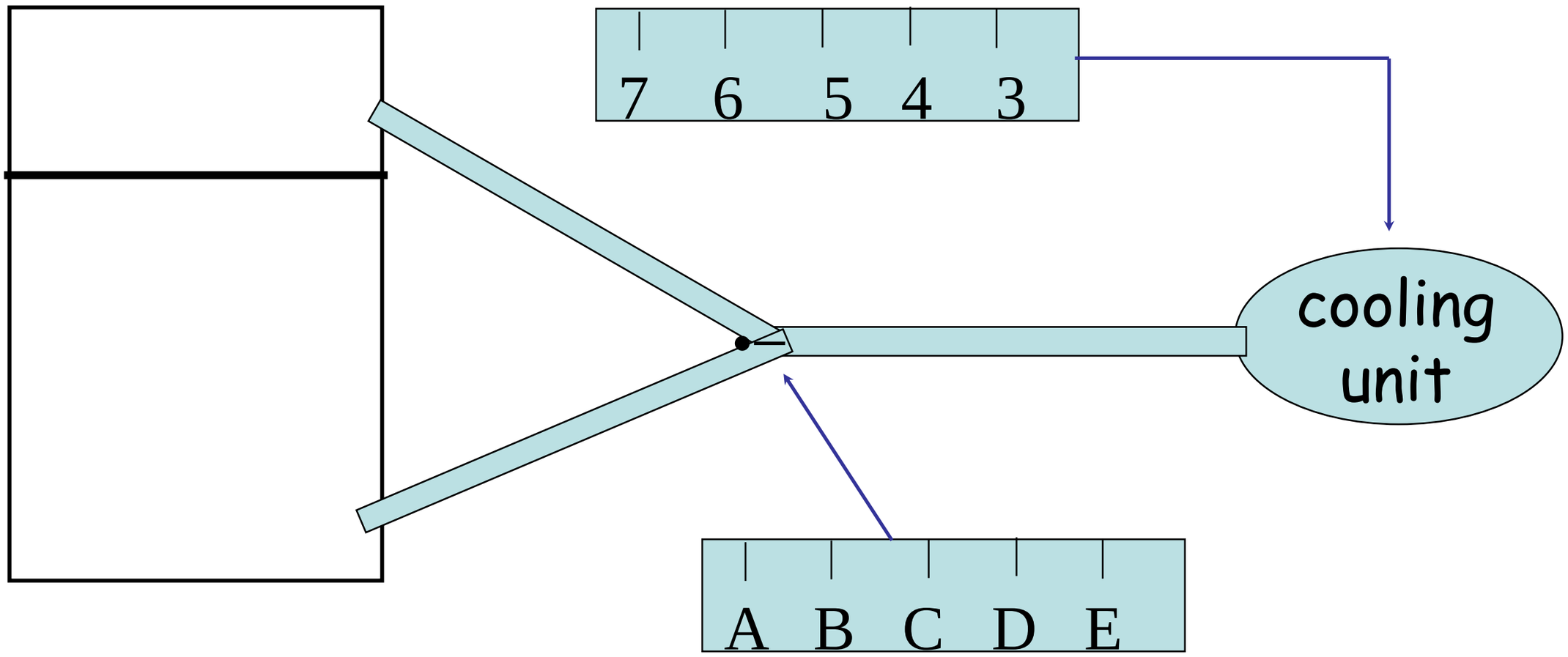
What is your conceptual model?

Most Likely Conceptual Model



Independent Controls

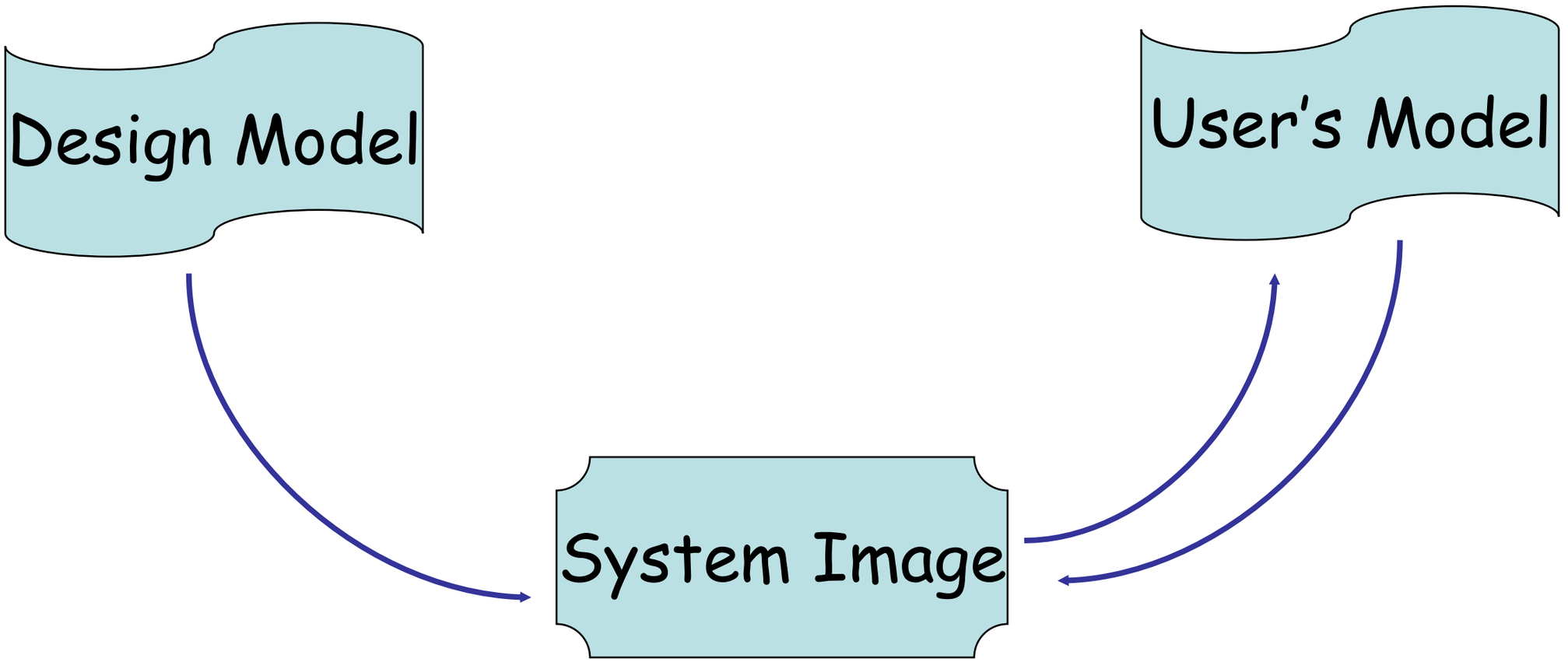
Correct Conceptual Model



Possible solutions:

- Make controls map to user's model *
- Make controls map to actual system

Conceptual Models



- Designers model may not match user's model
- Users get model from experience & usage
  - Users only work with system image, not with designer

- What if the two models don't match?

Mismatches between models

- Errors
- Slow
- Frustration
- ...

Preconceived Models

People have preconceived models of how things work:

- how does your car start?
- how does an ATM machine work?
- how does your computer boot?

Allows us to predict how things will work or not work

Based on slide by Saul Greenberg

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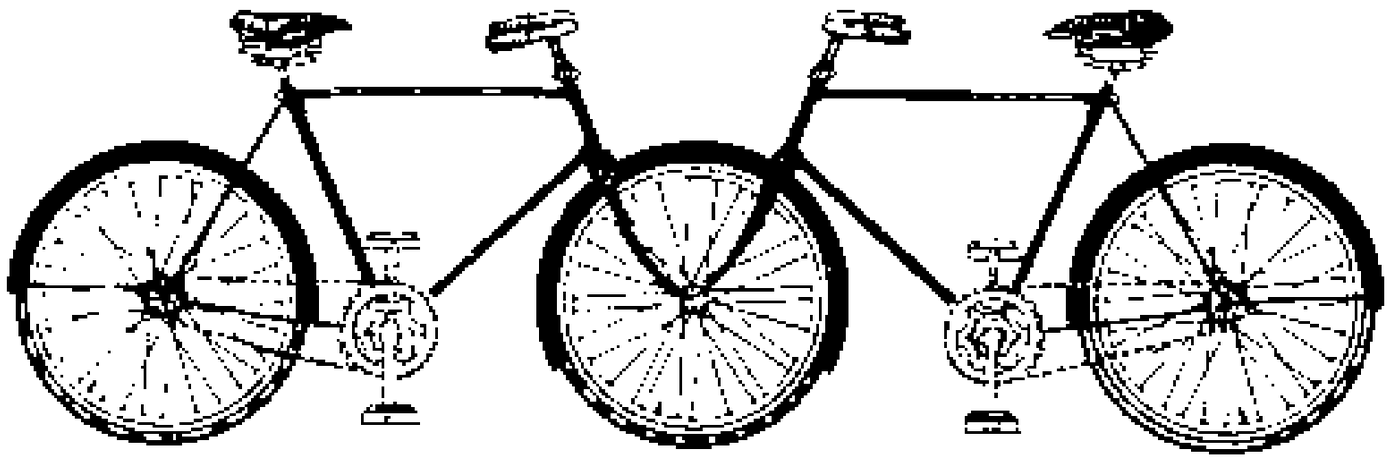


Based on slide by Saul Greenberg

Preconceived Models Often Wrong!

