CSE 440: Introduction to HCI

User Interface Design, Prototyping, and Evaluation

Lecture 02:
Design of Everyday Things

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Daniel Epstein
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Tuesday/Thursday
10:30 to 11:50
MOR 234

What is Interaction?

Two-Way

- one-way is a reaction

Communicative

- information is sent

Receptive

- information is received

Effective

- the parties are changed as a result

What is Interaction?

Two-Way
Communicative
Receptive
Effective

Knocking over a chair

Clicking a Submit button on a web page

Two televisions, turned on, facing each other

A computer sending data to another via a network

Typing on a computer that is turned off

Picking up a telephone and putting it to your ear

Typing ESC on a screen that does not allow it

Models of Interaction

Models of interaction allow a closer look

- Define and describe an interaction
- Isolate areas where problems occur
- Design new interaction

Two examples at different scales

- Buxton's 3-State Model
- Norman's Execution-Evaluation Cycle

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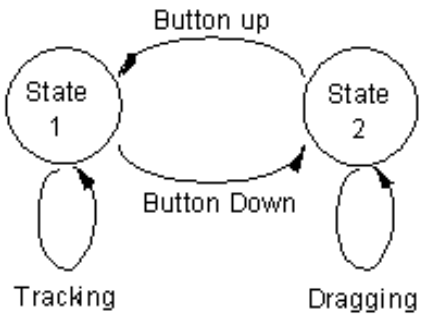
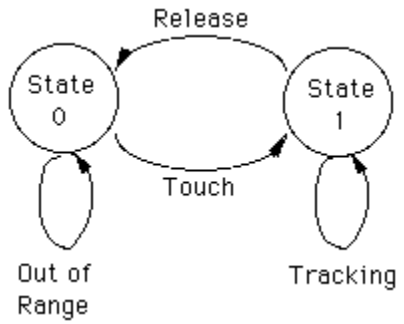
"All models are wrong, but some are useful"
George Box

Buxton's 3-State Model

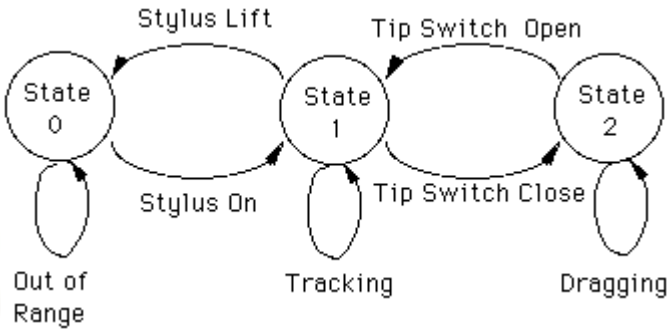
Mouse



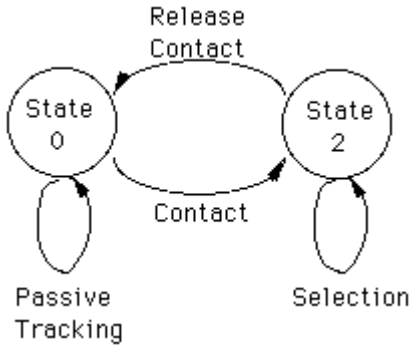
Touchpad



Stylus

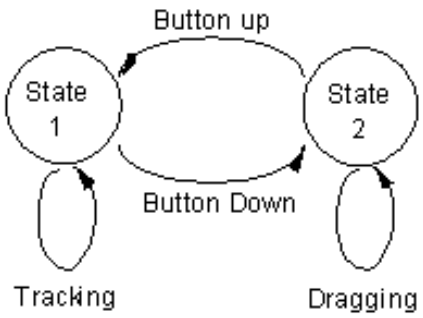


Touch Screen



Buxton's 3-State Model

Mouse



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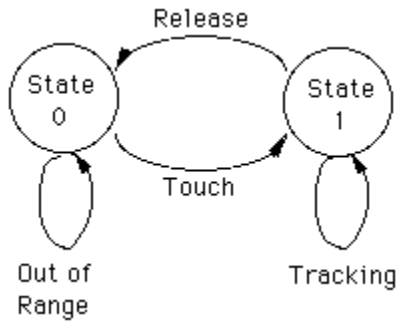

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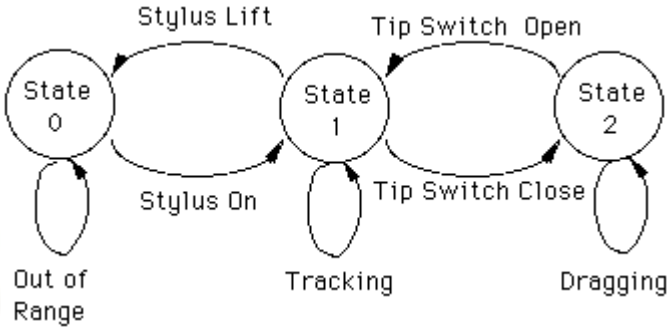

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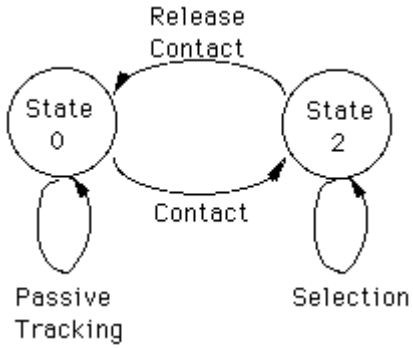


Which can support tooltip previews?

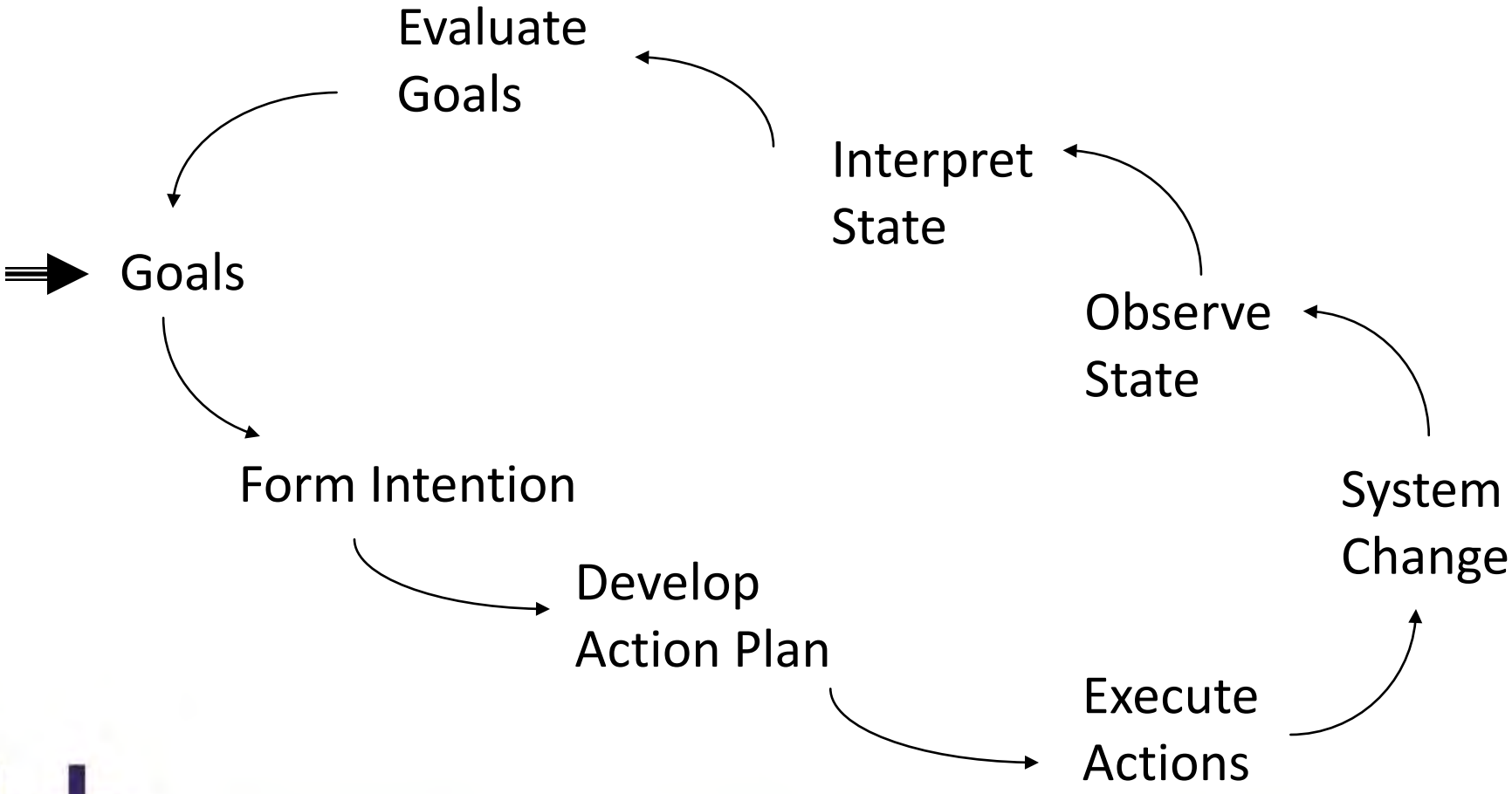
Norman's Execution-Evaluation Cycle

1. Establish the goal.
2. Form the intention.
3. Specify the action sequence.
4. Execute the action sequence.
5. Perceive the system state.
6. Interpret the system state.
7. Evaluate the system state with respect to the goals and intentions.

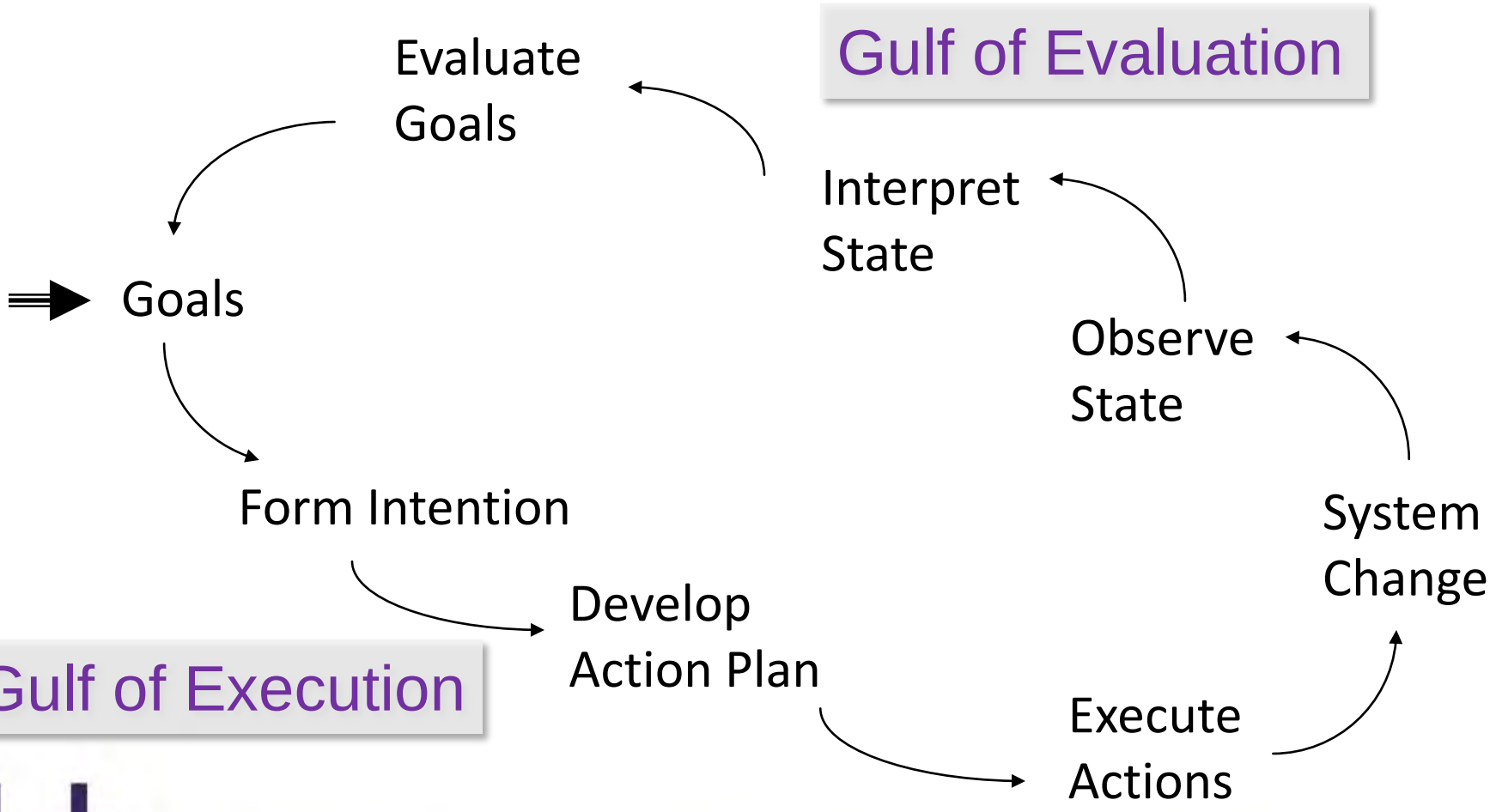
Turning on the Light

1. Establish the goal
   - Increase light in the room
2. Form the intention
   - To turn on the lamp
3. Specify the action sequence
   - Walk to the lamp, reach for the knob, twist the knob
4. Execute the action sequence
   - [walk, reach, twist]
5. Perceive the system state
   - [hear “click” sound, see light from lamp]
6. Interpret the system state
   - The knob rotated. The lamp is emitting light. The lamp seems to work
7. Evaluate the system state with respect to the goals and intentions
   - The lamp did indeed increase the light in the room [goal satisfied]

Norman's Execution-Evaluation Cycle



Norman's Execution-Evaluation Cycle



Bridging the Gulfs

Gulf of Execution: "How do I do it?"

- Commands and mechanisms need to match the goals, thoughts, and expectations of a person

Gulf of Evaluation: "What does it mean?"

- Output needs to present a view of the system that is readily perceived, interpreted, and evaluated

People build mental models to anticipate and interpret system response to their actions

- What can I do?
- How do I do it?
- What result will it have?
- What is it telling me?

