hci+d lab.

Week 04

Interaction Elements

HCI 연구방법론 2019 Fall

Human-Computer Interaction+Design Lab _ Joonhwan Lee

오늘 다룰 내용

- Interaction Elements

Interaction Elements

Interaction

- **Interaction** occurs when a human performs a task using computing technology
- Interaction tasks with a goal:
  - Send an e-mail
  - Burn a CD
  - Program a thermostat
  - Enter a destination in a GPS device
- Interaction tasks without a goal:
  - Browse the web
  - Chat with friends on a social networking site

Interaction Elements

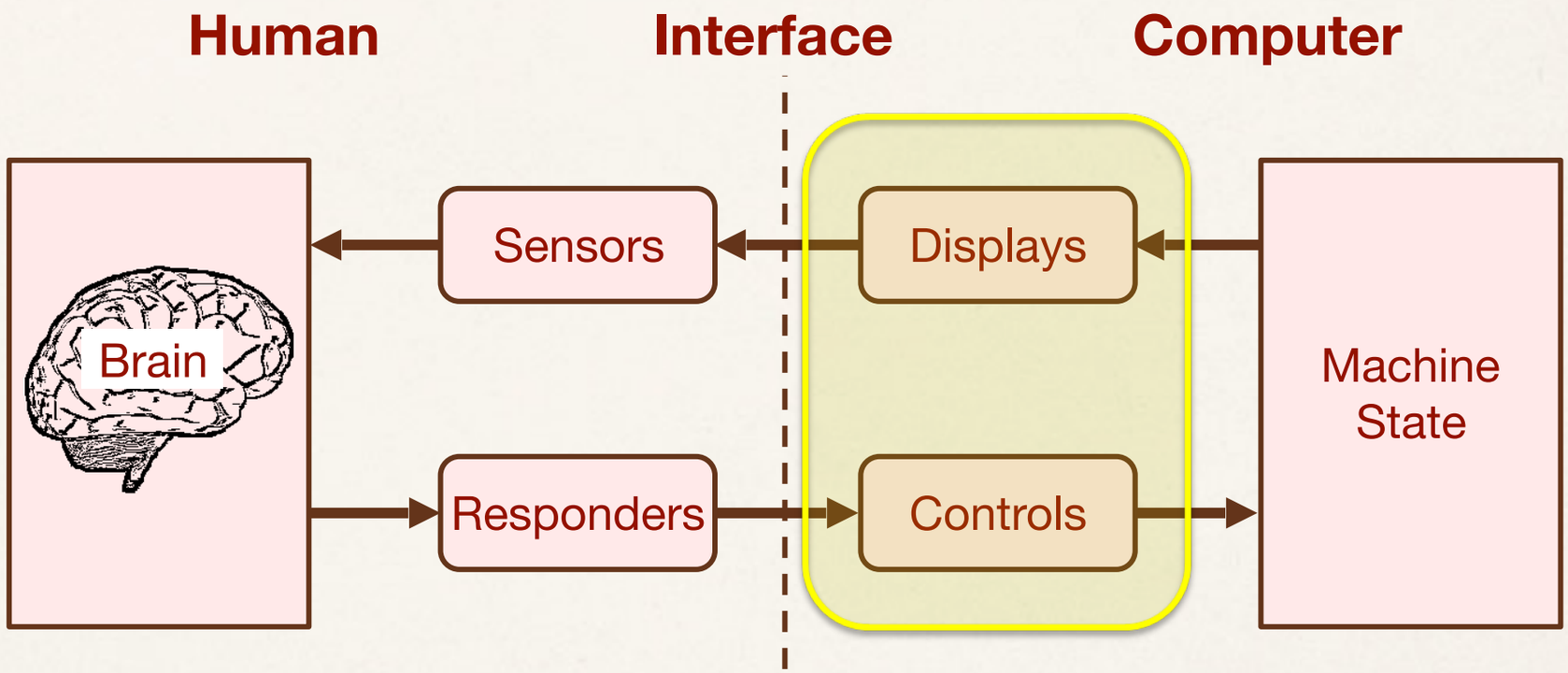
- Can be studied at many levels and in different contexts
- The tasks are in the cognitive band of Newell's *time scale of human action*
- Tasks in this range are well suited to empirical research
- Experimental methodology preferred (extraneous behaviours easy to control)
- Early human factors research on "knobs and dials" is relevant today

Interaction Elements

Newell's time scale of human action

Scale (sec)	Time Units	System	World (theory)
10^7	Months		SOCIAL BAND
10^6	Weeks		
10^5	Days		
10^4	Hours	Task	RATIONAL BAND
10^3	10 min	Task	
10^2	Minutes	Task	
10^1	10 sec	Unit task	COGNITIVE BAND
10^0	1 sec	Operations	
10^{-1}	100 ms	Deliberate act	
10^{-2}	10 ms	Neural circuit	BIOLOGICAL BAND
10^{-3}	1 ms	Neuron	
10^{-4}	100 µs	Organelle	