Extracted from fragmentary evidence

- Turn thermostat up above final setting to heat room up faster.

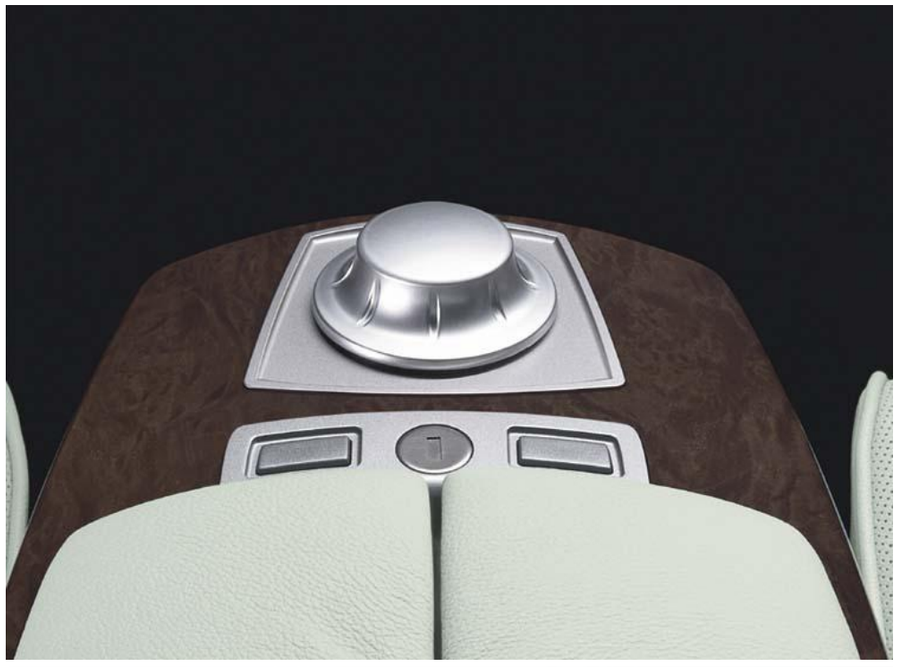
People find ways to explain things

- Computer terminal breaks when accessing the library catalog
- Certain you're driving on the correct road

Design Principles

1. Make Controls Visible

Poor Visibility (BMW's iDrive)



Don Norman's critique is here.

Poor Visibility (BMW's iDrive)

Single control to access 700 parameters.

Large display shows choices

- Full visual attention required
- Heavy use of abbreviations:
  - "DSC/DTC" "BC" etc

- Mapping inconsistent, sometimes turn left to move right.

How do you put someone on hold?

How do you set the alarm?

Too Much Visibility?

6 remote controls for “modest” home theater

2. Make Sure Mapping is Clear

Mapping: Relationship between controls and their result

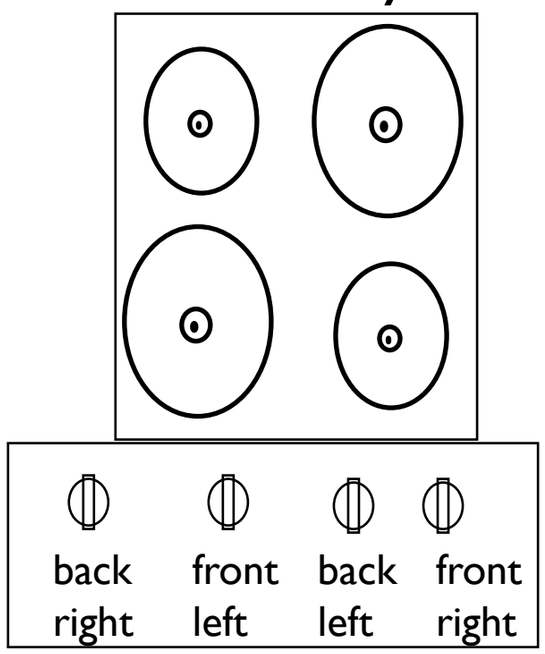
Mercedes Seat Adjustment

Front-back audio balance

Does it control moving sound left/right or front/back?

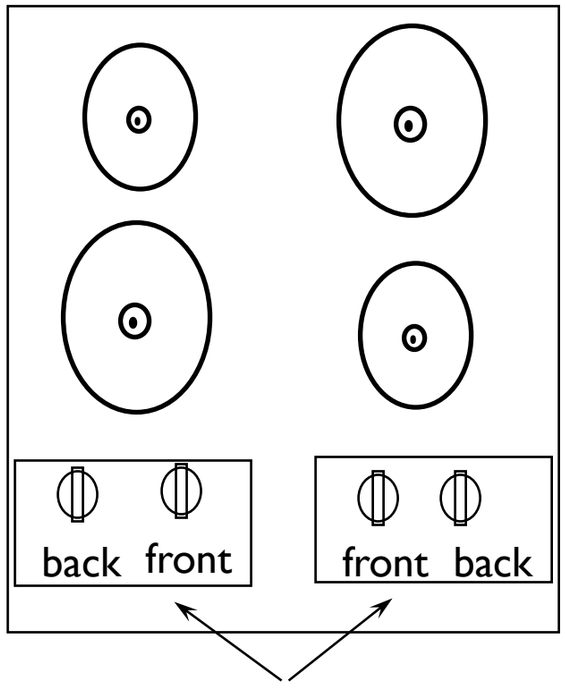
Stovetop Controls

arbitrary



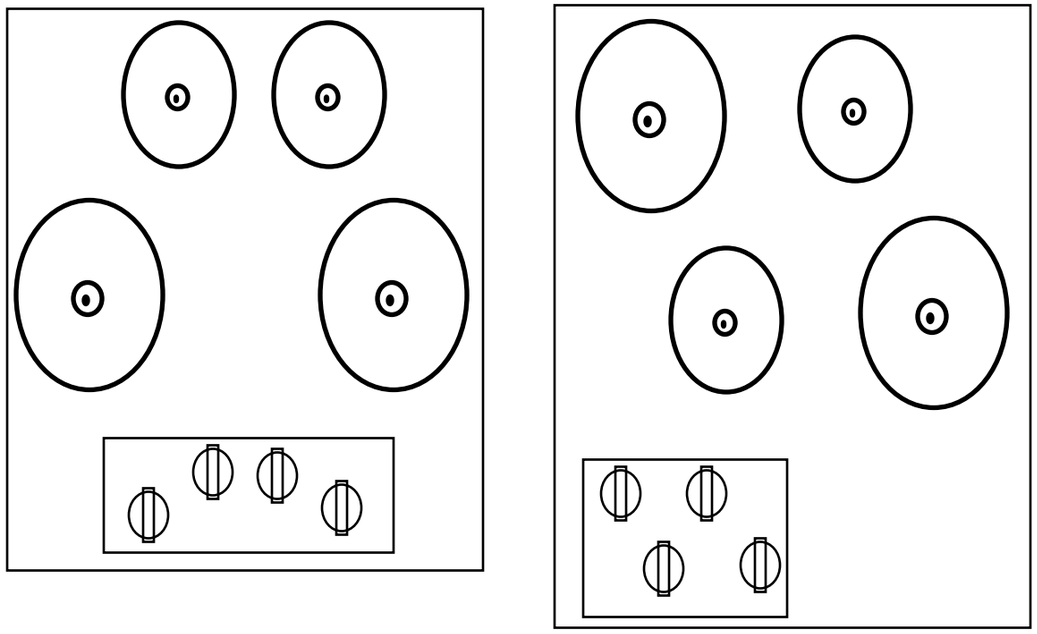
24 possibilities, requires:
-visible labels
-memory