Cooper's Mental Model Terminology

Implementation Model

How it works

(aka Design Model, Designer's Conceptual Model)

Manifest Model

How it presents itself

(aka System Image)

Mental Model

How a person thinks it works

(aka User Model, User's Conceptual Model)

Cooper's Mental Model Terminology

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Manifest Model

How it presents itself

(aka System Image)

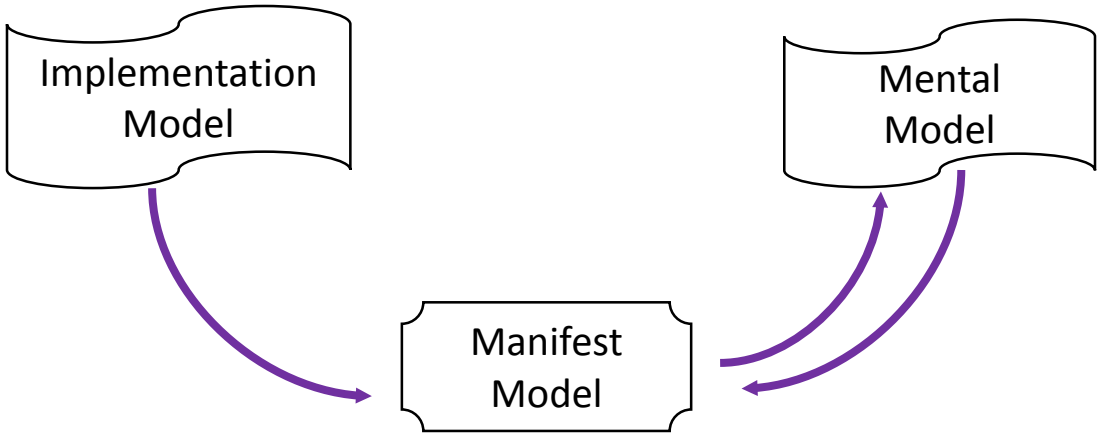
Mental Model

How a person thinks it works

(aka User Model, User's Conceptual Model)

These terms are sloppy and ambiguous out in the world

Manifest and Mental Models



Designer projects their model into an artifact

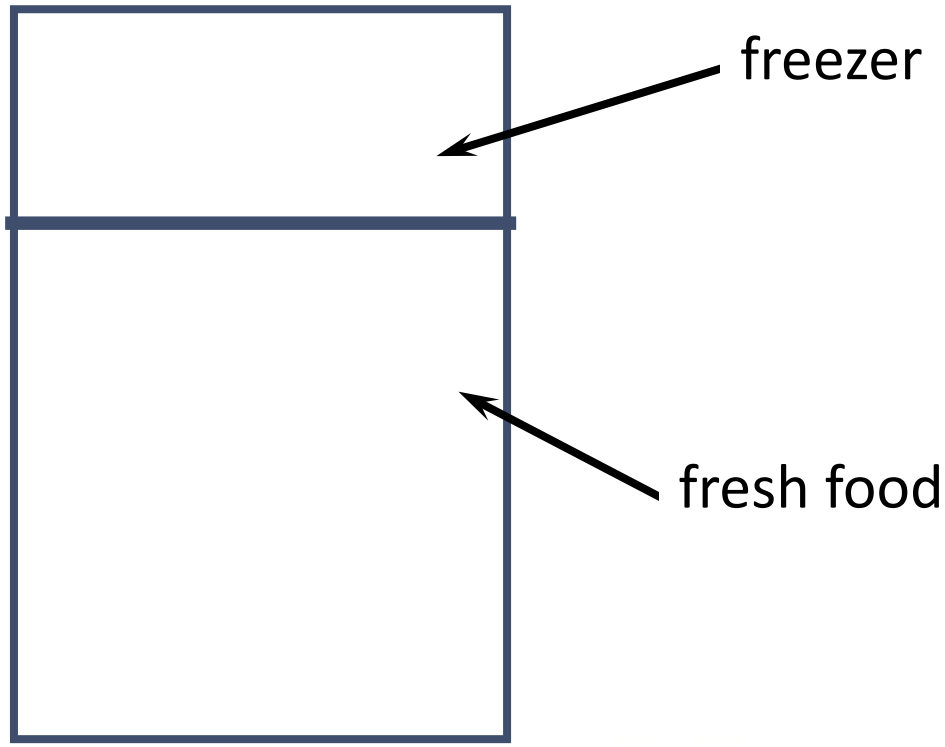
- Person forms their model based on interaction

People struggle until model matches manifest model

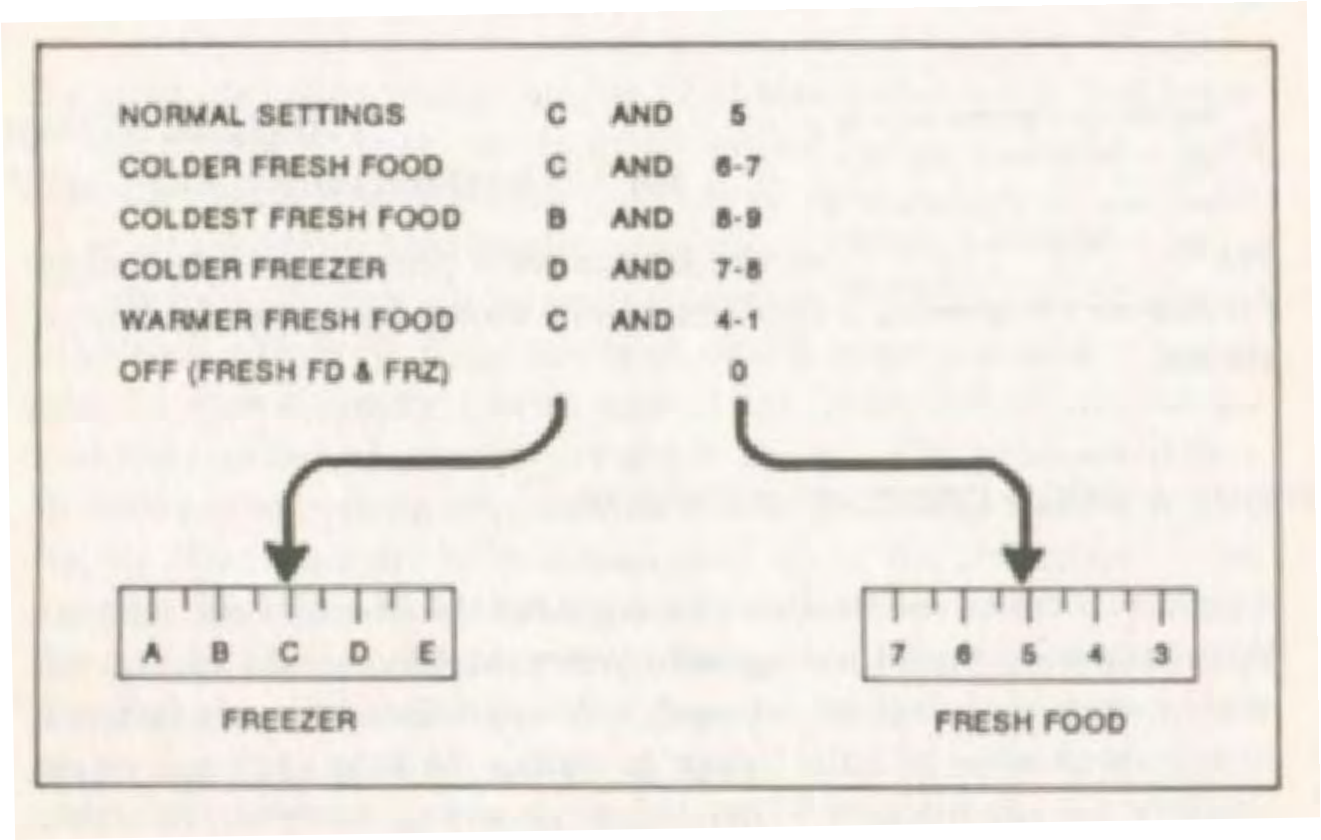
- Update mental model in response to breakdowns
- Not necessarily matching the implementation model

Mental Models

Problem: freezer too cold, fresh food just right

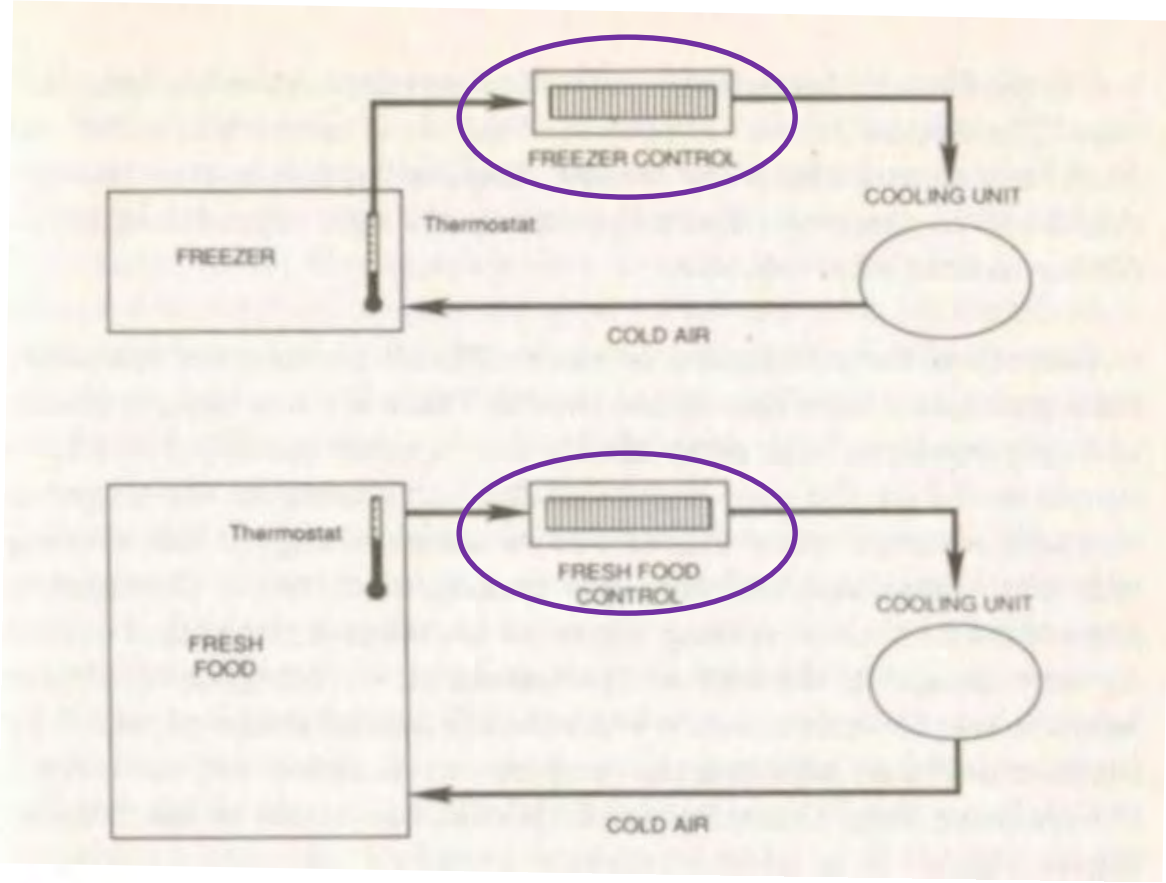


Manifest Model



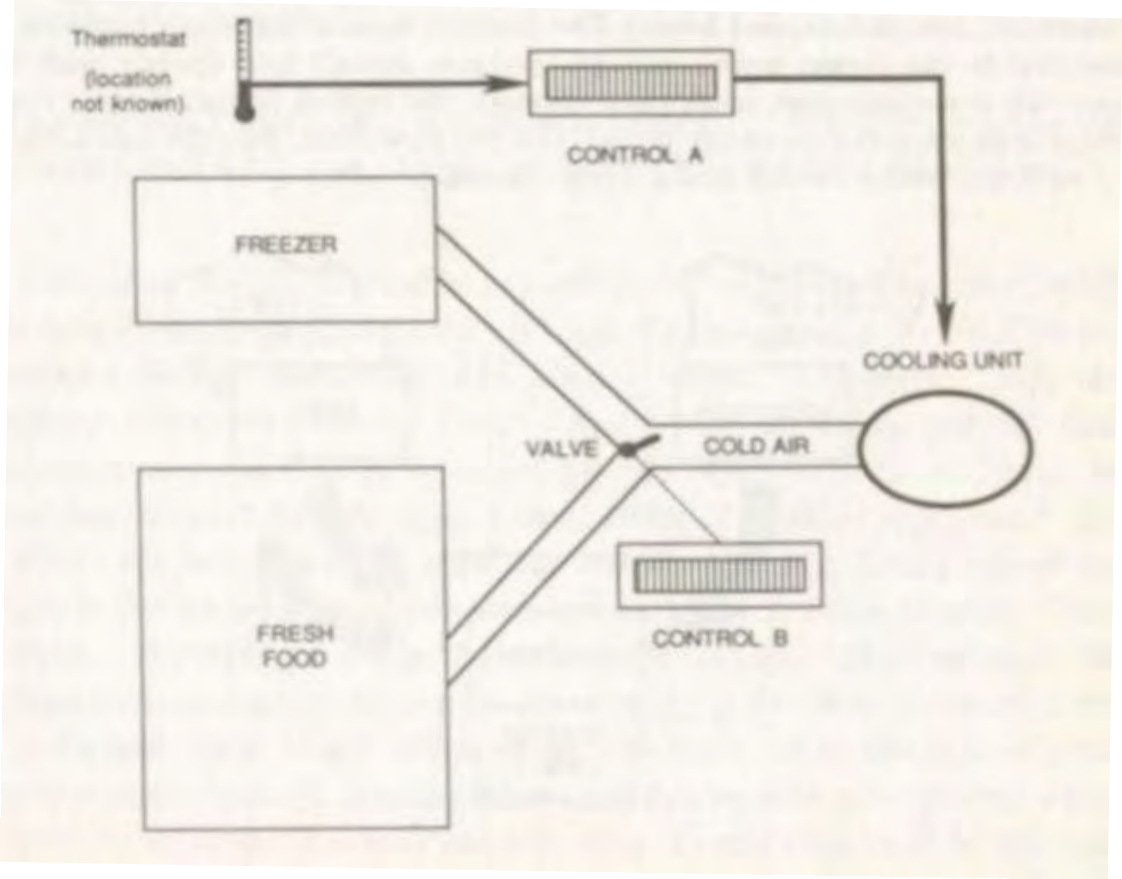
What if I want to make just the freezer warmer?