Human Factors Model



Hard Controls, Soft Controls

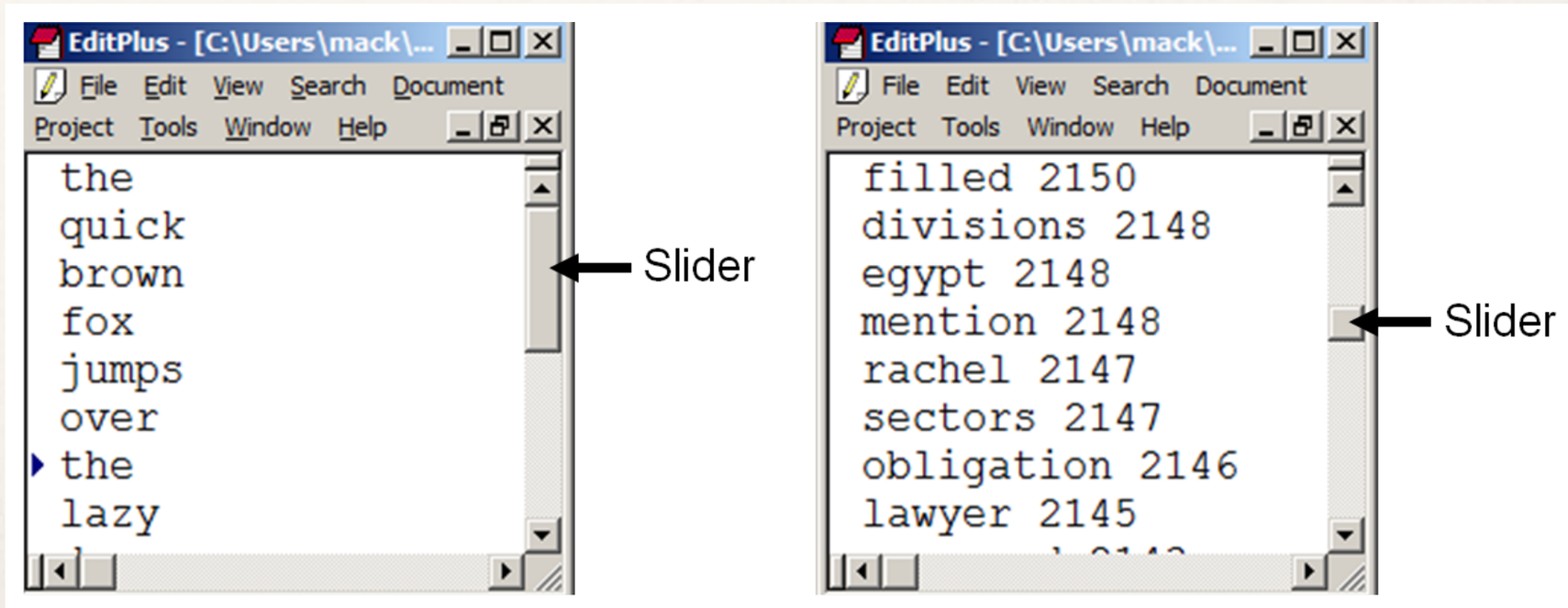
- In the past, controls were physical, single-purpose devices → **hard controls**
- Today's graphical displays are malleable
- Interfaces created in software → **soft controls**

- Soft controls rendered on a display
- Distinction blurred between soft controls and displays
- Consider controls to format *this* (see below)

Soft controls are also displays!