paired



2 possibilities per side
=4 total possibilities

full mapping

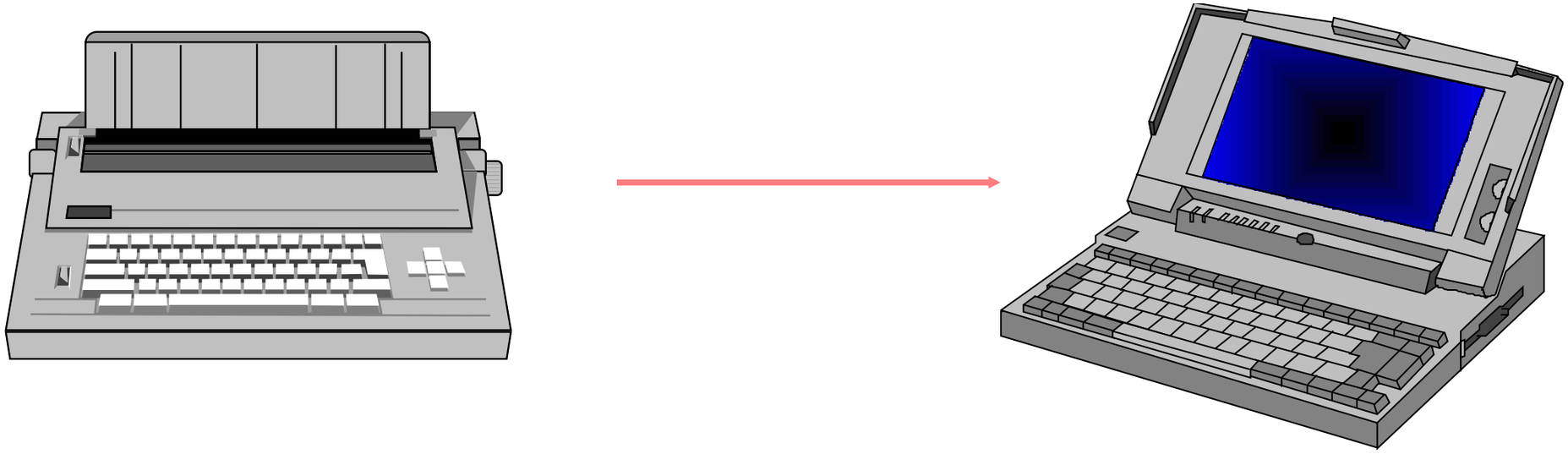


Slide adapted from Saul Greenberg

Transfer Effects

People transfer expectations from known objects to similar new ones

- Positive: previous experience applies to new situation
- Negative: previous experience conflicts with new situation



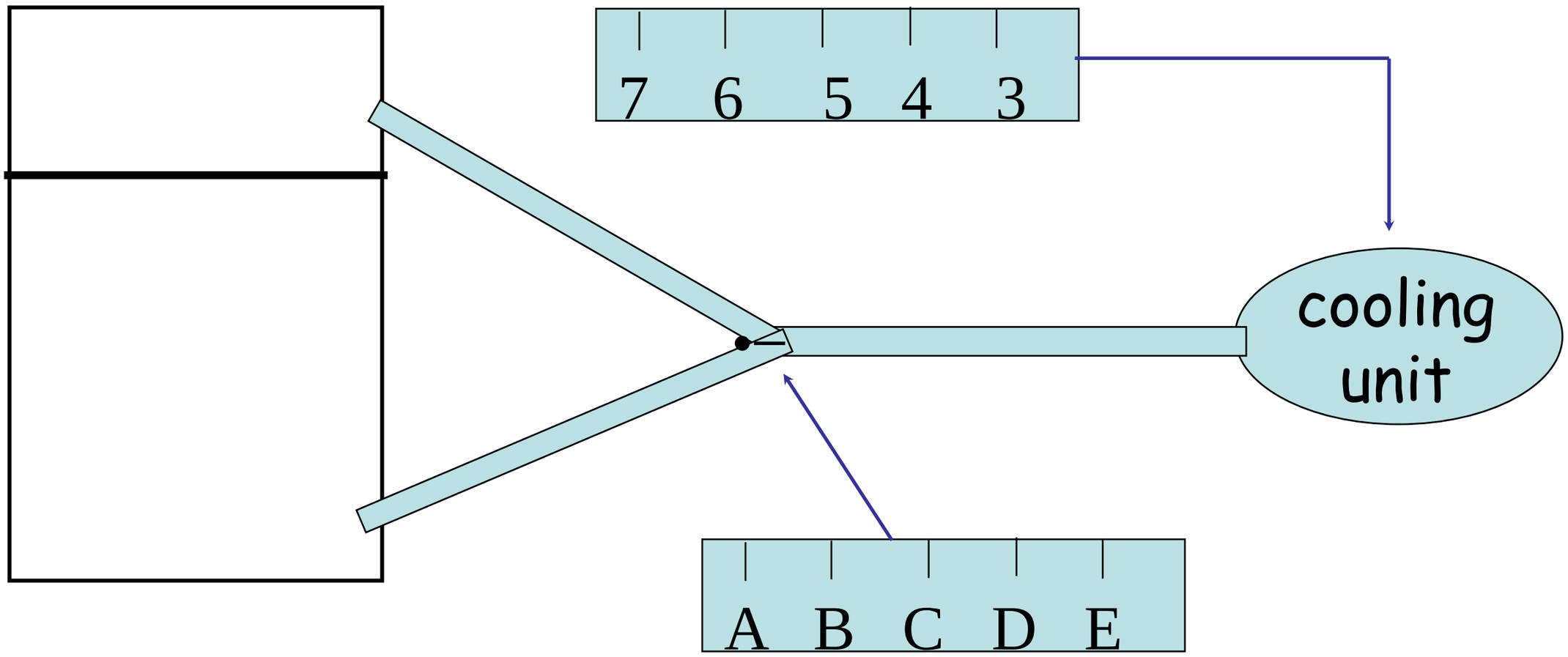
3. Provide Feedback

People press >> 1 time

- Unclear if system has registered the button press

Elevator buttons light up → reducing multiple presses

Poor Feedback



Took a day for refrigerator to adjust to new settings

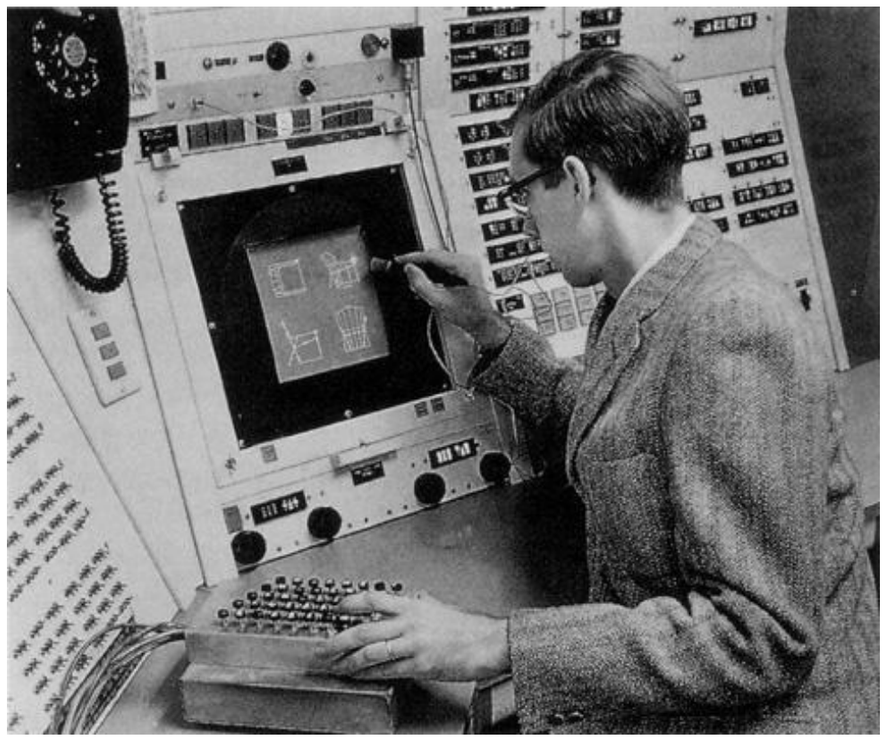
Direct Manipulation

Use one-to-one "identity" mappings.
Hand action = object action

First demonstrated in Sutherland's Sketchpad

Literal DM is hard to do without
a pen interface, in fact tangible interfaces the only real examples

But interfaces can be DM from the mouse pointer onward – the mouse interface doesn't require any more learning.