A Sensible Mental Model

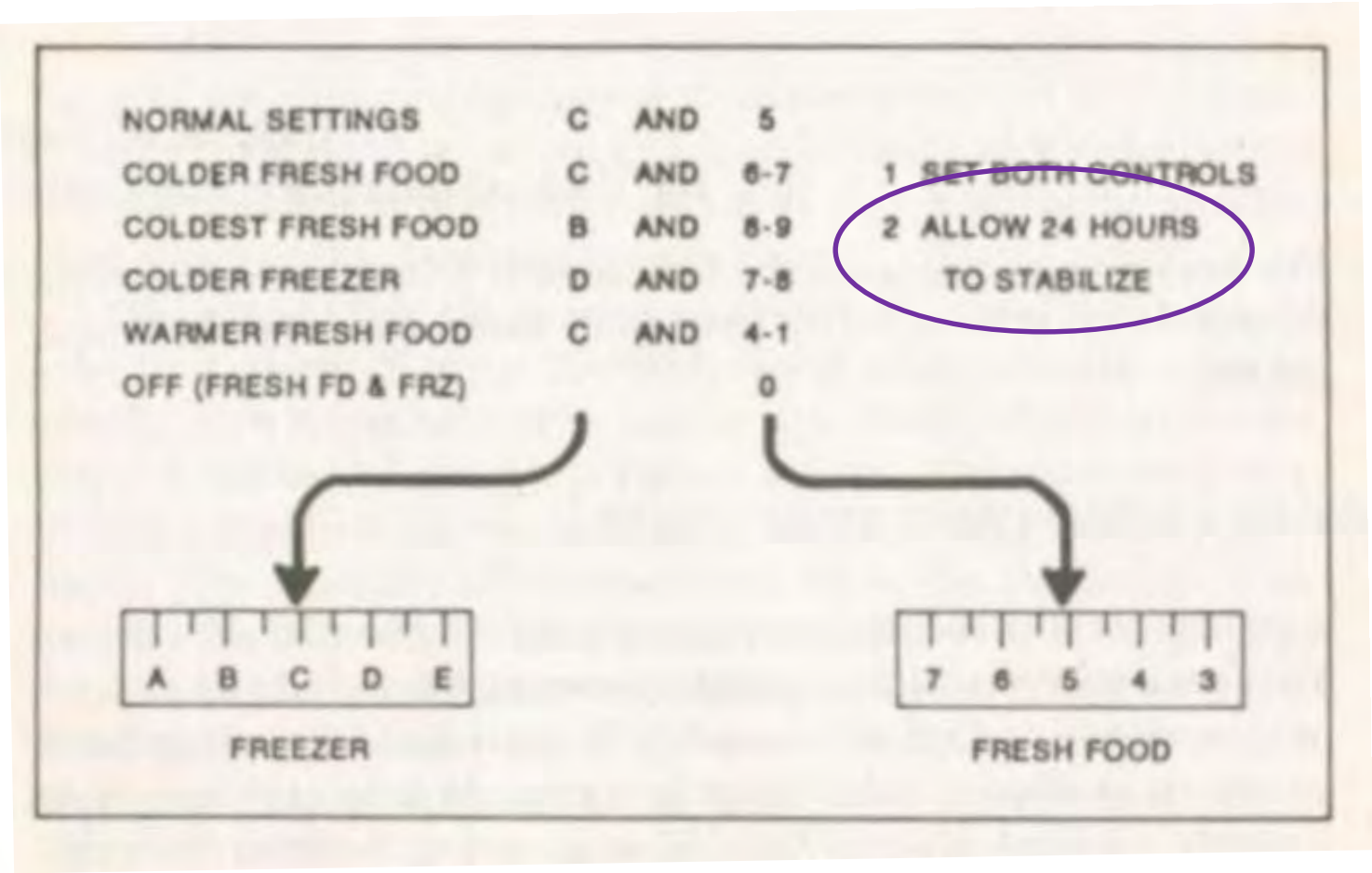


"The Freezer Control controls the freezer temperature and the Fresh Food Control controls the fresh food temperature"

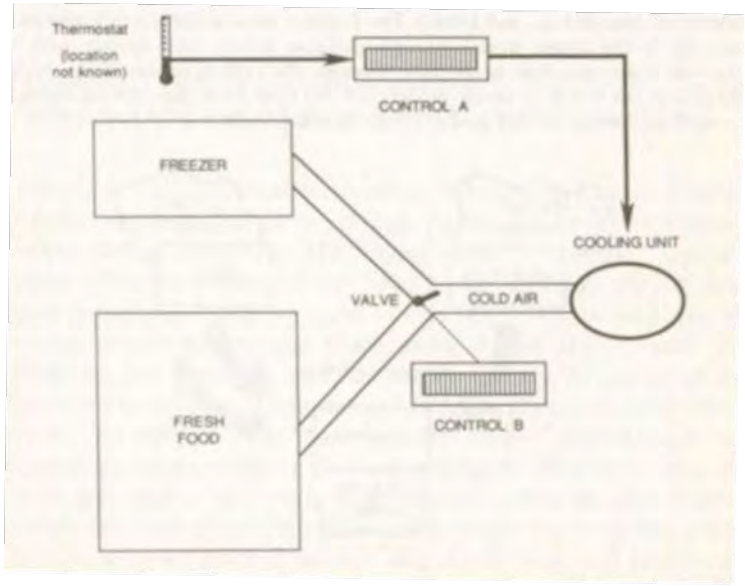
The Implementation Model



A Problem with Feedback



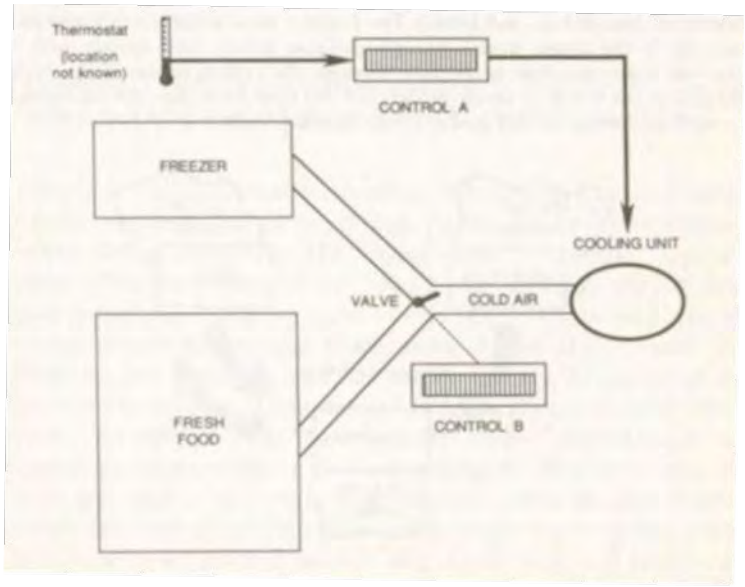
The Implementation Model



Why do we have a problem?

Can you fix the problem?

The Implementation Model



Why do we have a problem?

Cost constraints

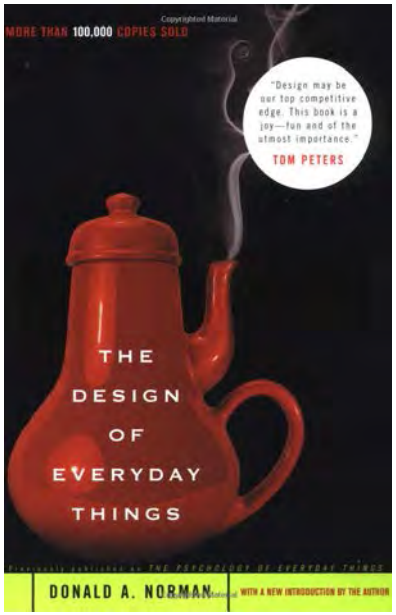
Can you fix the problem?

Make controls correspond to a person's mental model

Make controls correspond to the implementation model

Building the Right Model

Having the right model
helps people bridge the
Gulf of Execution and
the Gulf of Evaluation



How can we help people build the right models:

- Affordances
- Visibility
- Constraints
- Consistency
- Metaphors
- Knowledge in the World
- Mapping
- Modes

Affordances

Visual clue to interaction

knobs afford turning

levers afford moving

buttons afford pushing

Affordances

"The affordances of the environment are what it offers animals, what it provides or furnishes, for good or ill."

Gibson, part of an ecological approach to psychology

"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."

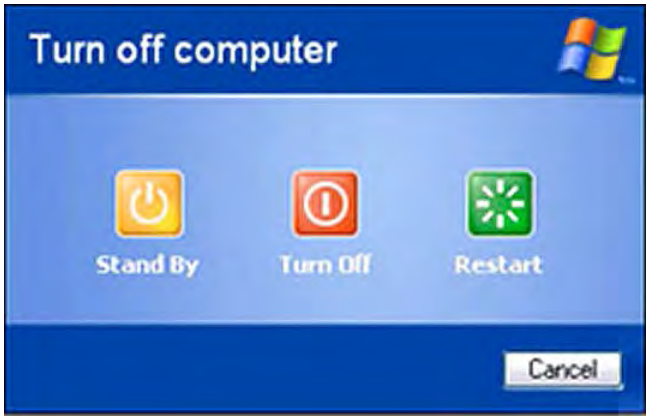
Norman

What's the Affordance?

Affordances

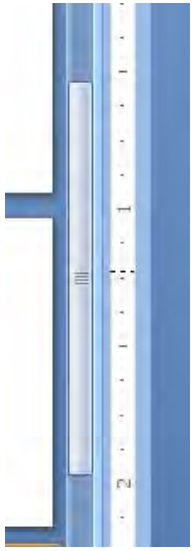
Affordances

Technology affordances are often based in affordances from the physical world



Affordances

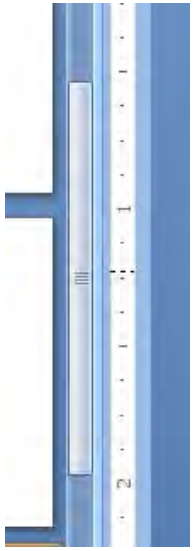
What is the affordance here?



Where does it come from?

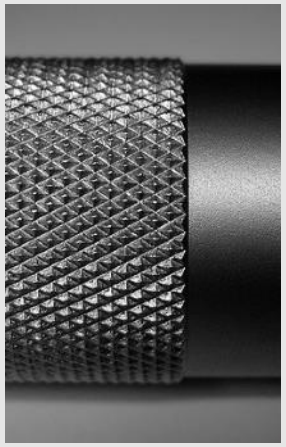
Affordances

What is the affordance here?



Where does it come from?

Knurling



Sequential Affordance

Acting on a perceptible affordance leads to information indicating new affordances

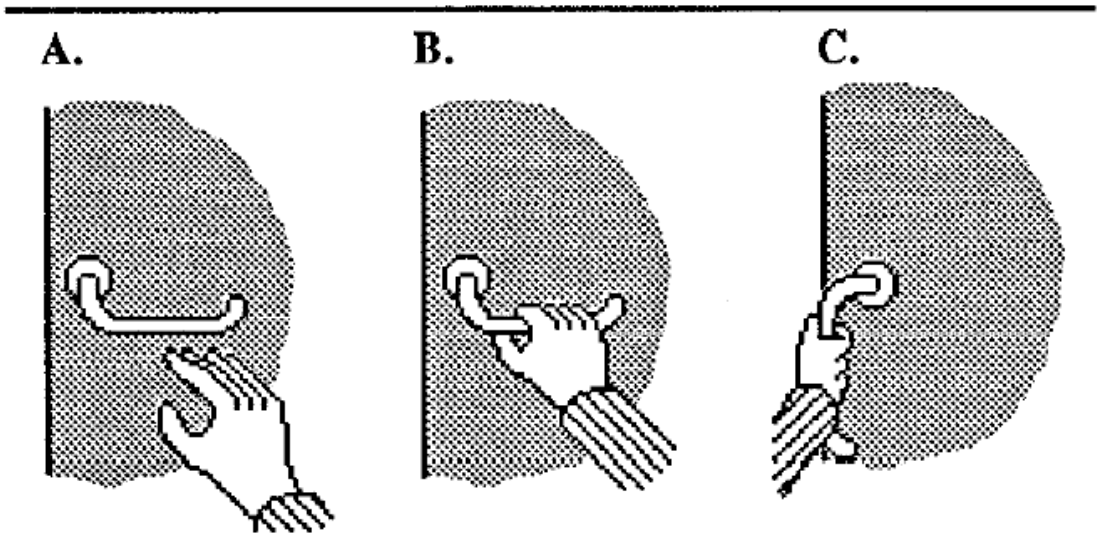
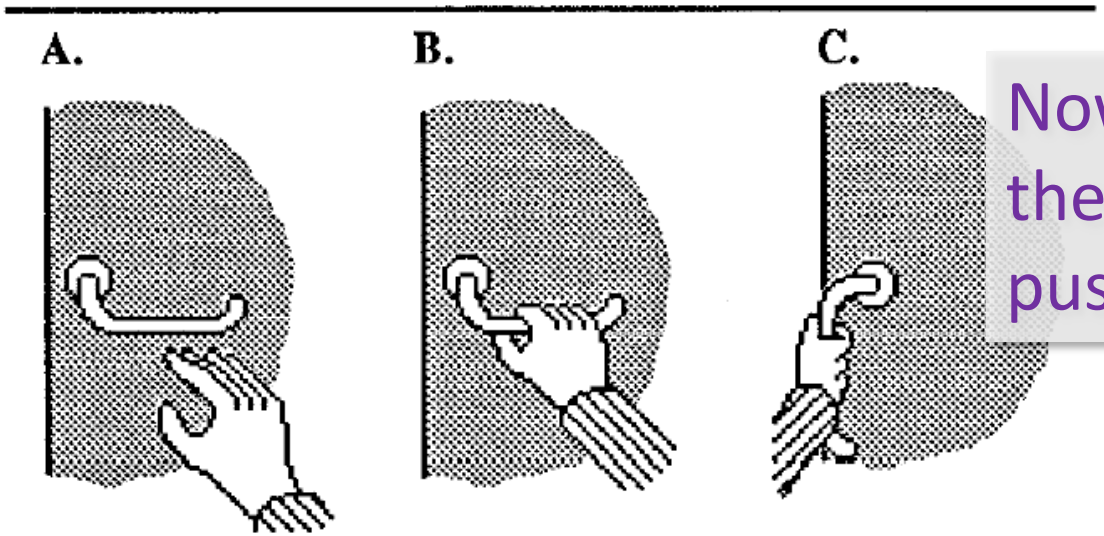