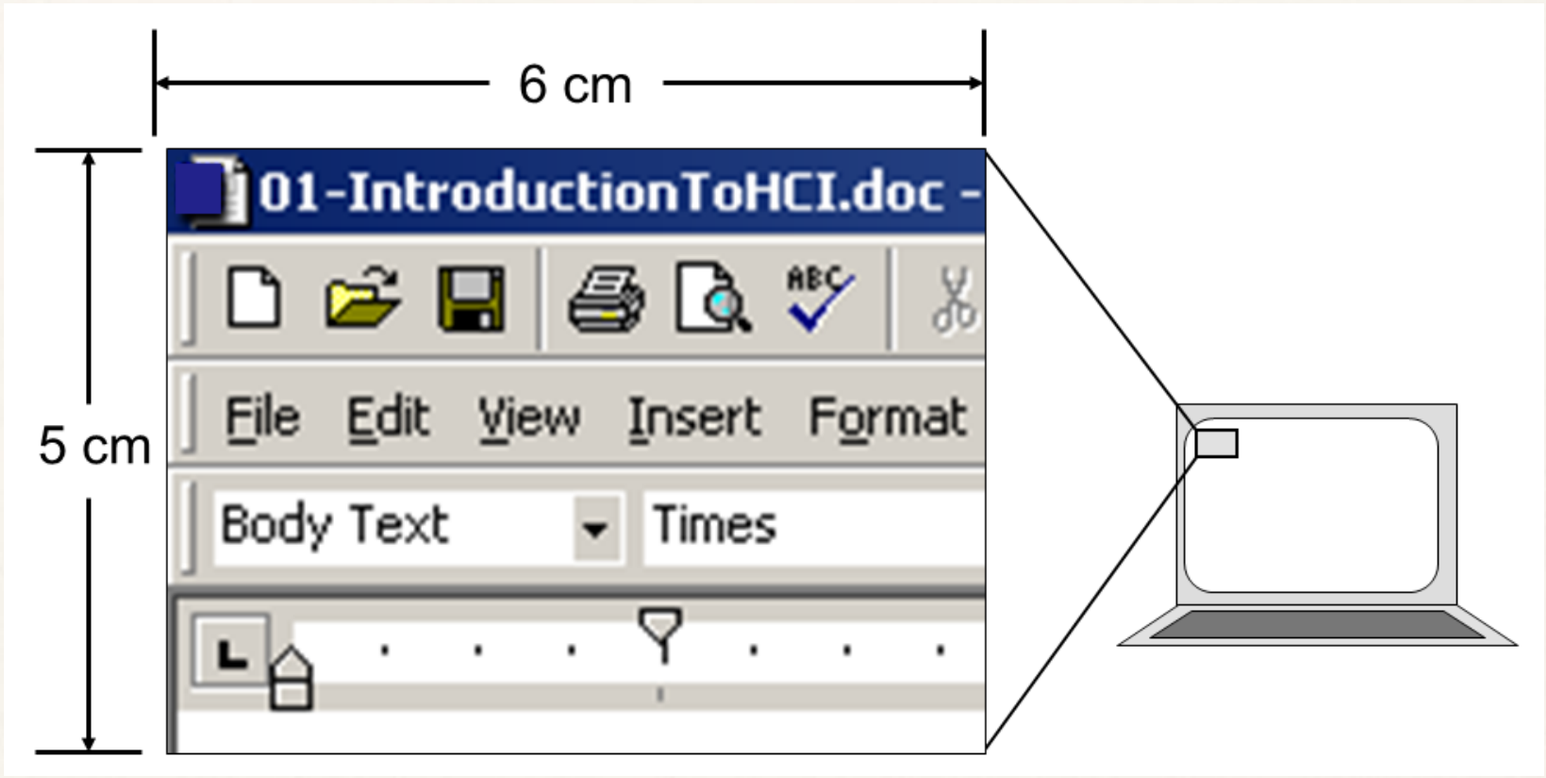
Scrollbar Slider

- Example of a soft control (control + display)
- As a control
  - Moved to change view in document
- As a display
  - Size reveals view size relative to entire document
  - Position reveals view location in document



GUI Malleability

- Below is a 30cm^2 view into a GUI
  - more than 20 soft controls (or are they displays?)

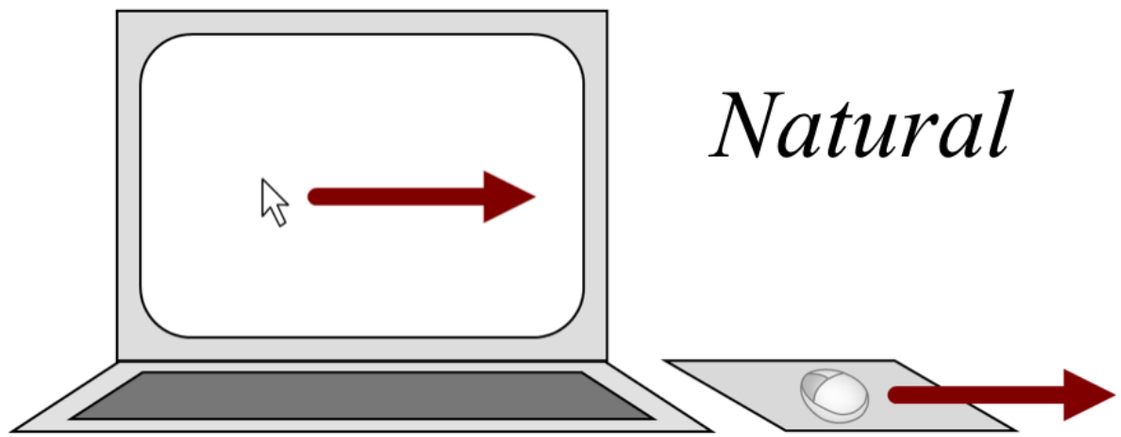


- Click a button and this space is morphed into a completely different set of soft controls/displays

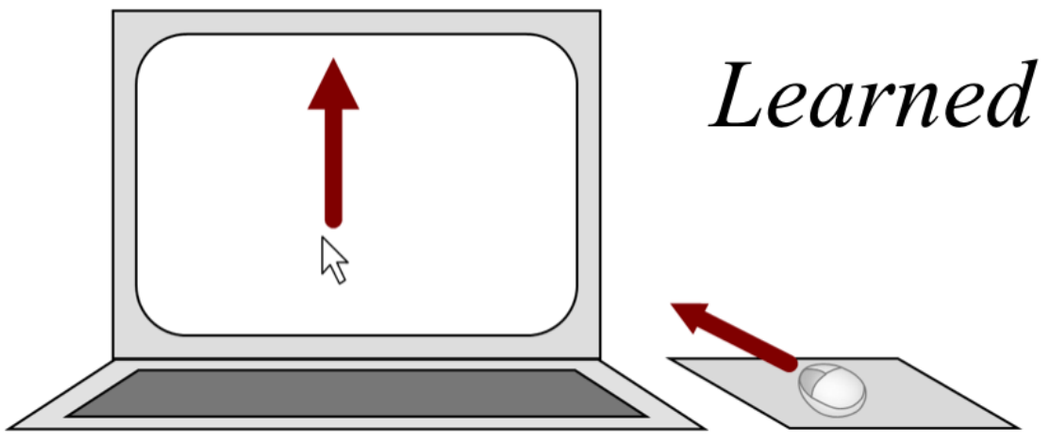
Control-Display Relationships

- Also called **mappings**
- Relationship between operation of a control and the effect created on a display
- At least three types:
  - Spatial relationships
  - Dynamic relationships
  - Physical relationships