Direct Manipulation

Topobo

Direct Manipulation

The touch screen

Direct Manipulation

Wii controllers

Direct Manipulation

Video

Metaphor

Definition

The transference of the relation between one set of objects to another set for the purpose of brief explanation

Lakoff & Johnson

– "...the way we think, what we experience, and what we do every day is very much a matter of metaphor."

– in our language & thinking - "argument is war"

- …he attacked every weak point
  ... criticisms right on target
  ... if you use that strategy

Metaphors can highlight some features, suppress others

– There is some systematicity to the transference

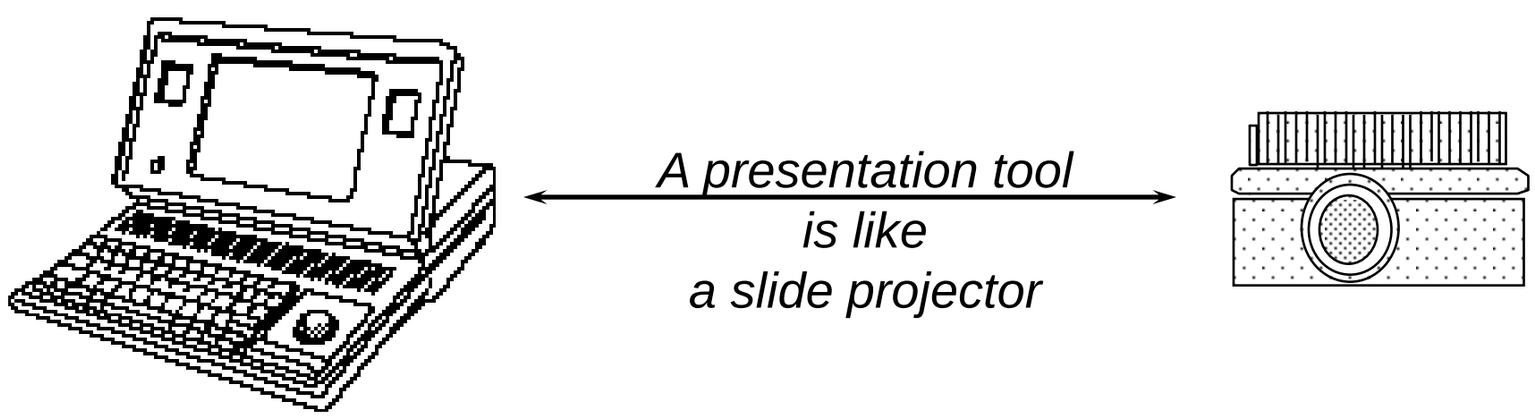
Interface Metaphors

Purpose

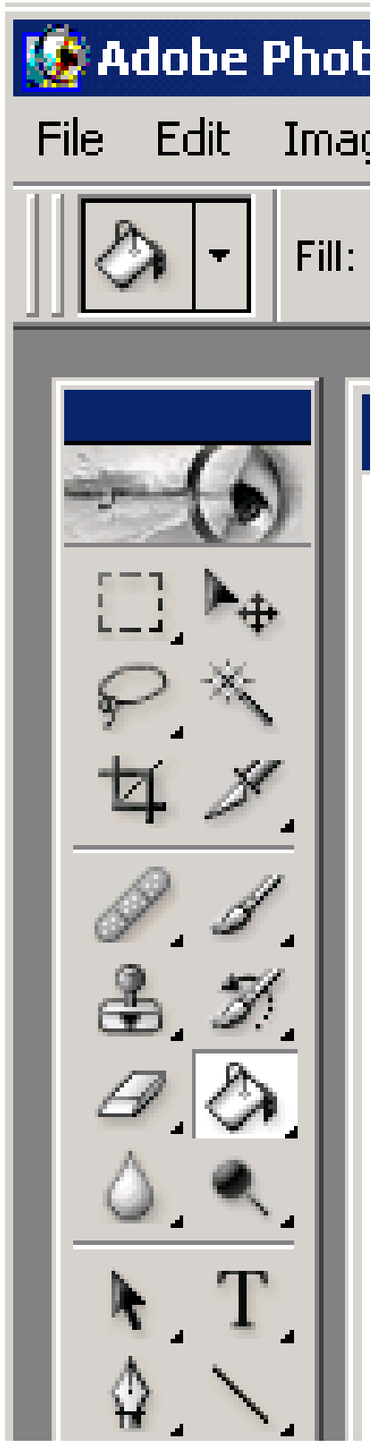
- Function as natural models
- Leverages knowledge of familiar, concrete objects/experiences
- Transfer this knowledge to abstract tasks and concepts

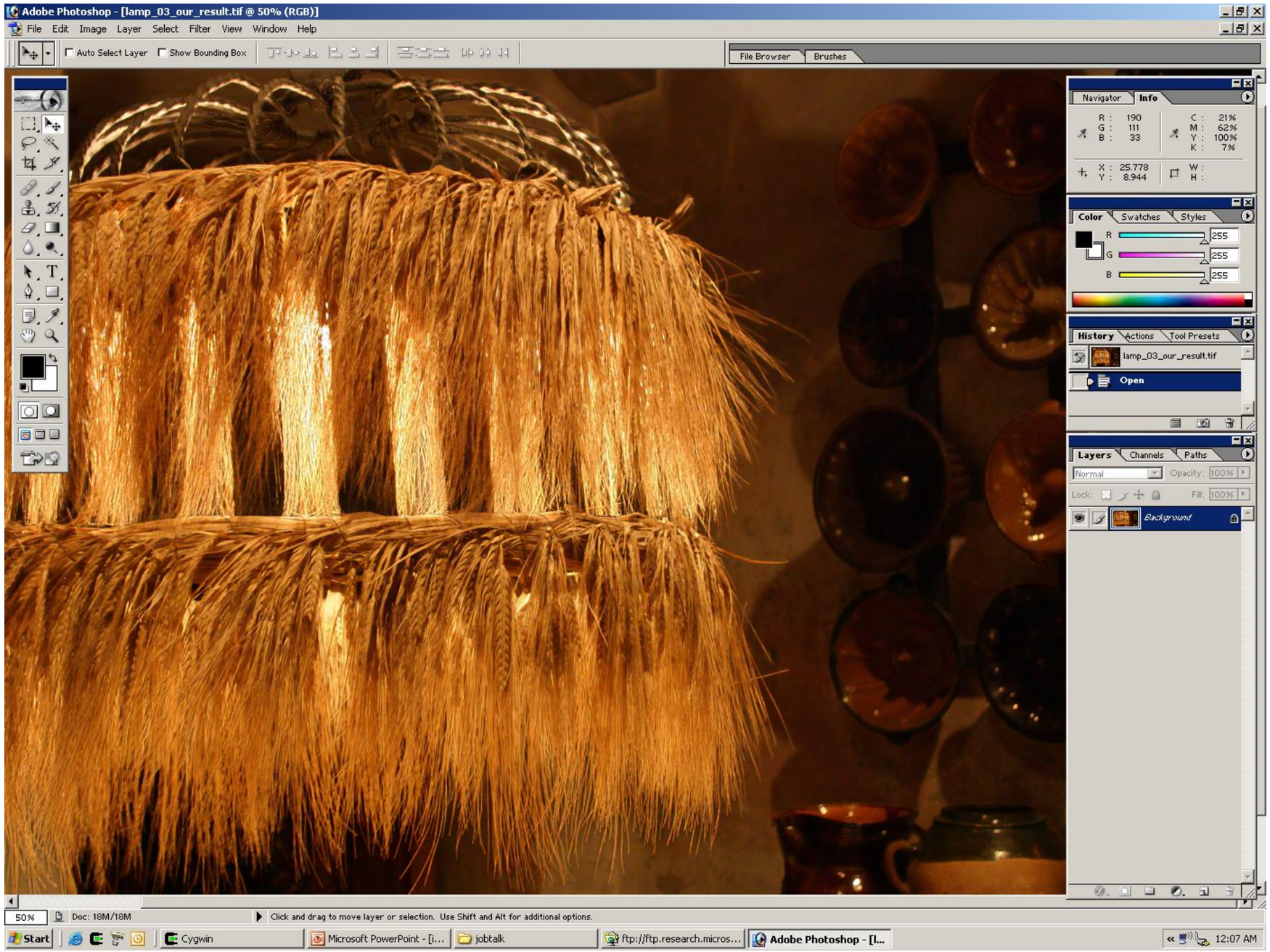
Problem

- Inaccurate or naive conceptual model of the system



The Painting Metaphor





The Desktop Metaphor

Started at Xerox PARC

- Xerox Star
- Bitmapped screens made it possible
- Windows, Folders
- Document actions: open, edit,…