Figure 4. *Sequential affordances: one affordance leads to another. Visual information indicates grasping (A & B); tactile information indicates turning (B & C).*

Sequential Affordance

Acting on a perceptible affordance leads to information indicating new affordances



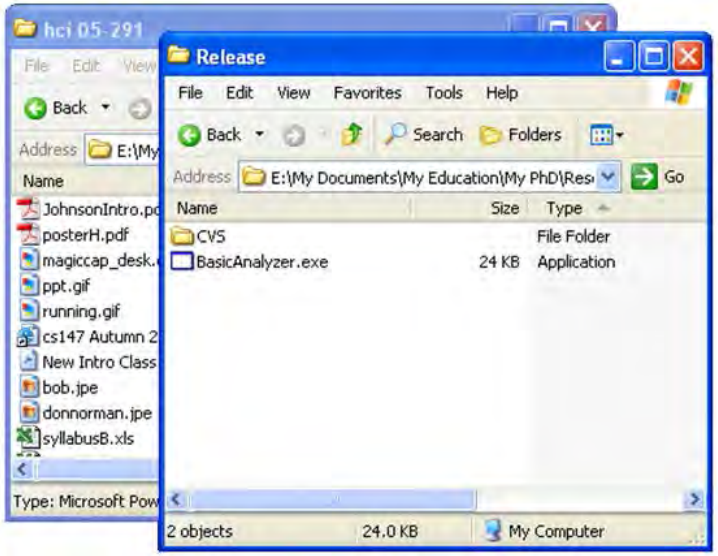
Now does the door push or pull?

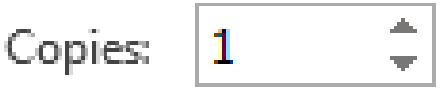
Figure 4. *Sequential affordances: one affordance leads to another. Visual information indicates grasping (A & B); tactile information indicates turning (B & C).*

Nested Affordances

Affordances due to spatial relationships revealing what actions can be done

Proximate to, contained in, part of





In Other Words

An affordance is what a thing communicates about how it can be used, often by its appearance

"In general, when the apparent affordances of an artifact matches its intended use, the artifact is easy to operate. When apparent affordances suggest different actions than those for which the object is designed, errors are common."

Gaver

Challenges arise if there is a mismatch between implied use versus intended use

False Affordances

When there is perceptual information suggesting an implied use that does not exist

(Just an image of a button, not one that responds)

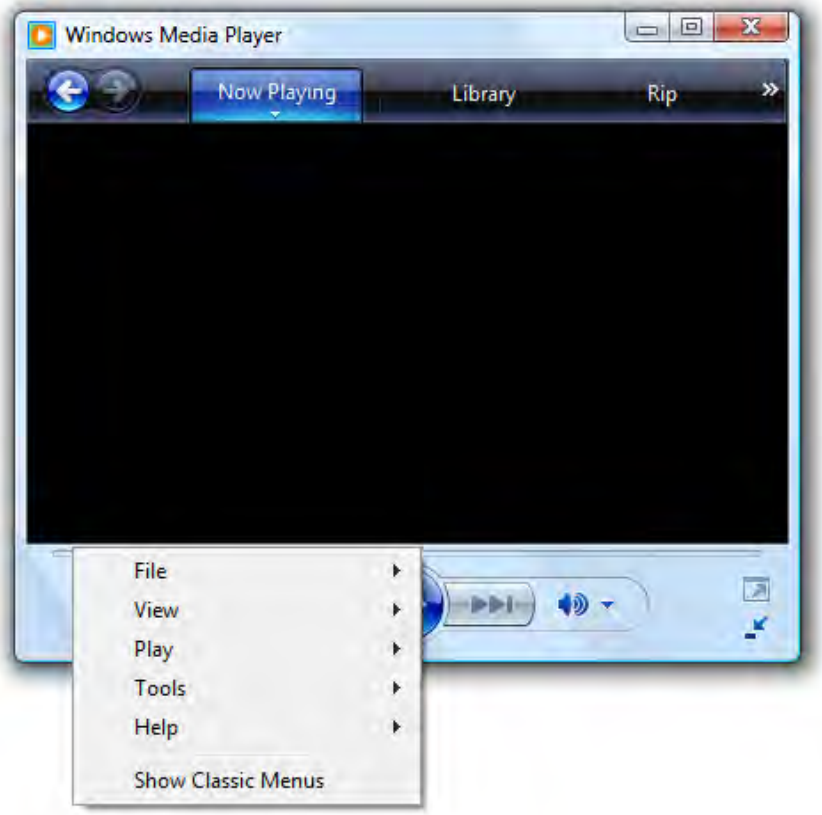
False Affordances

False Affordances

False Affordances

Hidden Affordances

When there is no perceptual information suggesting an actual intended use



Hidden Affordances

Hidden Affordances

Logos linking to home is a convention, but not afforded by the page

Confusion of the Term

"Note also that affordances are not intrinsic, but depend on the background and culture of users. Most computer-literate user will click on an icon. This is not because they go around pushing pictures in art galleries, but because they have learned that this is an affordance of such objects in a computer domain…"

Dix

Disagree. Icons do not afford "pushability" or "clickability" by their attributes. They do not give an indication of their intended use, except by convention.

Clarification on Convention

"Designers sometimes will say that when they put an icon, cursor, or other target on the screen, they have added an 'affordance' to the system. This is a misuse of the concept. … It is wrong to claim that the design of a graphical object on the screen 'affords clicking.' … Yes, the object provides a target and it helps the user know where to click and maybe even what to expect in return, but those aren't affordances, those are conventions, and feedback, and the like. … Don't confuse affordances with conventions."

Norman

Metaphors

Suggest an existing conceptual model

- “horseless carriages”, “iron horses”, “wireless”

Desktop metaphor

- Not an attempt to simulate a real desktop
- Leverages knowledge of files, folders, trash
- Explains why some windows seem hidden

Metaphors

Suggest an existing conceptual model

- “horseless carriages”, “iron horses”, “wireless”

Desktop metaphor

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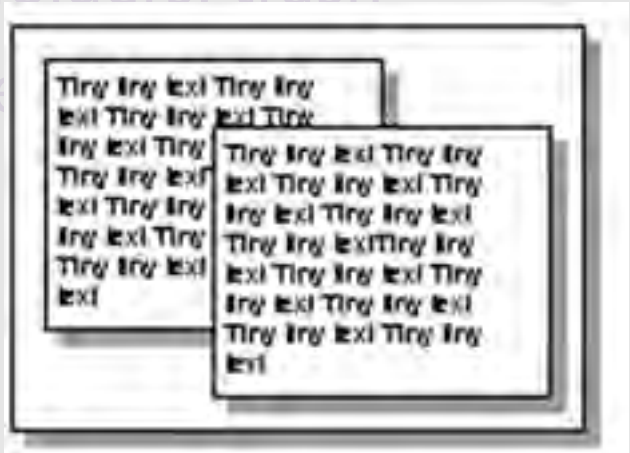
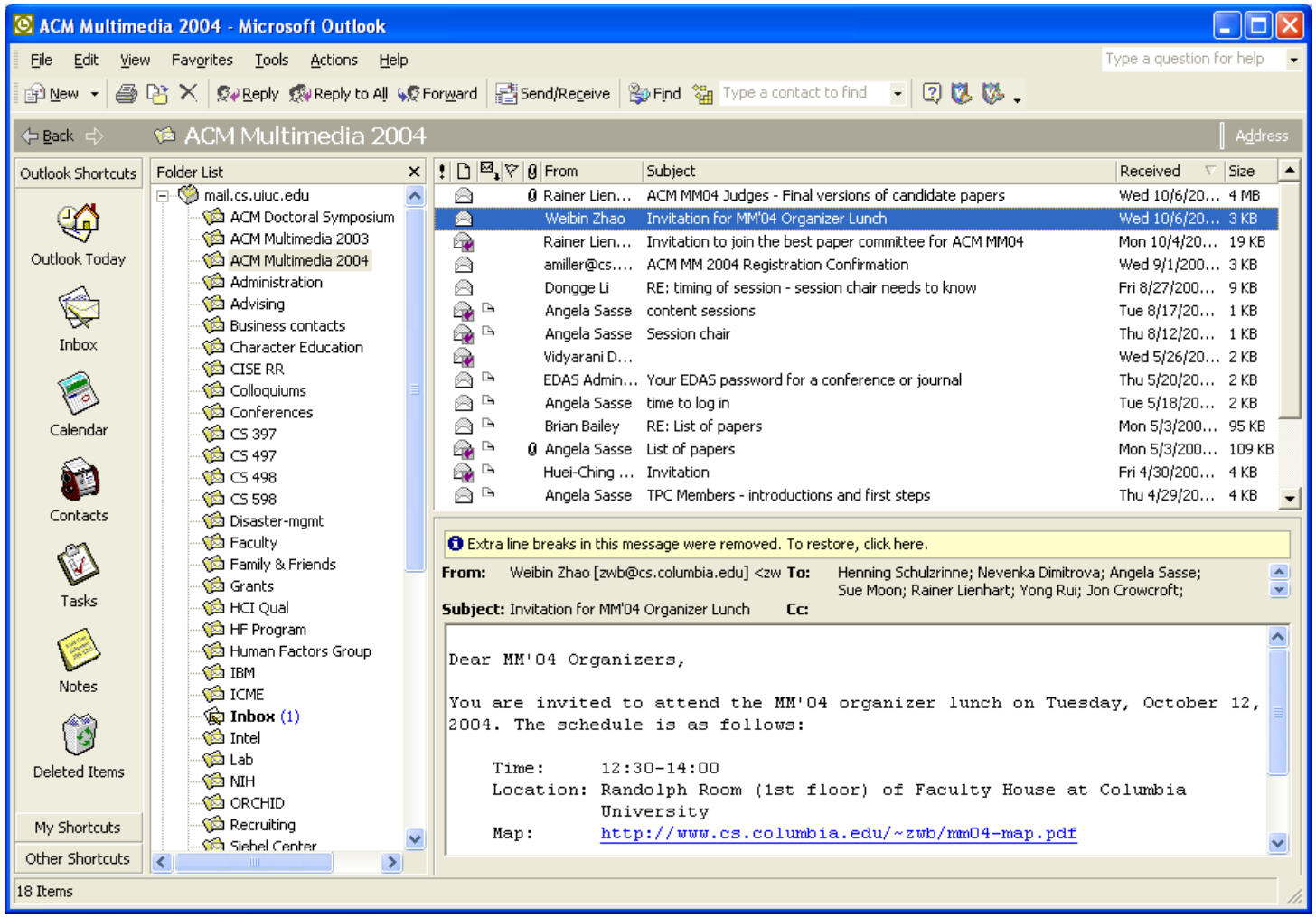
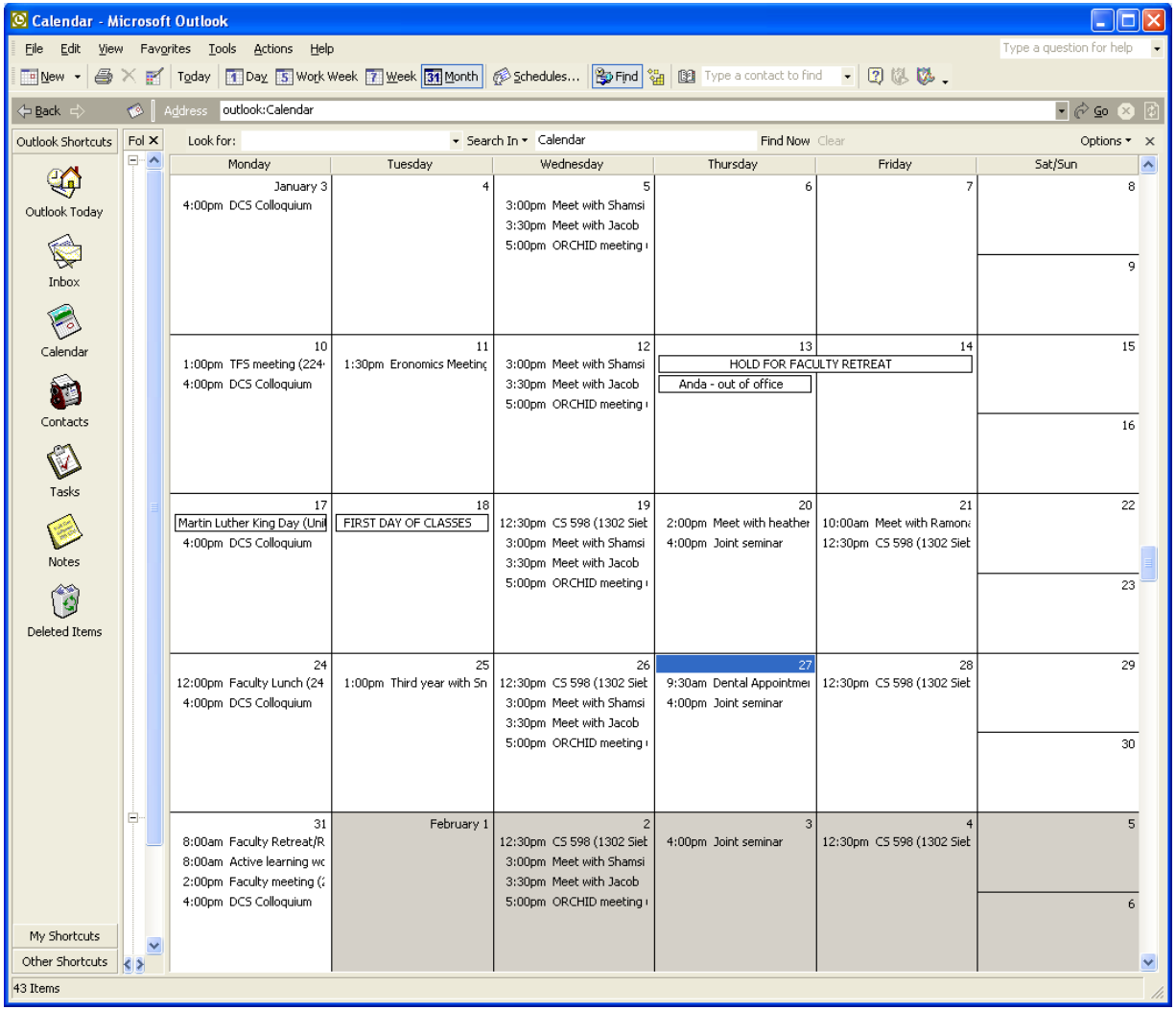