Spatial Relationships



Spatial congruence
Control: right
Display: right



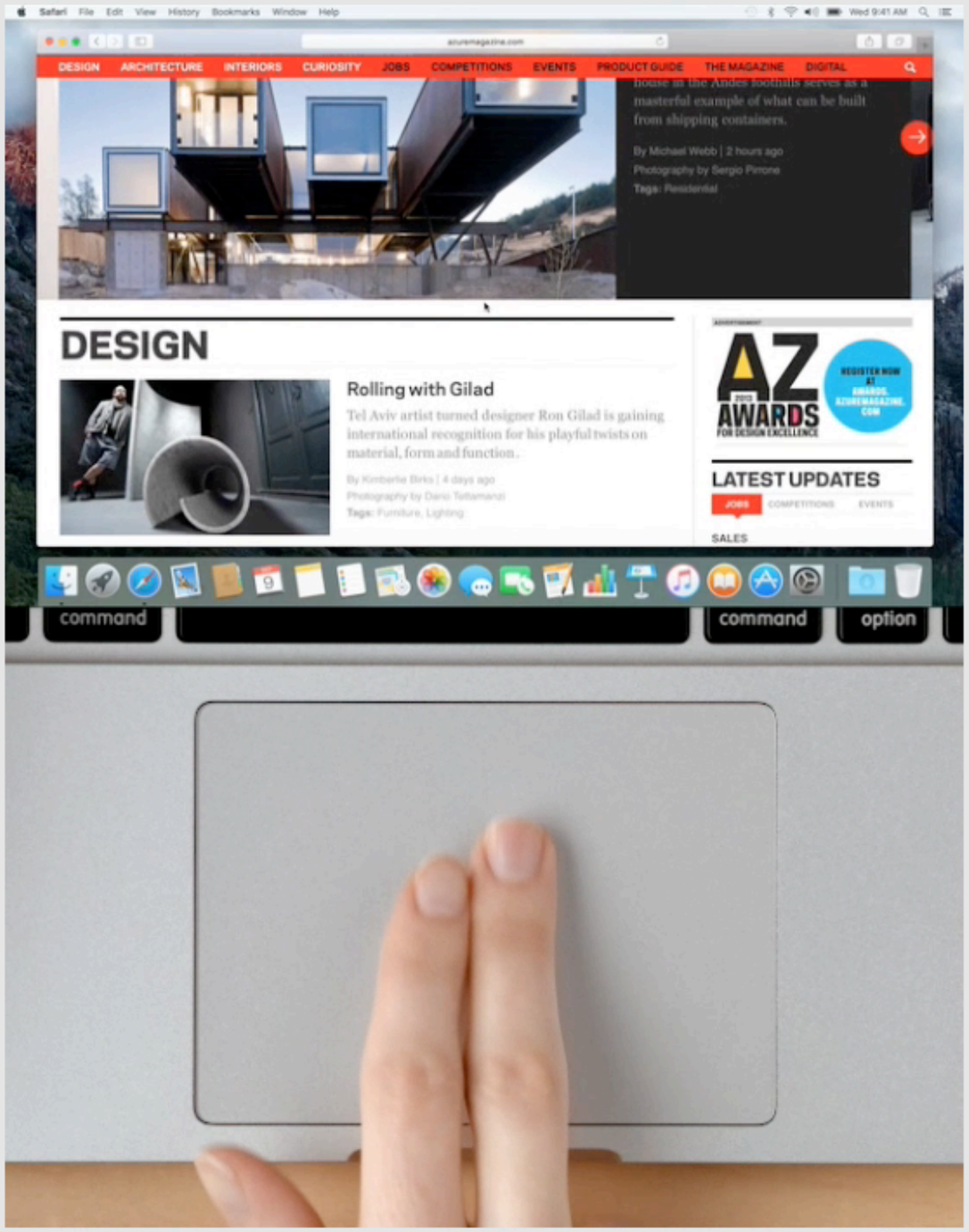
Spatial transformation
Control: forward
Display: up

Trackpad

Search

Point & Click | Scroll & Zoom | More Gestures

- [x] **Scroll direction: natural**
  Content tracks finger movement
- [x] **Zoom in or out**
  Pinch with two fingers
- [x] **Smart zoom**
  Double-tap with two fingers
- [x] **Rotate**
  Rotate with two fingers