Not meant to be a real desktop

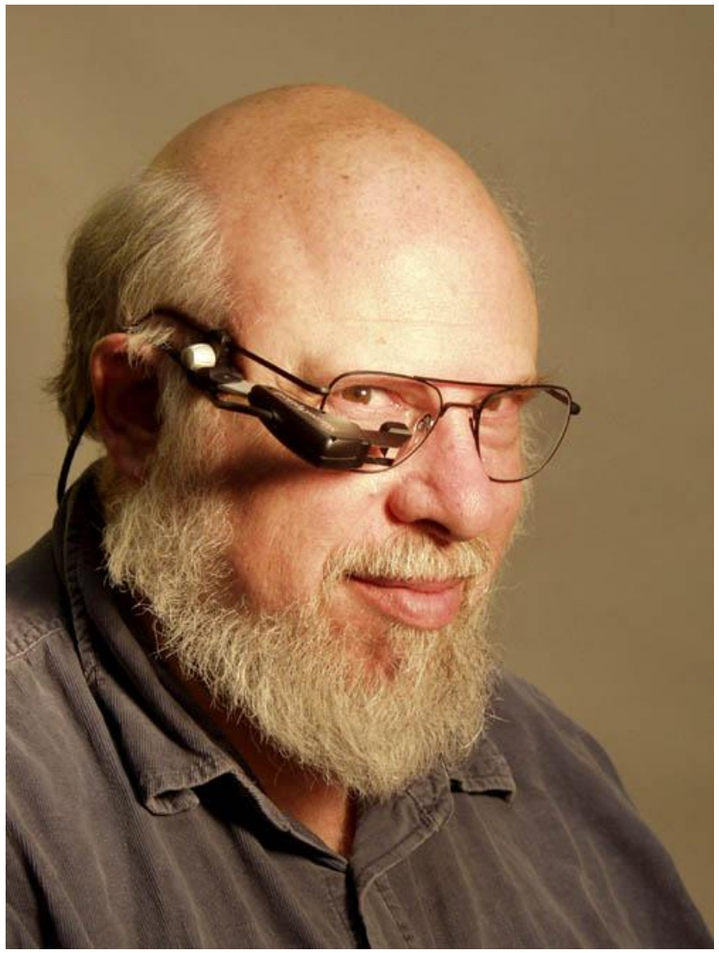
- Idea is to organize information in a way to allow people to use it in the way they use information on their desktops
- Allow windows to overlap – make the screen act as if there were objects on it

Mobile Metaphors?

Rubber Sheet

Flick scroll – Heavy sheet

Cognition



Jef Raskin

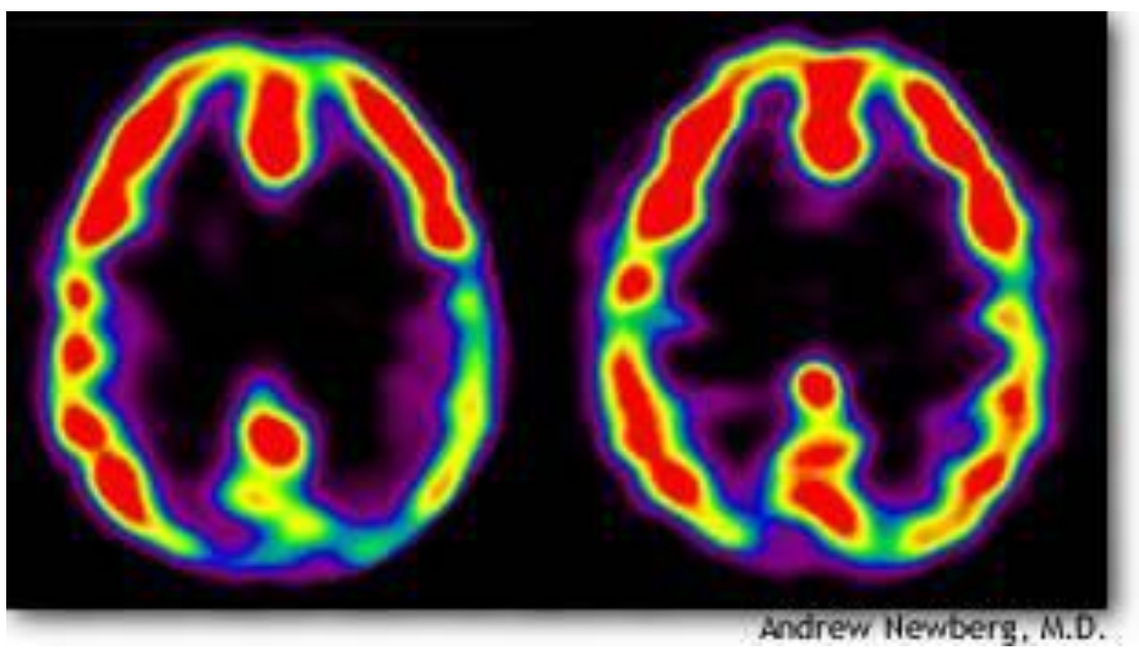
Cognitive Engineering

- Ergonomics:
  - Accounts for statistical variation of human variability
    - Design a car seat that fits 95% of the population
  - Says that designing products that interact with us physically is reasonable straightforward

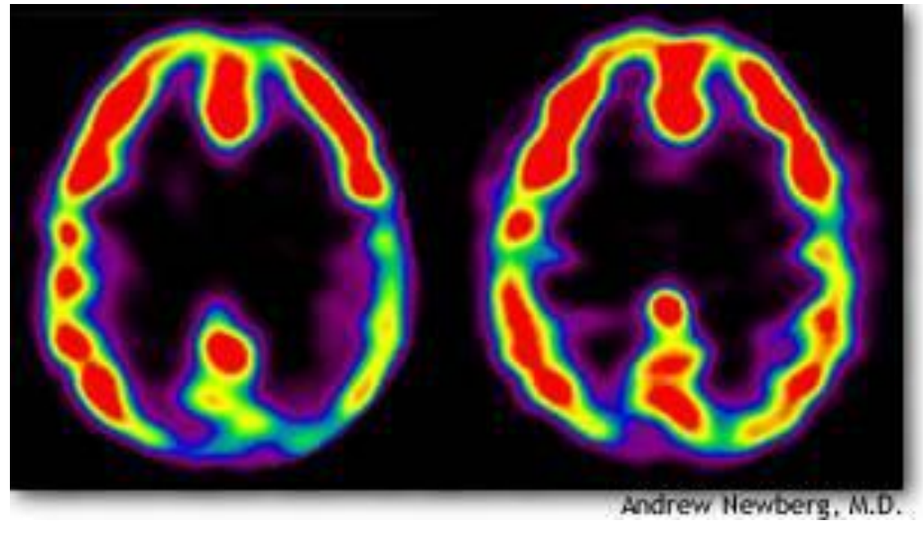
- Cognetics: Ergonomics of the mind
  - Study of the "engineering scope of our mental abilities"
  - This is the applied side of cognitive science

Cognitive Conscious / Unconscious

- Examples?
  - What is the last letter in your first name?
    - You know it but weren't consciously accessing this information a moment ago, but now you are.
  - How do your shoes feel right now?
  - How did "The Shining" make you feel?
  - Having a name on the "tip of your tongue"



Locus of Attention



- What is it?
  - An idea/object/event about which you are intently and actively thinking
  - The one entity on which you are currently concentrating
    - You see and hear much more
    - E.g., background noise

- Why locus?
  - Focus implies volition; locus not always consciously control
  - Attention can be either active or "going with the flow"

Locus of Attention

Why is it important for HCI?

- Cannot be conscious of more than one task at a time
- Make the task the locus of attention
- Beware of the power of mental habits
  - Repetitive confirmations don't work
- Take advantage of it
  - Do pre-loading while user thinking about next step
  - Streamline resumption of interrupted tasks

Modes

Modes: Definition

What are they?

Modes: Definition

- What are they?
  - The same user actions have different effects in different situations.