Mail Metaphor

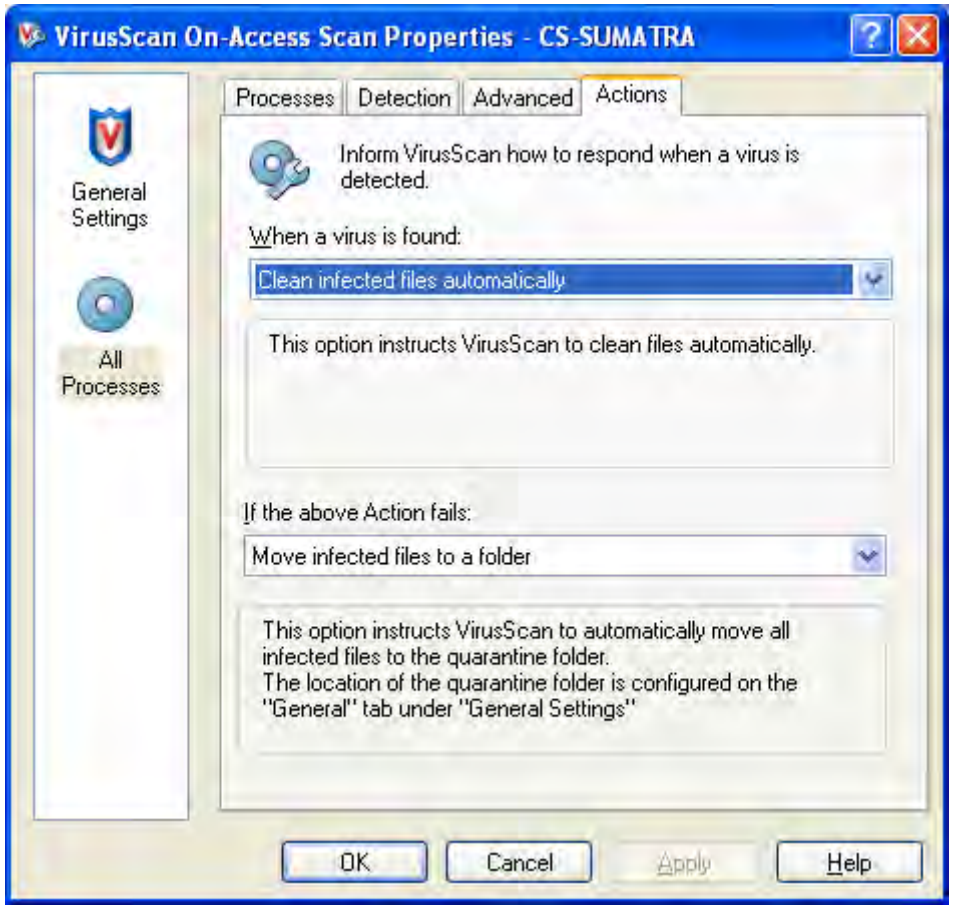


Calendar Metaphor



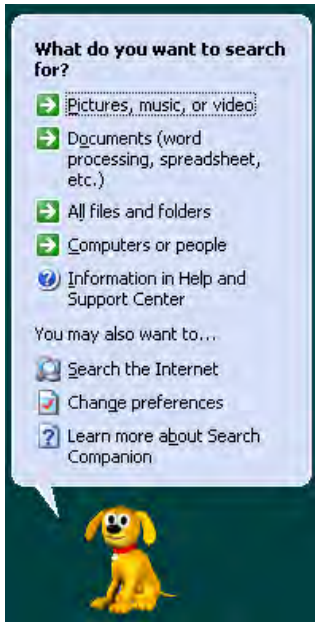
University of Washington

Health Metaphor



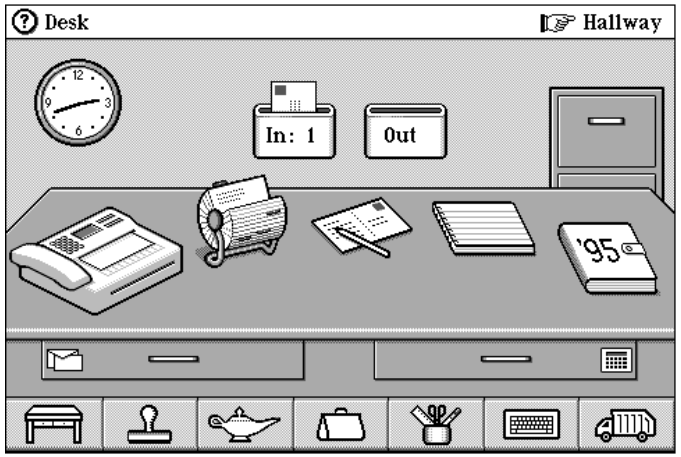
Shallow or Inappropriate Metaphors

Informs a small range of possibilities, or none at all



It is just a menu and a dialog box?

What does the living room add?



Magic Cap

Microsoft Bob

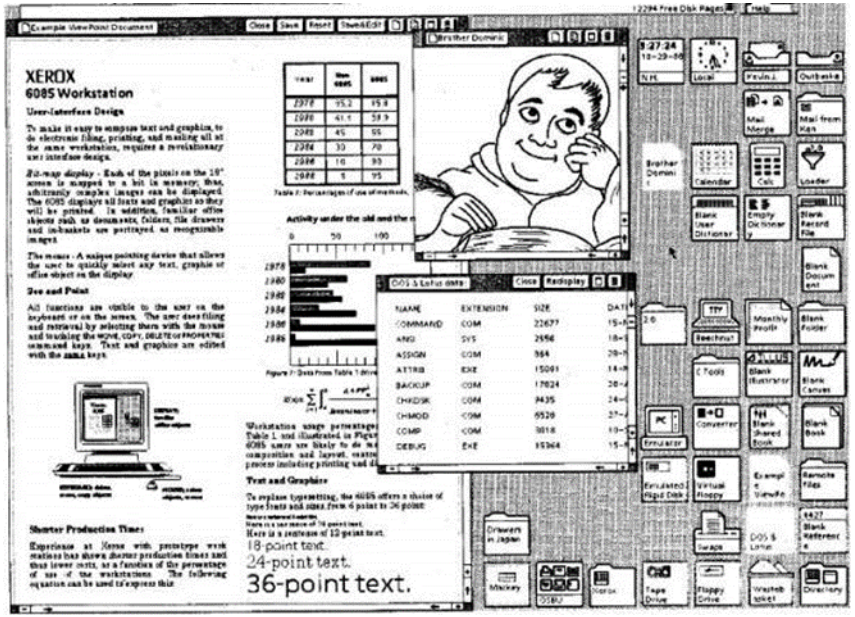
Mixed Metaphors

Two or more different metaphors coexist with some supposed relation

- The desktop metaphor
- Windows into content

Good? Bad?

Neither? Both?

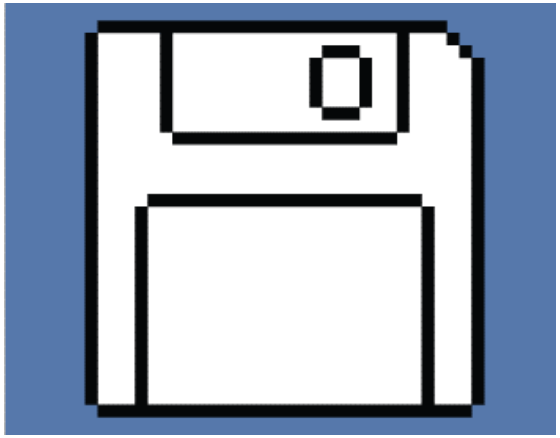


Windows are views into larger content regions

No desktop has windows

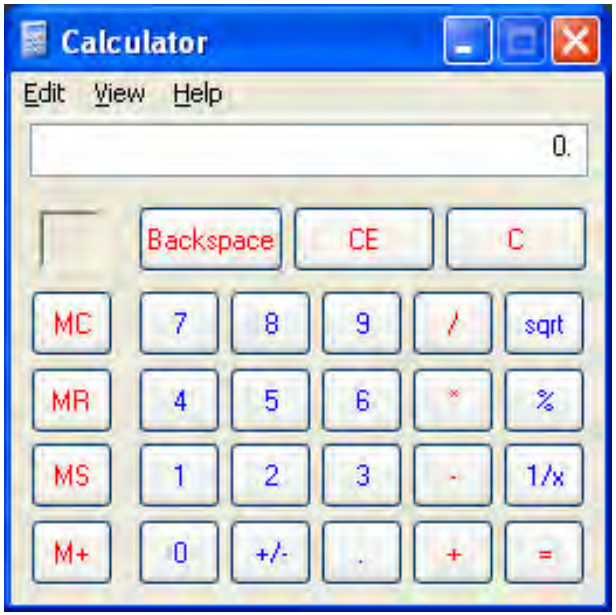
Broken Metaphors

Are not consistent, do not operate in every circumstance, or do not uphold things consistent with what the metaphor would suggest



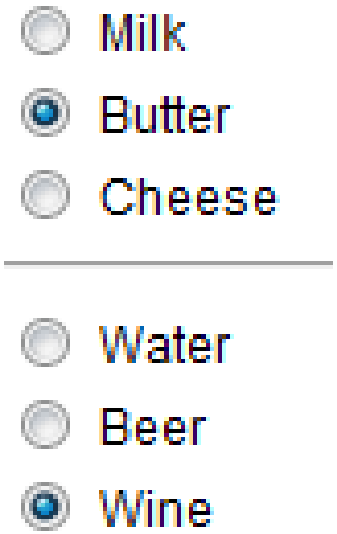
Mechanical-Age Metaphors

Operate as their mechanical-age counterparts did, not taking advantage of the digital domain to escape the limitations of the original



Dead Metaphors

Lost the original imagery of their meaning



Metaphors versus Idioms

Idioms

rely on shared experience or custom

are learned, often early in life

are supported or revealed by context

become conventions

do not rely on metaphors

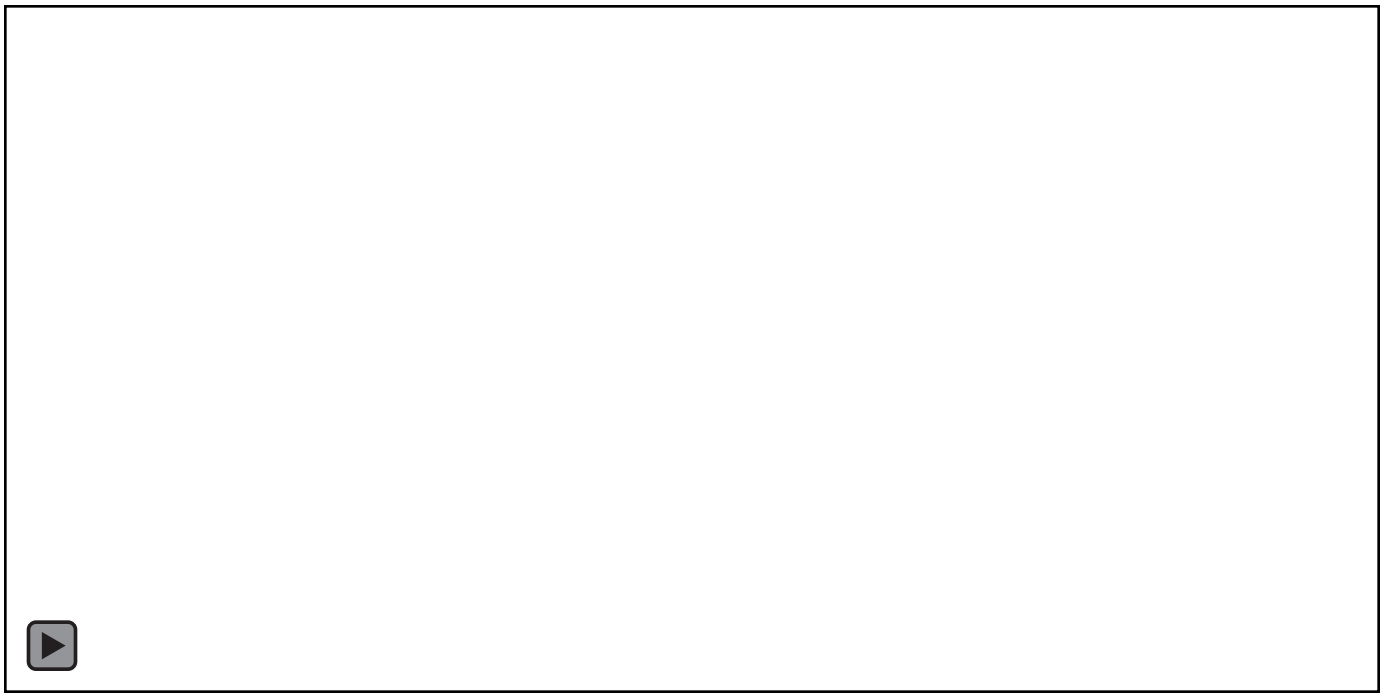
Hyperlinks

Idiomatic widgets (e.g., screen splitter, dragable title bar)

Single click to select, double click to open

Idioms

Star Trek IV: Scotty Uses a Mouse



Metaphors and Affordances

Affordances “jump start” a model for interaction

Metaphors “jump start” a model of a system

But if designed poorly, both can be damaging

- Lead to an incorrect model, undermining interaction
- Can limit designer creativity
- Can reduce the advantages of software
- Can be “cute” at the expense of functional

Visibility

Phones

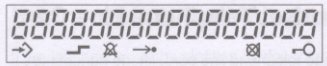
How do you

- put somebody on hold
- change volume

Visibility

Location of Controls

Display



(This display shows all of the possible configurations.)