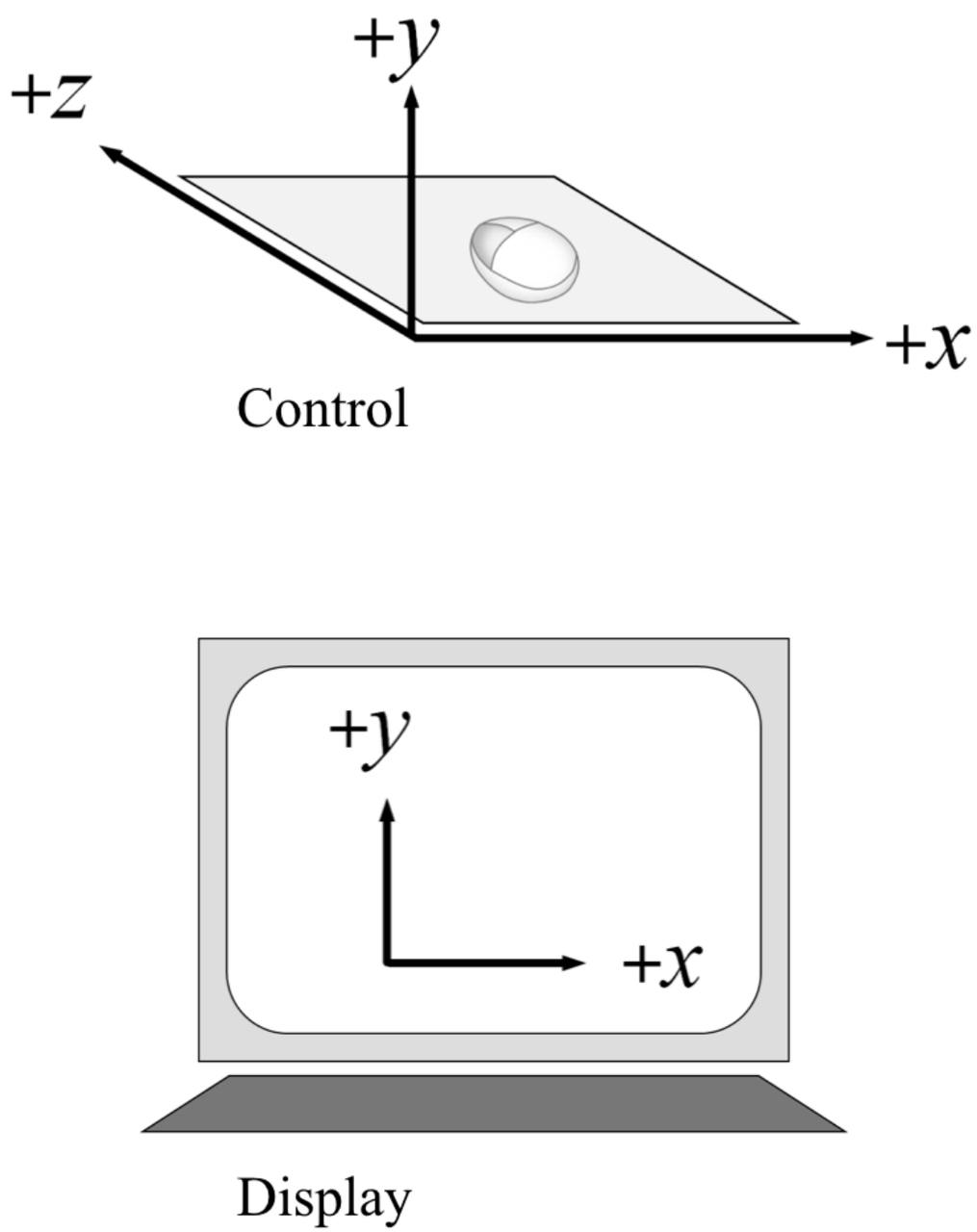


Natural Scrolling

Set Up Bluetooth Trackpad...

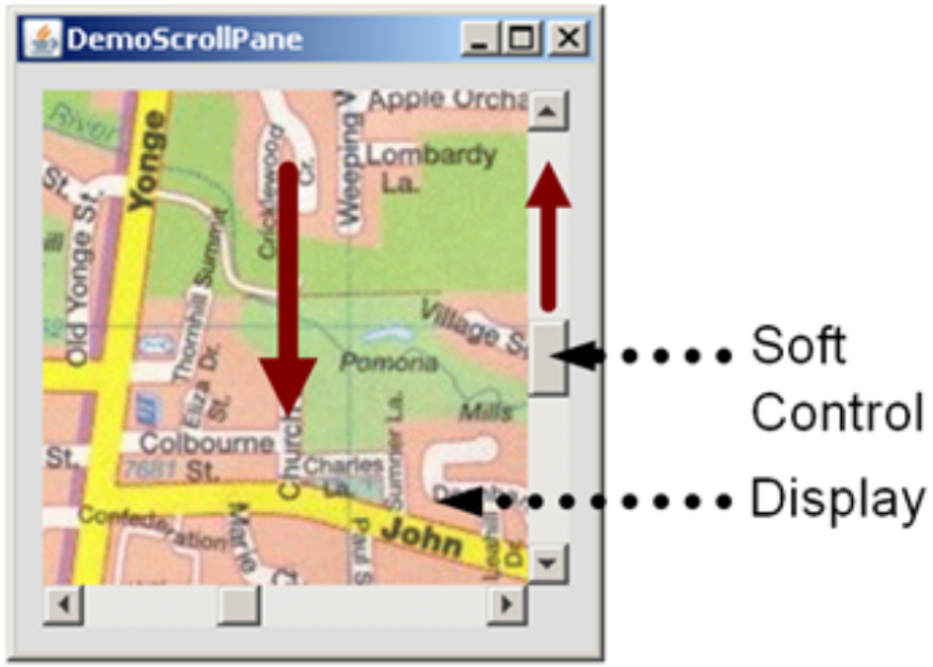
?