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  - Examples?
    - Keycaps lock

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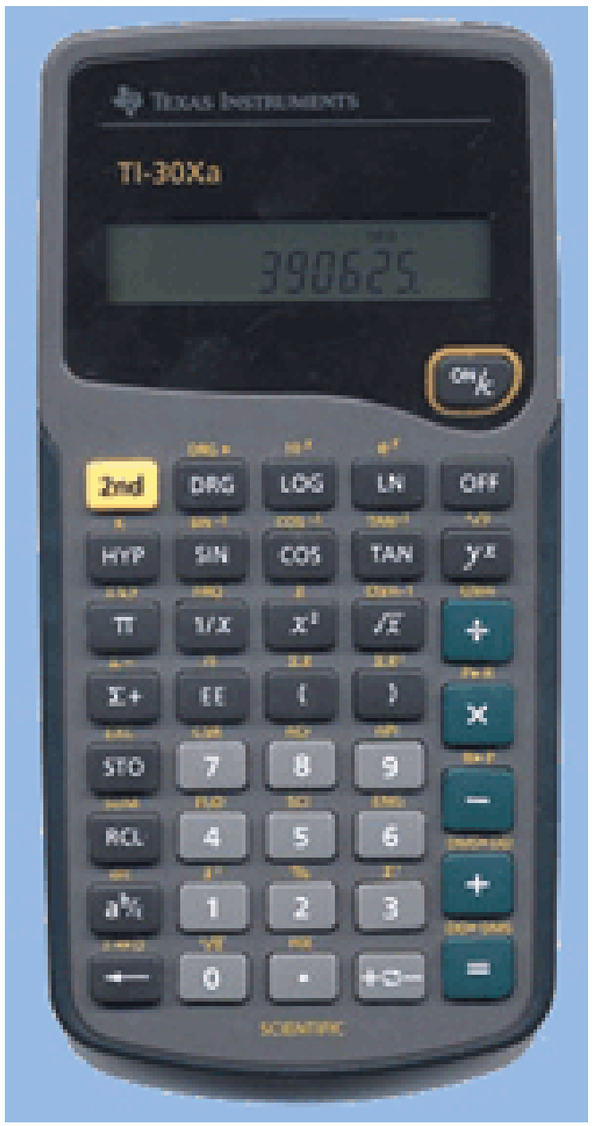


Search Interface Desiderata

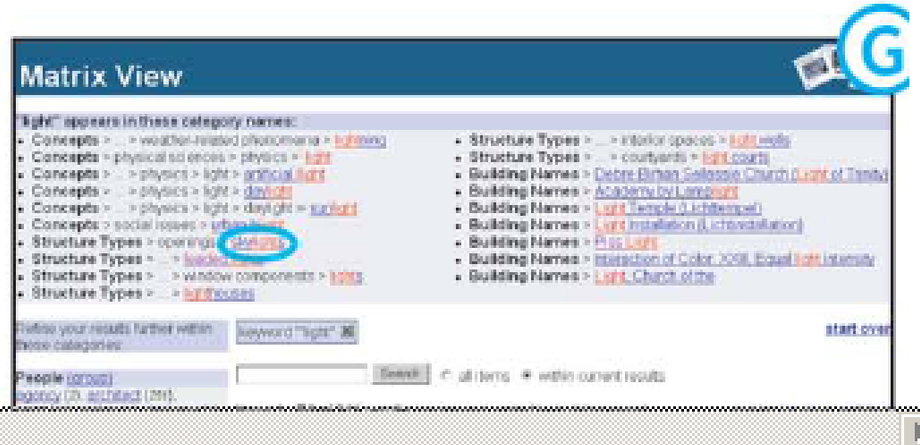
How does one build an interface that successfully supports both direct search and browsing? The press is rife with accounts of failed searches and unhappy users. For example, a recent report by Forrester Research found that while 76% of firms rated search as "extremely important" only 24% consider their Web site's search to be "extremely useful" [6].

In our view, the way to do things correctly is to use the evidence found in the results of usability studies of search systems. Unfortunately, most studies of search behavior are inconclusive about how to improve the system (for example, [12]), but some consistencies do emerge about what works. Here, we summarize which search features tend to work well, and which fail, in practice. Throughout this article, the assumption is that the user population for a browsing task, and a direct search interface when they knew precisely what they wanted.

Features found to work well across studies are color highlighting of search terms in result listings (also known as "keywords-in-context"); sorting of search results along criteria such as date and author; and grouping search results according to well-organized category labels [5].

Certain features are helpful in principle, but only work in practice if the underlying algorithms are highly accurate and if the interface is carefully designed. Some examples of such features include spelling correction, automated term expansion, and simple relevance feedback (also known as "more like this"), in which the user selects one item and the system shows items that are similar in scope along several dimensions.

Search for



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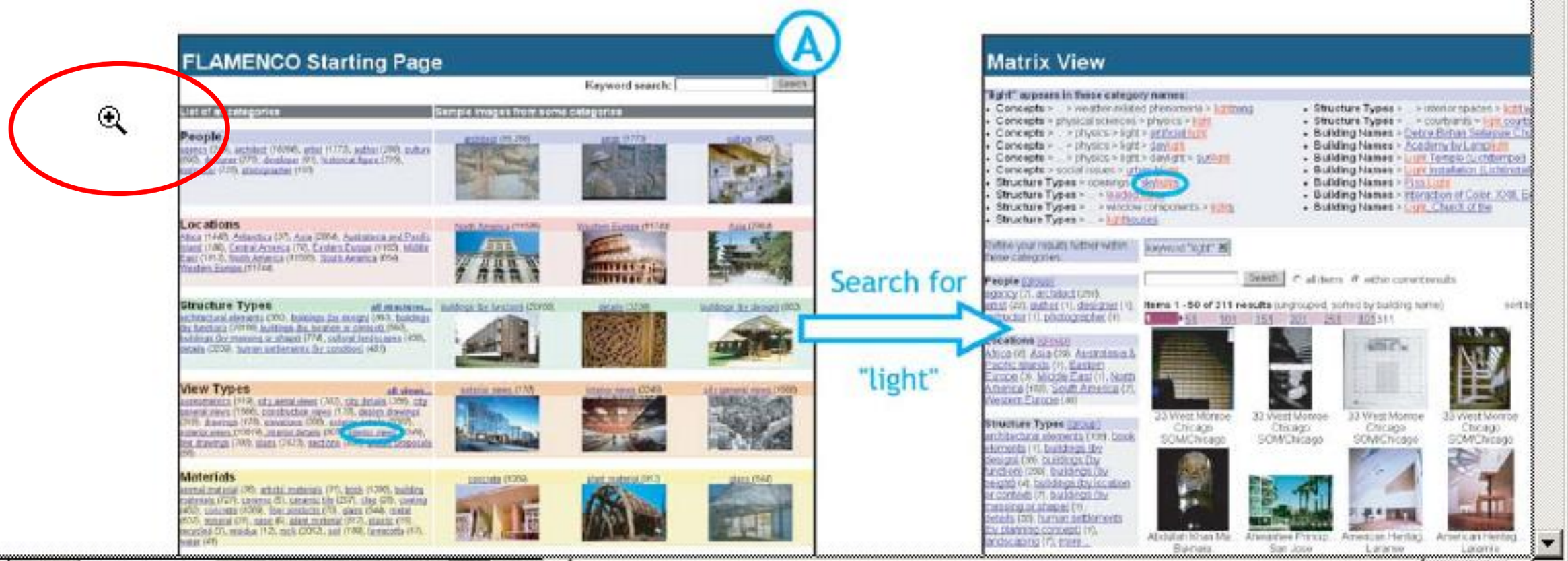