0 15-30	During a conversation, the call duration is displayed. (Example: 15 minutes, 30 seconds)
→	The unit is in the programming mode (p. 9, 16, 20).
→•	The AUTO button was pressed while dialing or storing phone numbers for the Speed Dialer (p. 16, 19).
⌐	The LOWER button was pressed (p. 21, 23).
🔕	The ringer is set to OFF (p. 10).
⊠	The MUTE button was pressed during a conversation (p. 24).
⊸	The dial lock mode is set. To cancel the mode, see page 27.
F	The FLASH button was pressed while storing phone numbers.
P	The PAUSE button was pressed while dialing or storing phone numbers.
ϟ	You pressed ✱ while dialing or storing phone numbers in the TONE mode.
=	You pressed # while dialing or storing phone numbers in the TONE mode.
▫	While storing a phone number in an UPPER memory location for the One-Touch Dialer, "▫" will appear when you press a one-touch auto dial button (p. 20).
▫	While storing a phone number in a LOWER memory location for the One-Touch Dialer, "▫" will appear when you press a one-touch auto dial button (p. 21).
[-]	The MUTE button was pressed as a secret button while storing phone numbers (p. 18, 22).
_	While programming function items, such as the dialing mode, "_" will flash as a cursor.

Preparation

5

Visibility

Changing Ringer Volume

- Press “Program”
- Press “6”
- Set Volume
  - Low - Press “1”
  - Medium - Press “2”
  - High - Press “3”
- Press “Program”

Visibility

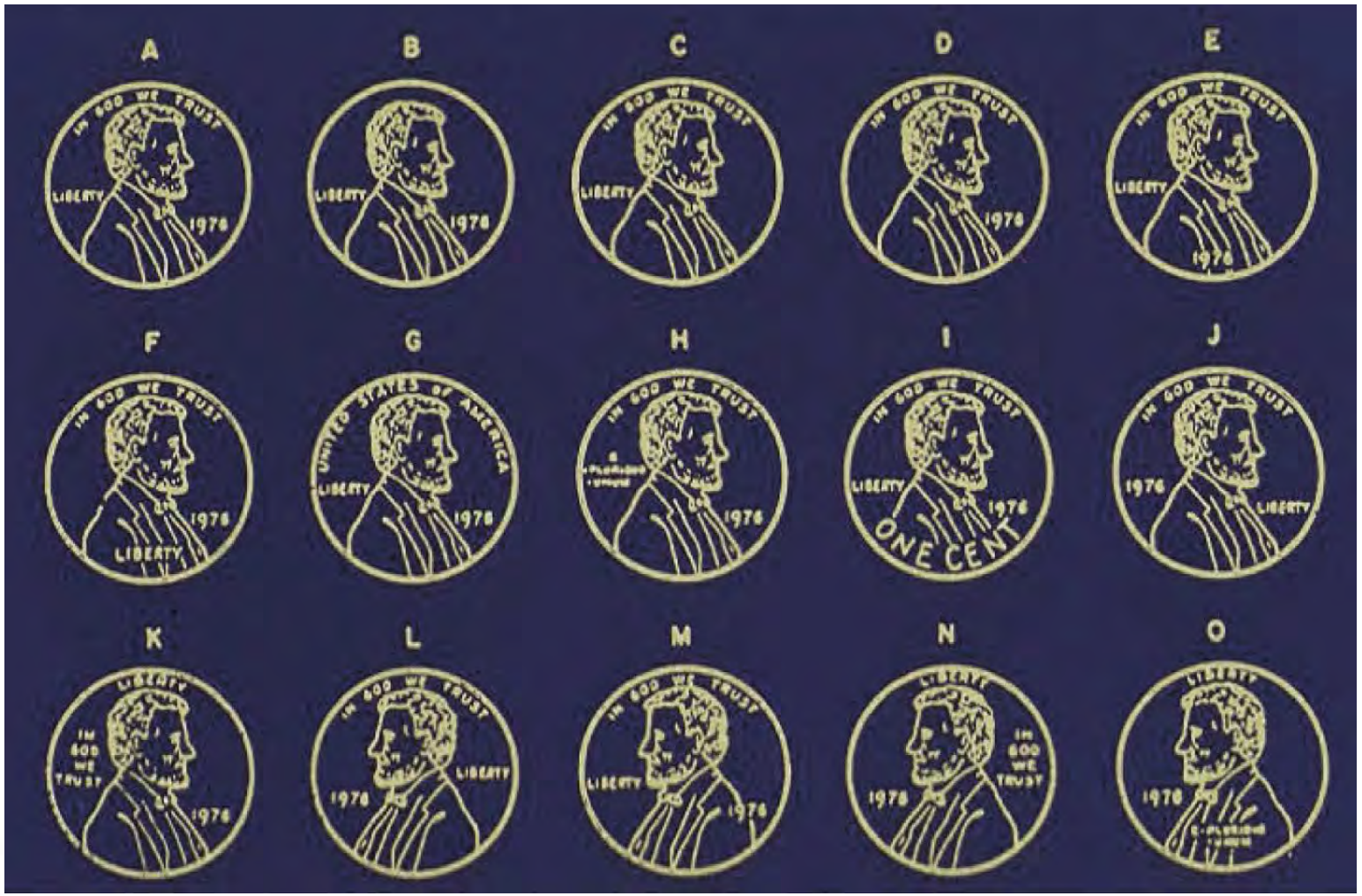
Controls available on watch with 3 buttons?

- Too many and they are not visible

Compare to controls on simple car radio

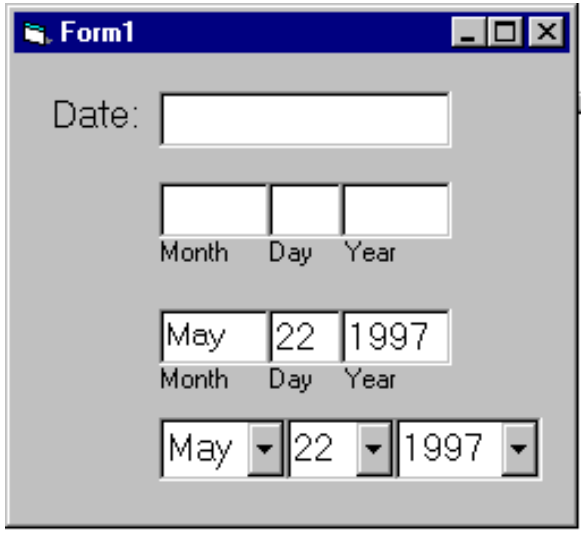
- Number of controls ≈ Number of functions
- Controls are labeled and grouped together

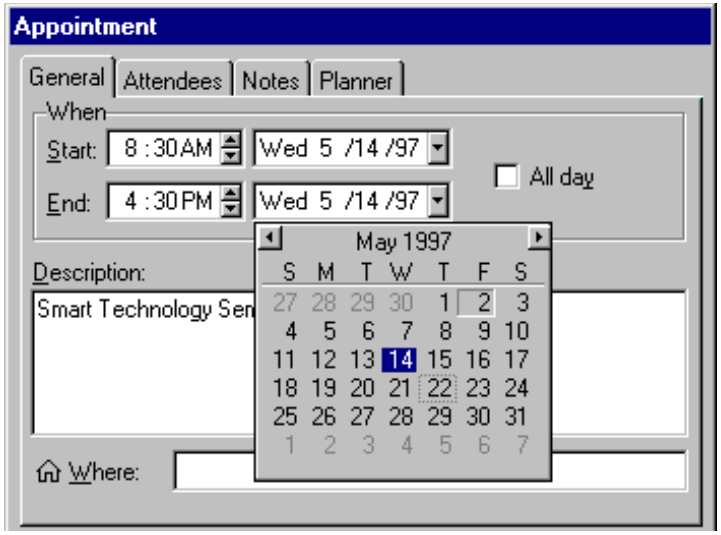
Knowledge in the World



Constraints

Prevent some actions while allowing others





Prevent errors before they can happen

Disruptive error messages are a last resort

Constraints

Constraints

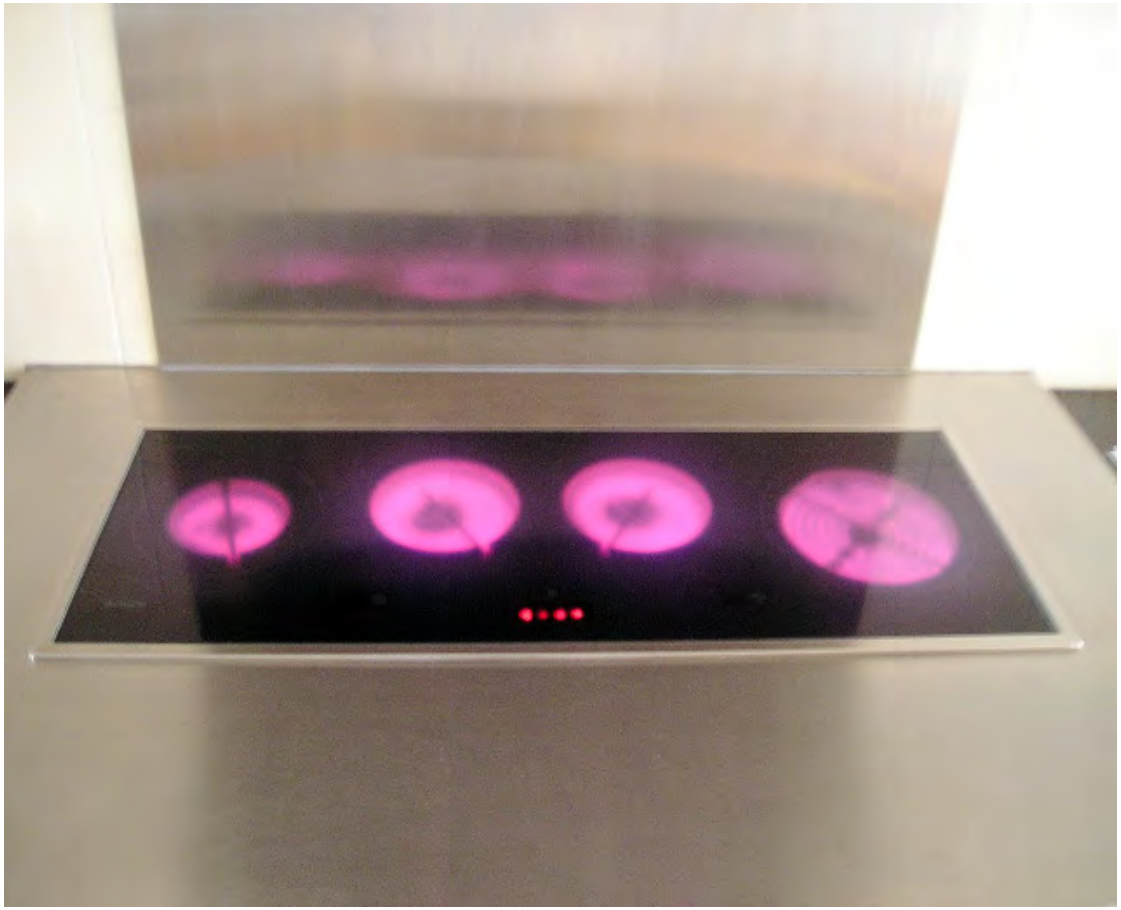
Constraints

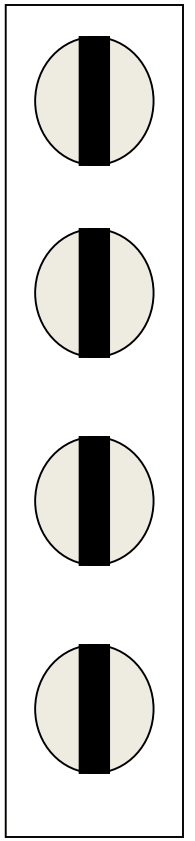
Mapping

Correspondence between an interface and the corresponding action in ‘the world’

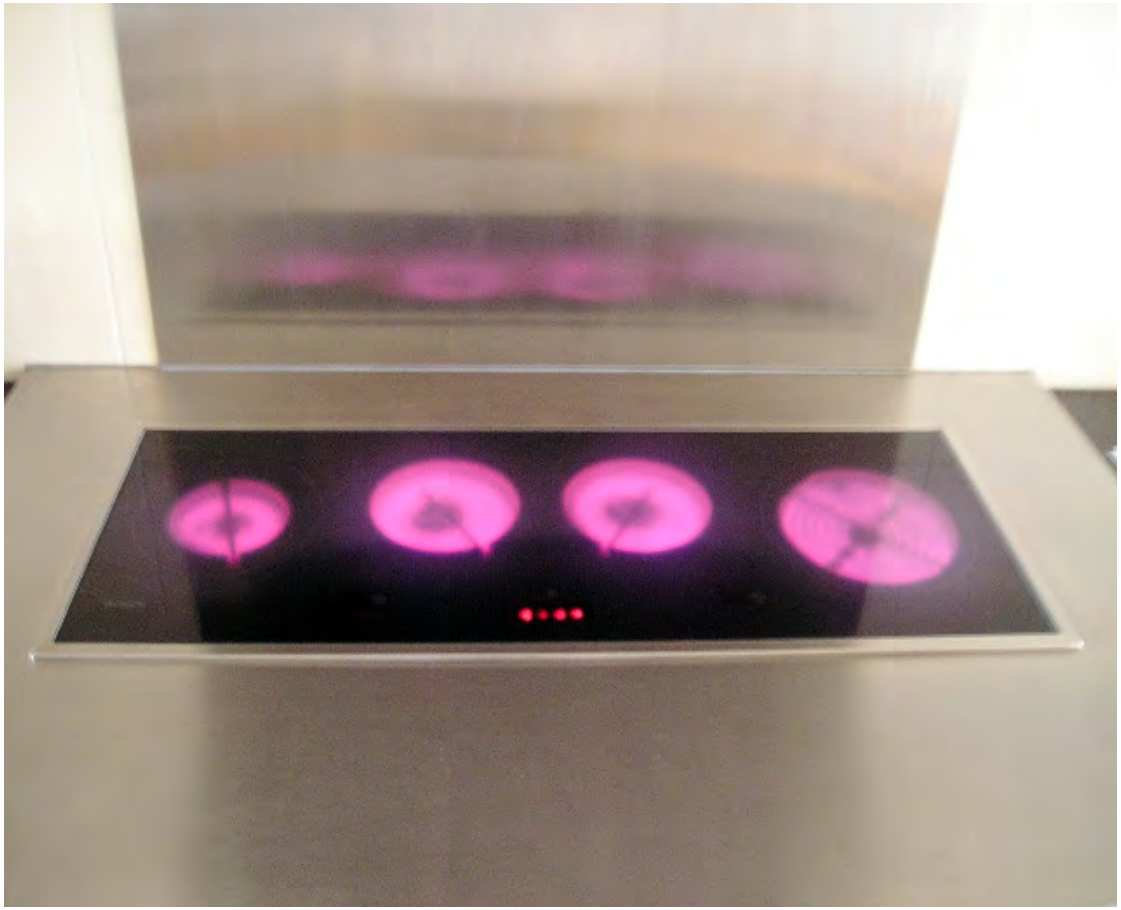
Minimize cognitive steps to transform action into effect, or perception into comprehension (i.e., execution and evaluation)