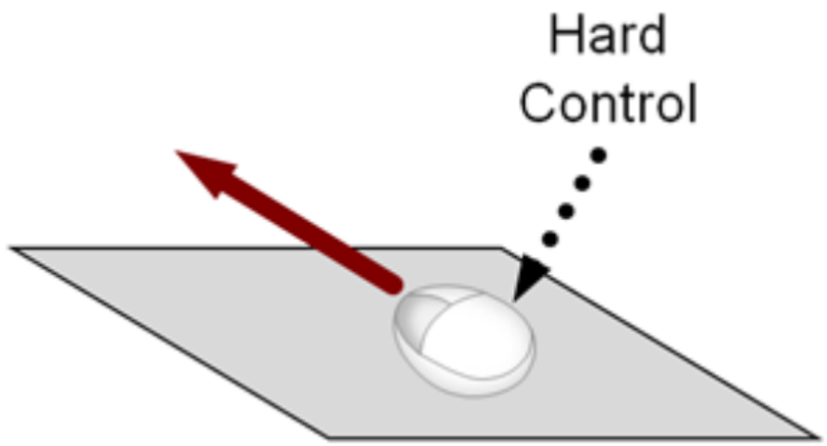
Axis Labeling



Axis	Control (mouse)	Display (cursor)
x	+	+
y		+
z	+	

Third Tier



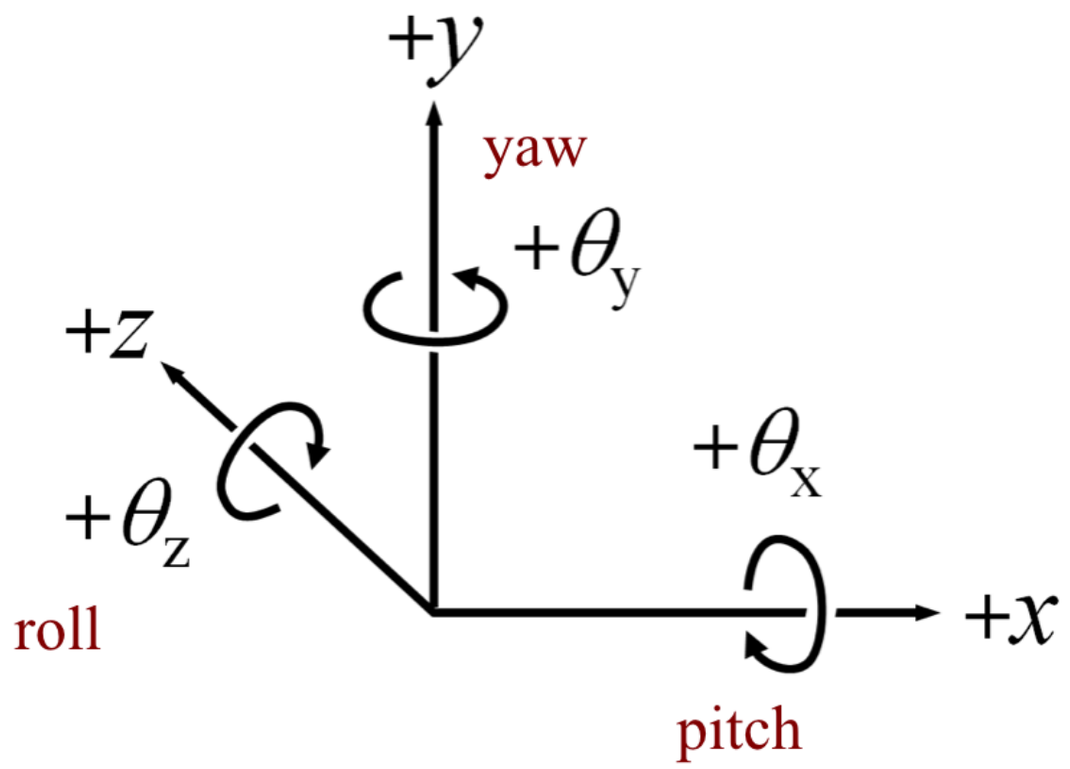


DOF	Hard Control	Soft Control	Display
x			
y		+	-
z	+		
θ_x			
θ_y			
θ_z			

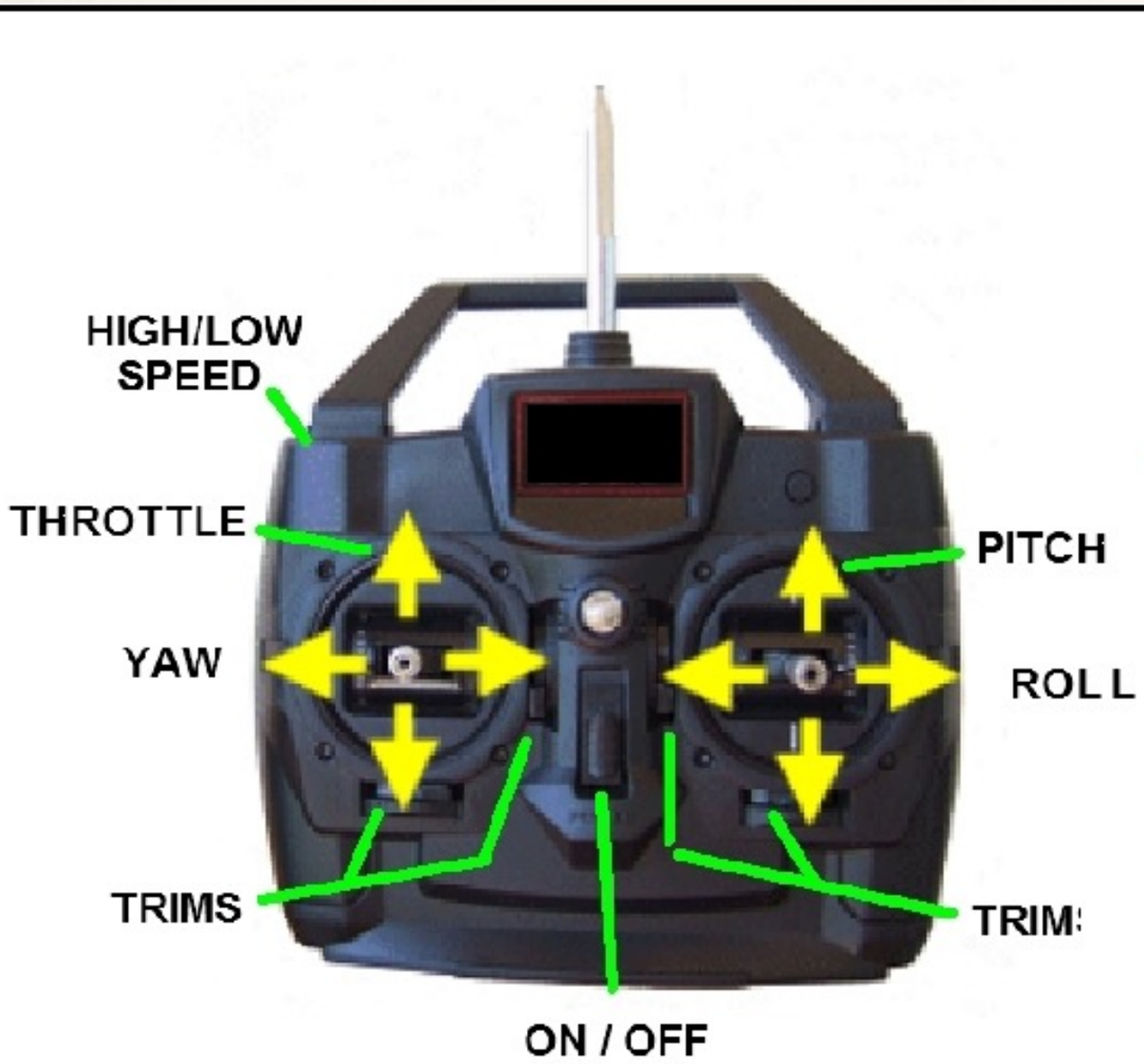
3D

- In 3D there are 6 degrees of freedom (DOF)