Using Modes in Interfaces

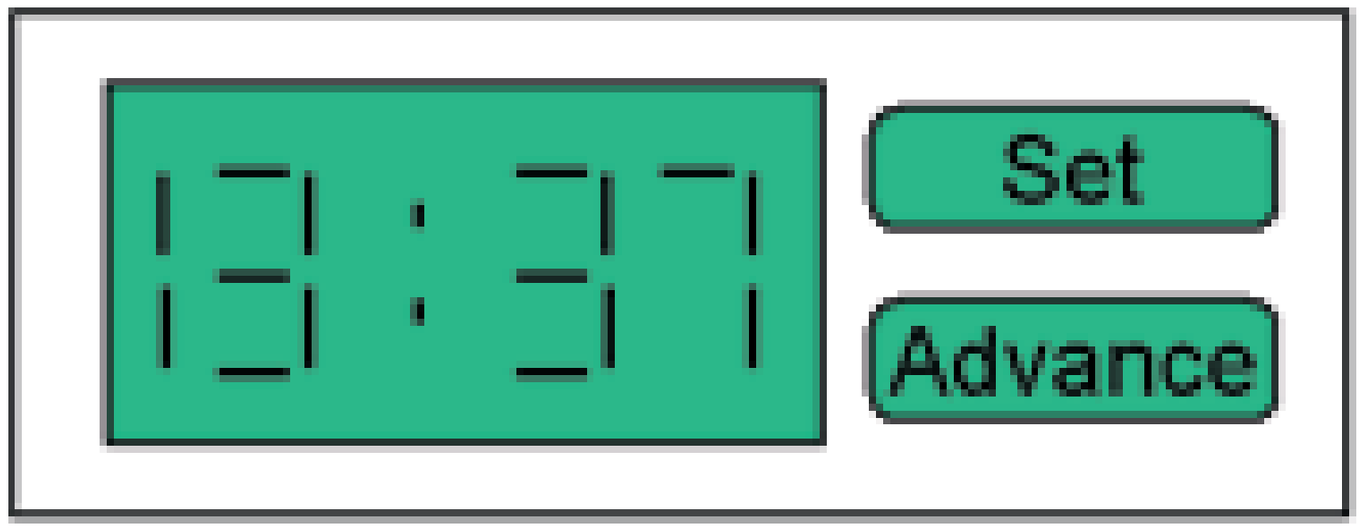
- When are they useful?
  - Temporarily restrict users' actions
  - When logical and clearly visible and easily switchable
    - Drawing with paintbrush vs. pencil
    - Autocorrect (if easy to switch the mode)

- Why can they be problematic?
  - Big memory burden
  - Source of many serious errors

- How can these problems be fixed?
  - Don't use modes – redesign system to be modeless
  - Redundantly visible