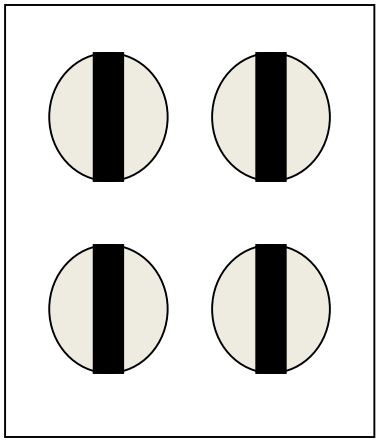
Very Bad Mapping





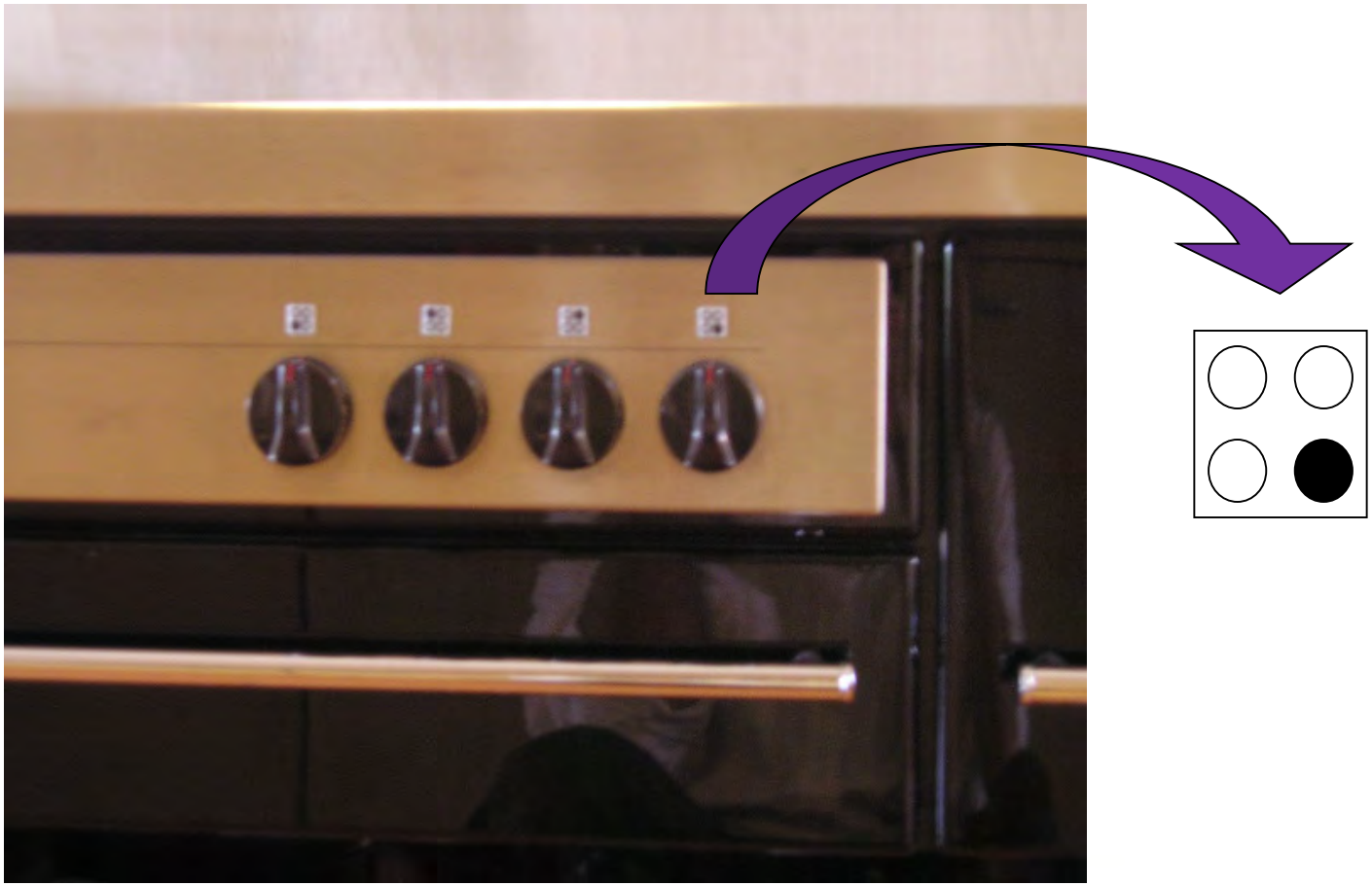
Slightly Better Mapping



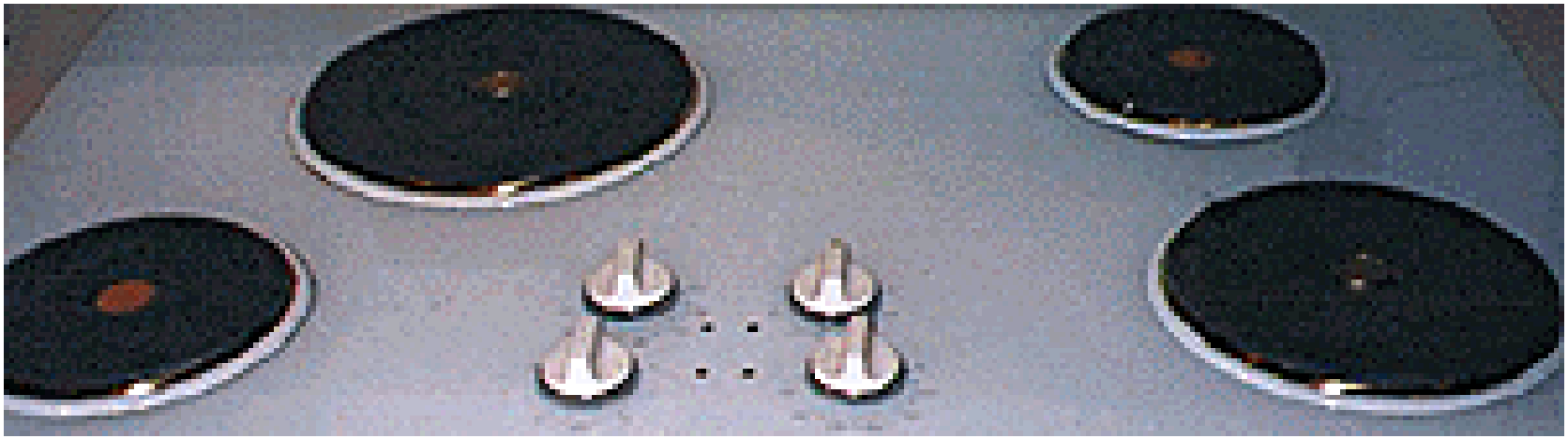


Good Mapping

Not this Stove



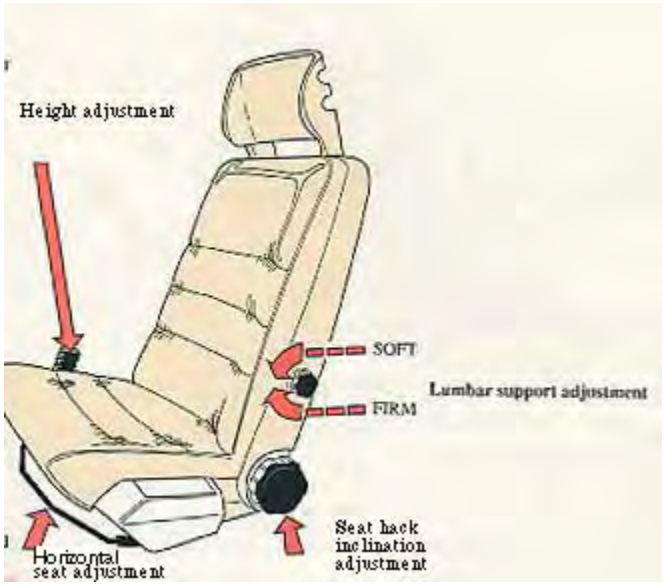
Great Mapping

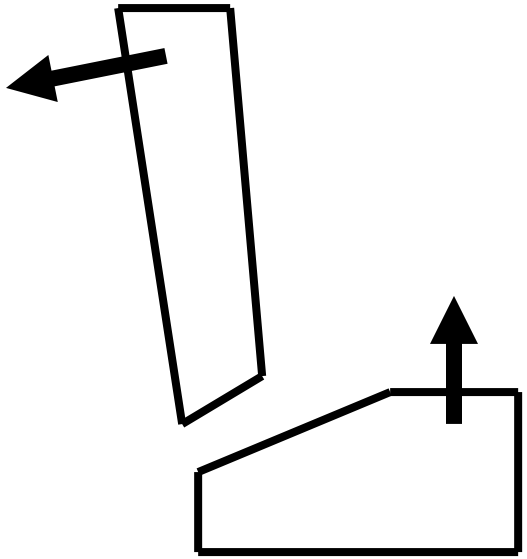


Mapping


500 EURO
200 EURO
200
500
100 EURO
100
10 EURO
10
50 EURO CENT
20 EURO CENT
10 EURO CENT

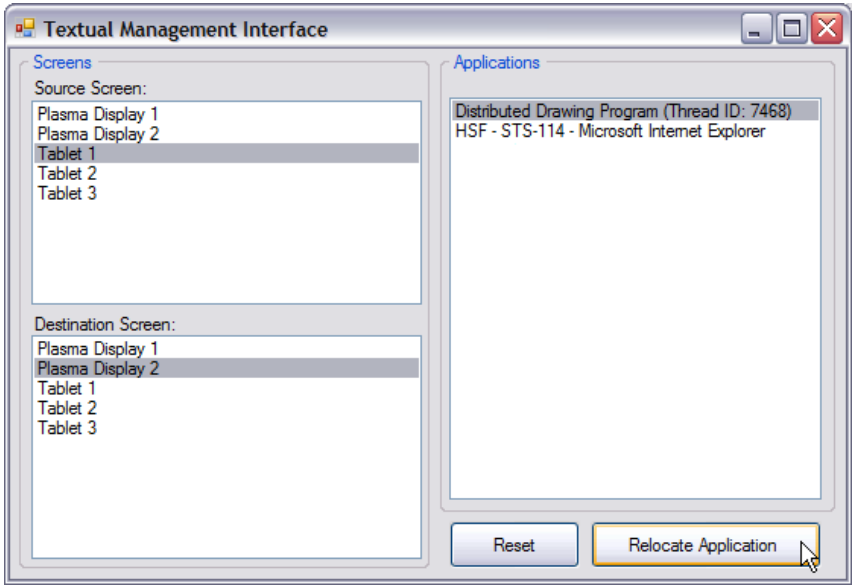
Mapping


Height adjustment
SOFT
Lumbar support adjustment
FIRM
Seat back inclination adjustment
Horizontal seat adjustment

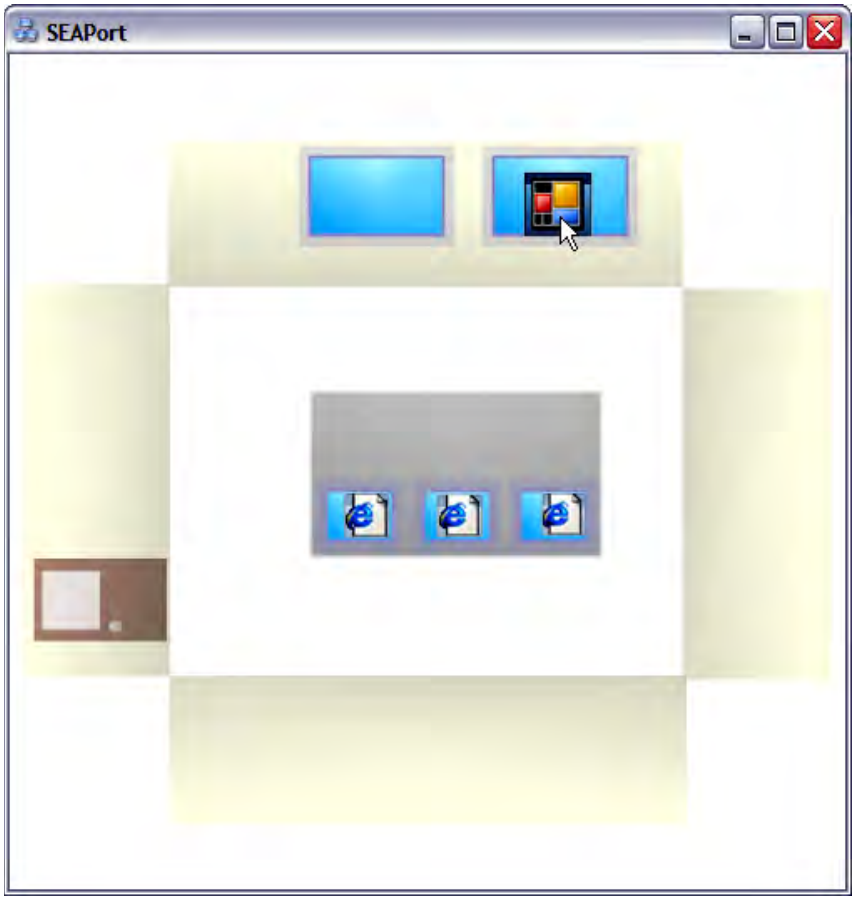


Mapping


ORCHID


Textual Management Interface
Screens
Source Screen:
Plasma Display 1
Plasma Display 2
Tablet 1
Tablet 2
Tablet 3
Destination Screen:
Plasma Display 1
Plasma Display 2
Tablet 1
Tablet 2
Tablet 3
Applications
Distributed Drawing Program (Thread ID: 7468)
HSF - STS-114 - Microsoft Internet Explorer
Reset
Relocate Application