  - 3 DOF for position (x, y, z)
  - 3 DOF for orientation (θx, θy, θx)

In aeronautics…



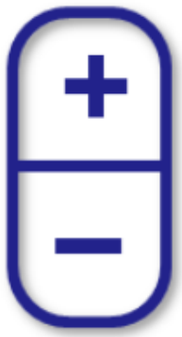
Joysticks & RC Transmitters



3D in Interactive Systems

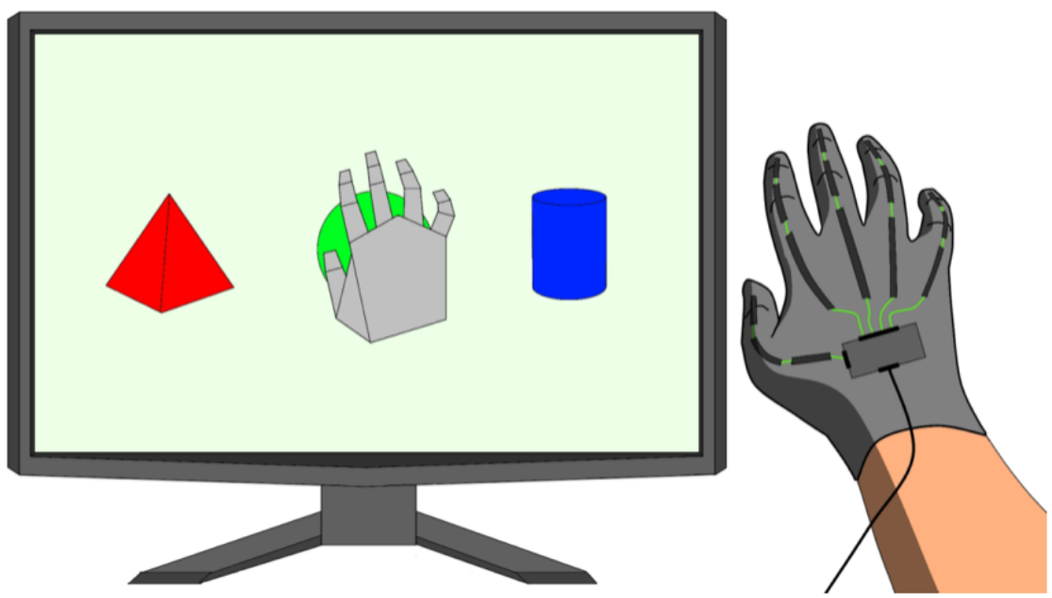
- Usually a subset of the 6 DOF are supported
- Spatial transformations are present and must be learned
  - E.g., Google StreetView