Redesigning to Avoid Modes

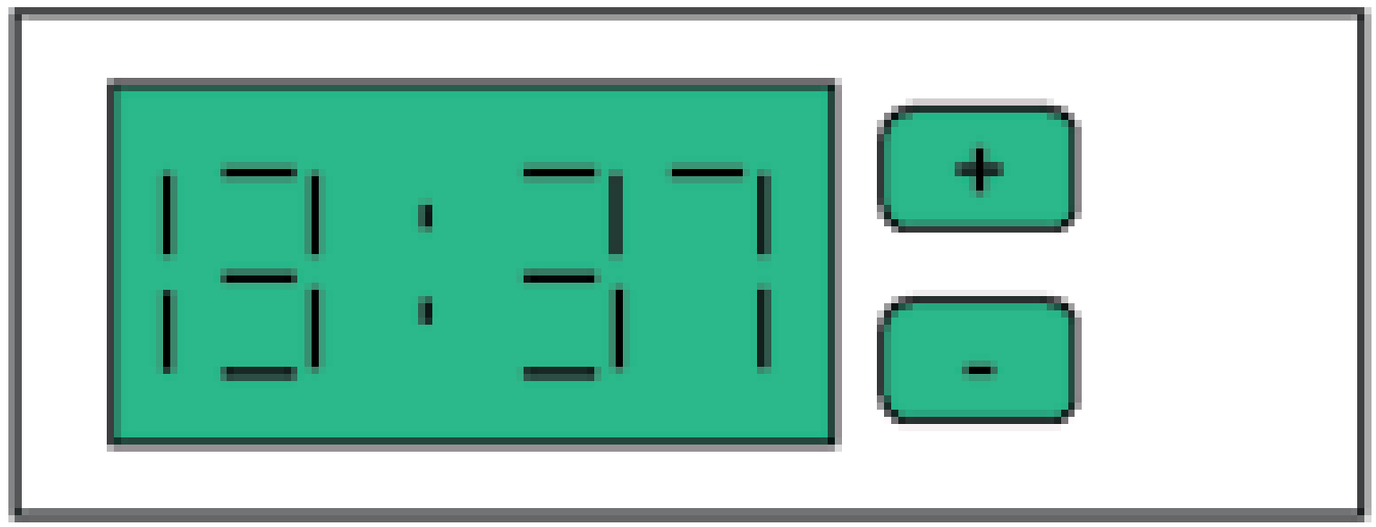
- Setting the time on a clock



Modal

Redesigning to Avoid Modes

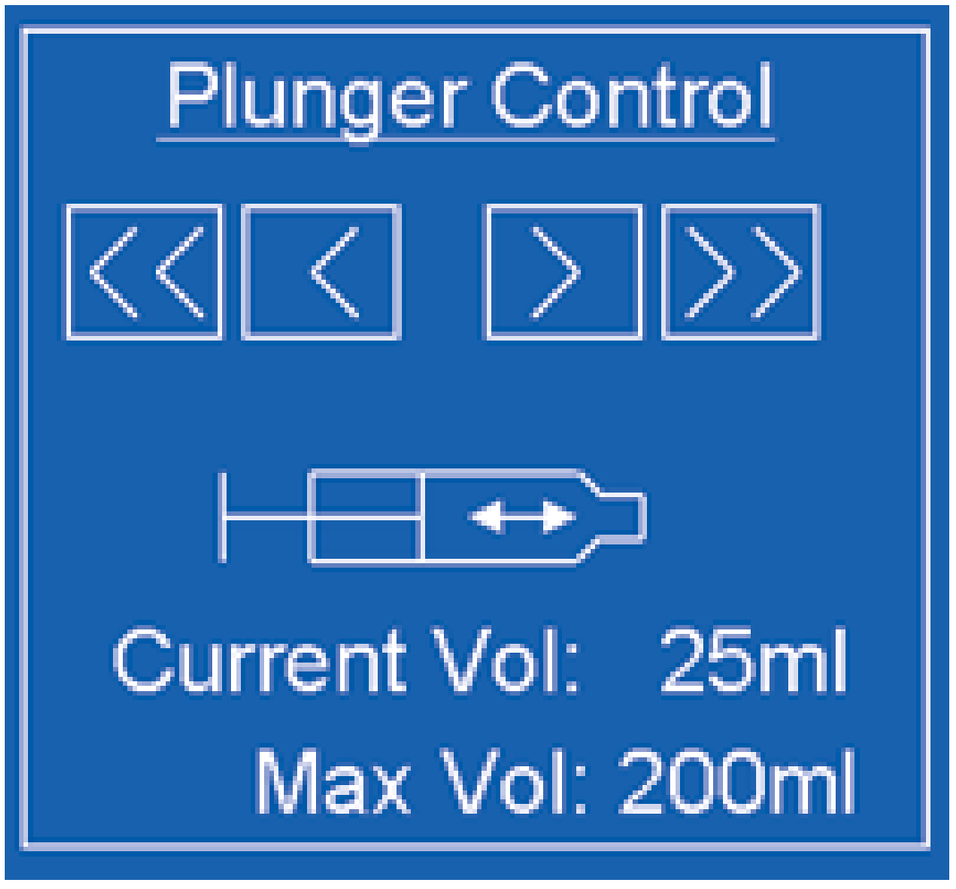
Setting the time on a clock



Modeless

Modes are Sometimes Good

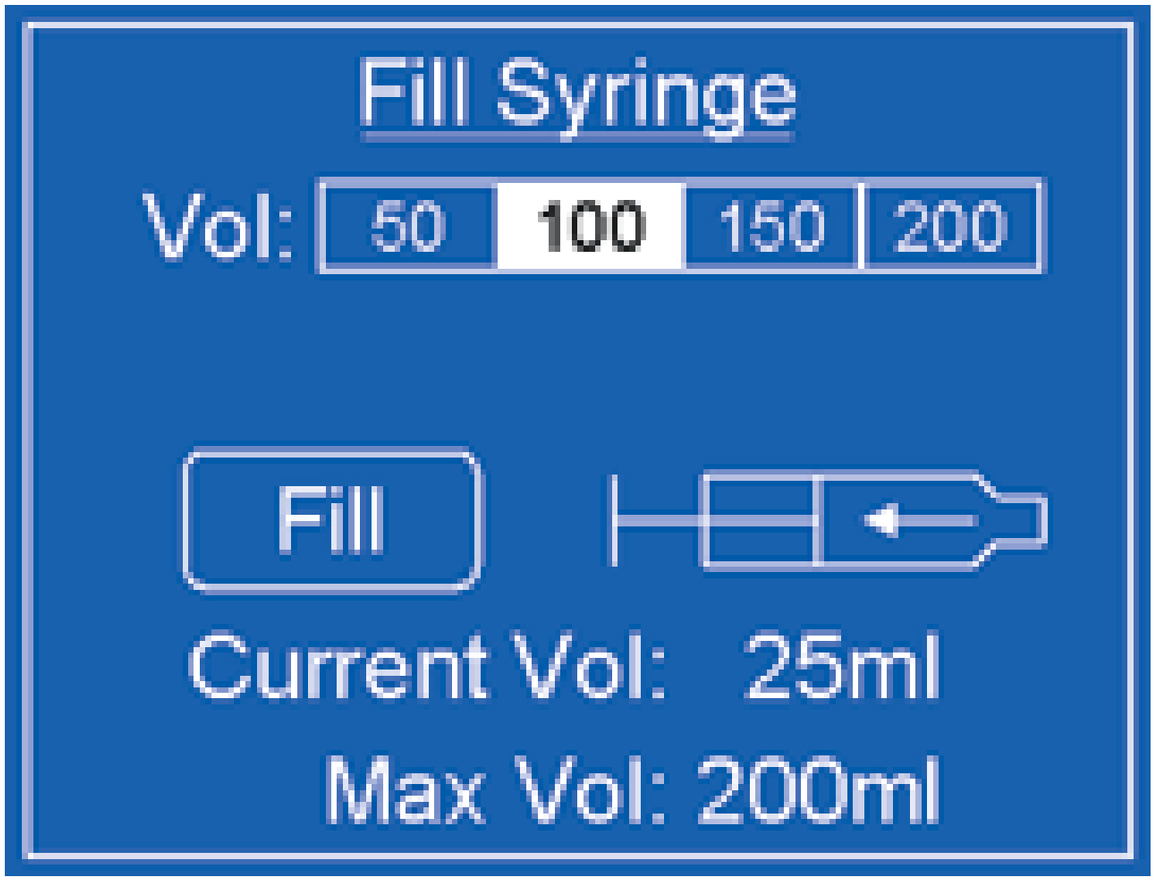
- Fill and empty syringe



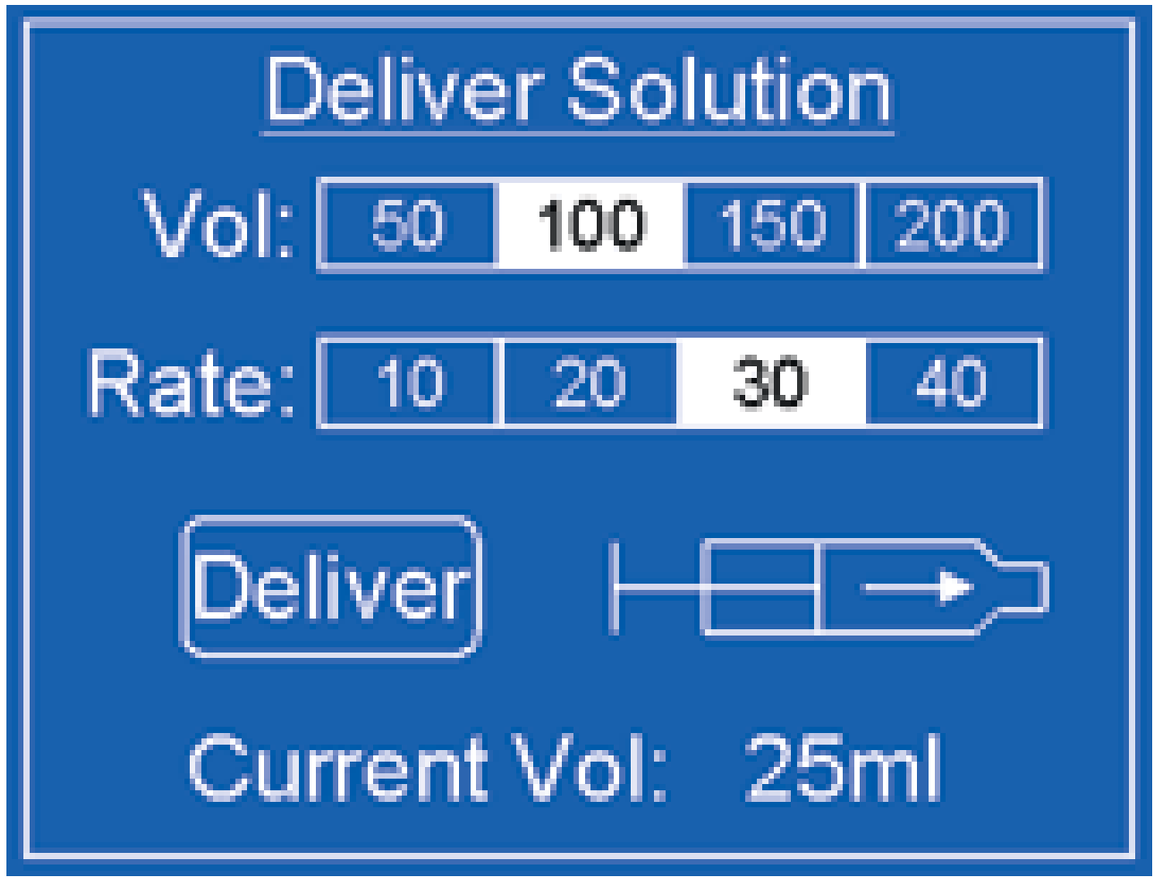
Modeless

Modes are Sometimes Good

- If task requires modes, interface may also contain modes



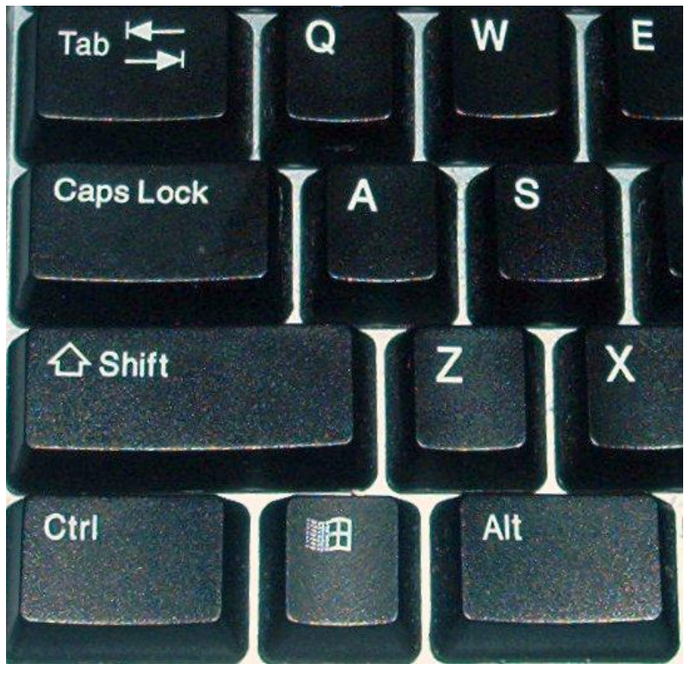
Fill Mode



Deliver Mode

Quasimodes

- Set and hold a mode via conscious, continuous action
  - Shift key to capitalize (vs. Caps Lock)
  - Foot pedal that must remain pressed
  - Pull down menus
  - Muscle tension reminds users they are holding a mode

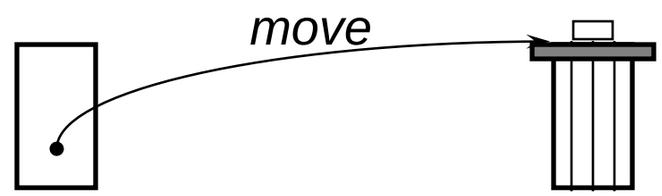


- Also known as “spring-loaded modes”

Noun-Verb VS Verb-Noun

- Noun-Verb: Select object, then do action
  - Emphasizes 'nouns' (visible objects) rather than 'verbs' (actions)

- Advantages
  - Closer to real world
  - Modeless interaction
  - Actions always within context of object
    - inappropriate ones can be hidden
  - Generic commands
    - the same type of action can be performed on the object
    - e.g. drag ‘n drop:



Bob's "Living Room" Metaphor

Apple's Cyberdog

Metaphor Caveats

Too limited

- The metaphor restricts interface possibilities

Too powerful

- The metaphor implies the system can do things it can't

Too literal or cute

- Makes it difficult to understand abstract concept

Mismatched

- The metaphor conveys the wrong meaning

Summary

- Affordances
- Conceptual Models
- Design Principles
- Metaphors
- Cognitive Conscious and Unconscious
- Modes