Mapping



Consistency

Interfaces should be consistent in meaningful ways

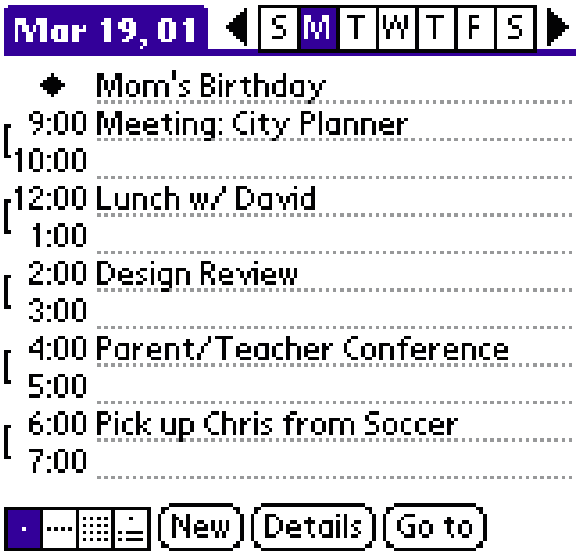
- Ubiquitous use of same keys for cut/copy/ paste

Types of consistency

- Internal (i.e., within itself)
  - e.g., same terminology and layout throughout
- External (i.e., with other applications)
  - e.g., common widget appearance
  - e.g., design patterns common across applications

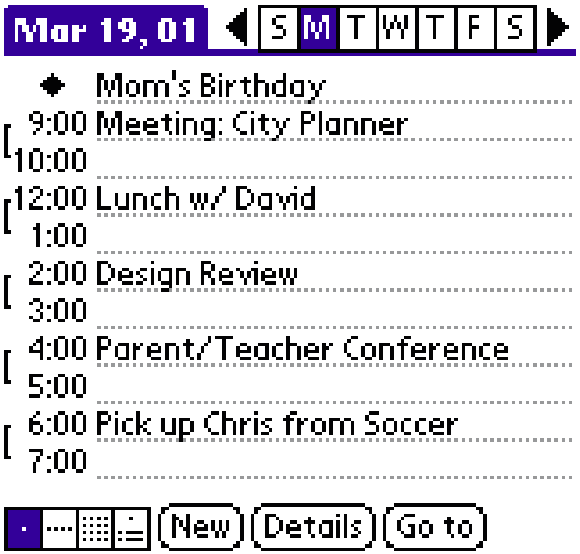
Is Consistent Always Better?

Should “new” & “delete” be in the same place?



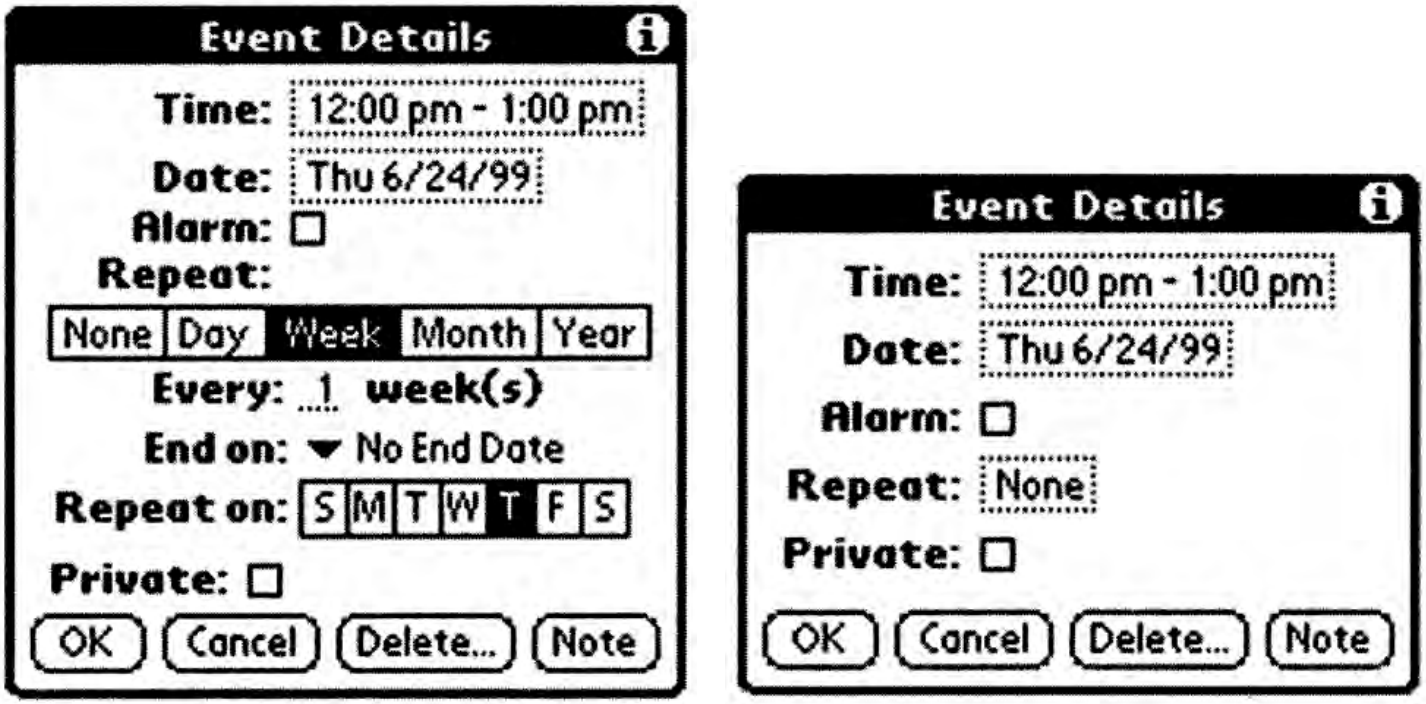
Is Consistent Always Better?

Should “new” & “delete” be in the same place?

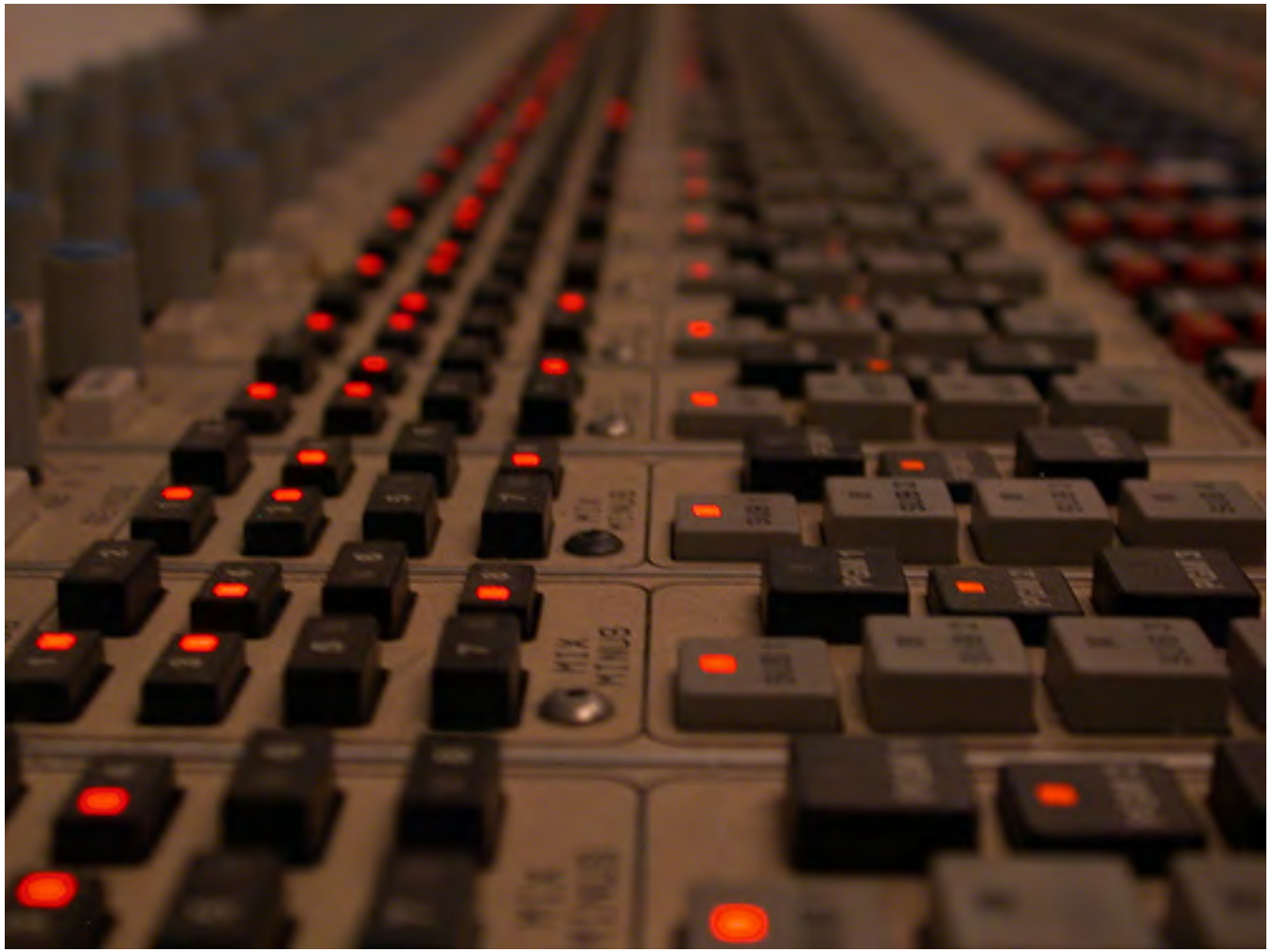


New is common, delete is not

Is Consistent Always Better?



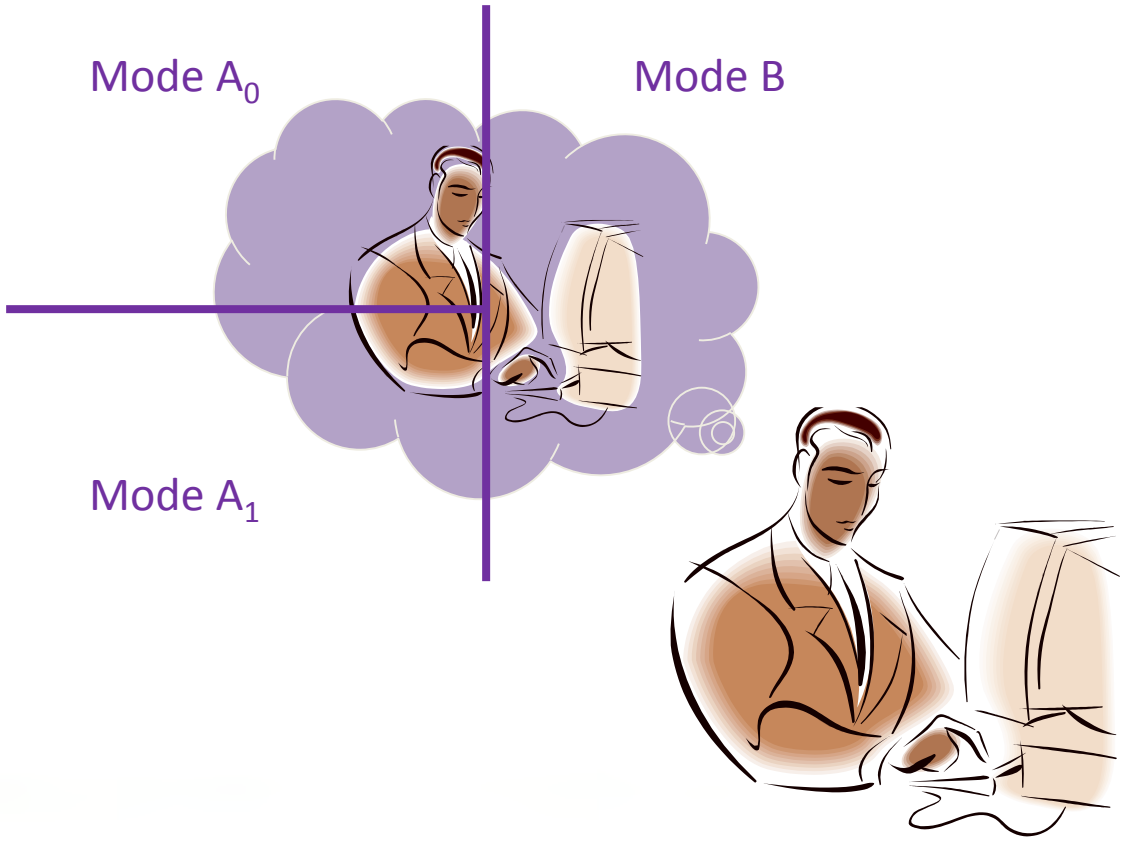
Is Consistency Always Better?



Is Consistency Always Better?

Modes

Modes force people to divide their model



Active versus Passive Modes

Active modes require constant action to maintain

- Once that action has retired, so does the mode
- e.g., Shift

Passive modes require action to set, and a separate action to unset, or to set again

- e.g., CAPS LOCK

Active modes are generally preferred

Standardization

If all else fails, standardize

- Fewer things to memorize
- Reduced learning time
- Adapt to new situations faster

e.g., keyboard layout not optimal, but standard

Norman's Seven Principles for Design

Use knowledge in the head and in the world

Simplify the structure of tasks

Making things visible

Get the mappings right

Exploit the power of constraints

Design for error

When all else fails, standardize

CSE 440: Introduction to HCI

User Interface Design, Prototyping, and Evaluation

Lecture 02:
Design of Everyday Things

James Fogarty
Daniel Epstein
Brad Jacobson
King Xia

Tuesday/Thursday
10:30 to 11:50
MOR 234