Pan



Zoom

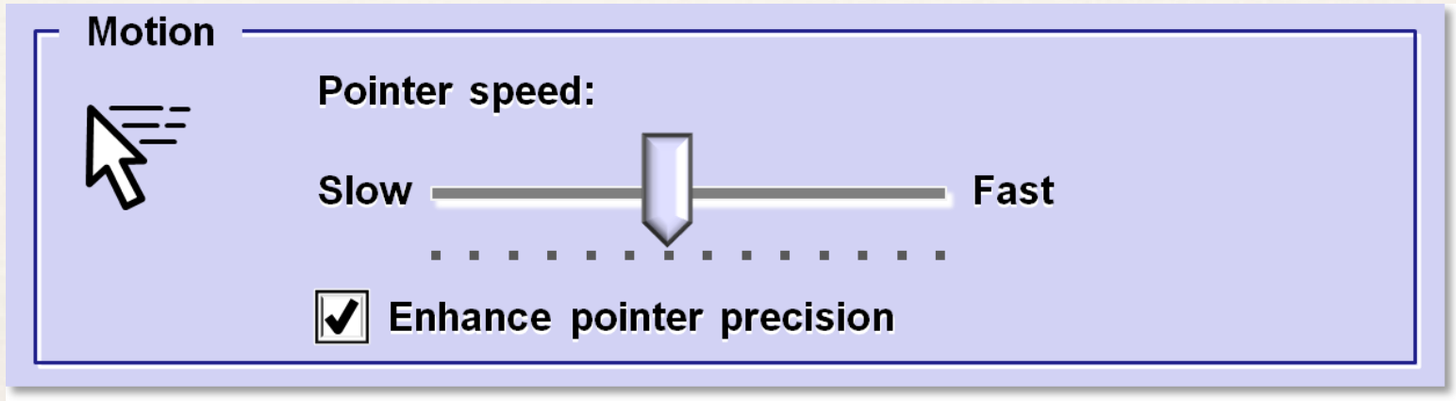
Spatial Congruence in 3D



DOF	Control	Display
x	+ ●	● +
y	+ ●	● +
z	+ ●	● +
θx	+ ●	● +
θy	+ ●	● +
θz	+ ●	● +

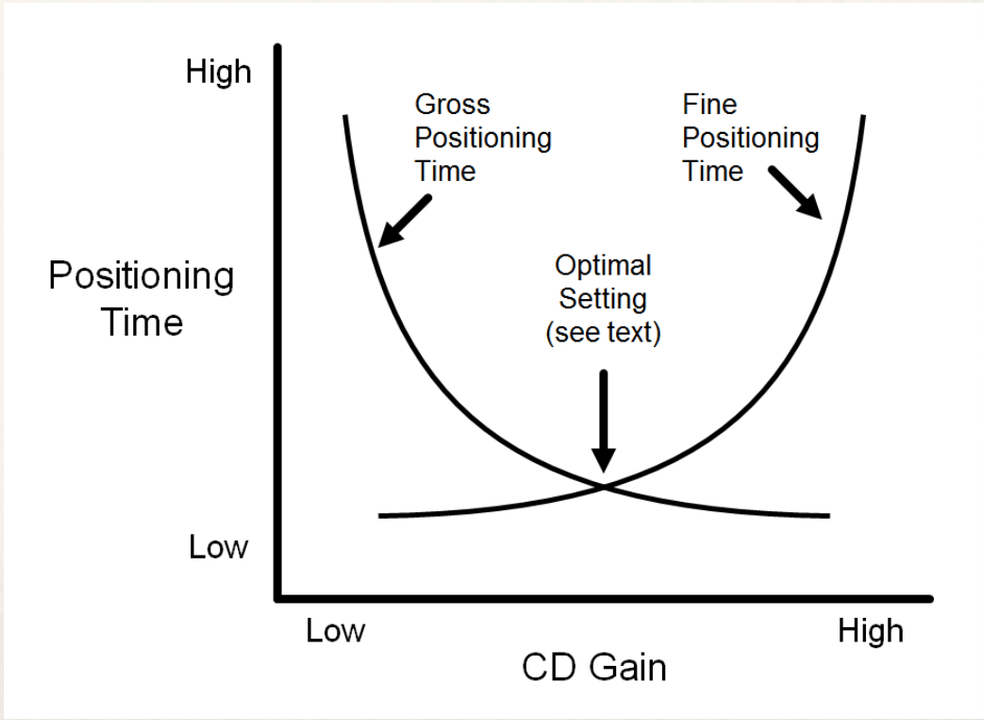
Control-Display Gain

- Quantifies the amount of display movement for a given amount of controller movement
  - E.g., CD gain = 2 implies 2 cm of controller movement yields 4 cm of display movement
- Sometimes specified as a ratio (C:D ratio)
- For non-linear gains, the term transfer function is used
- Typical control panel to adjust CD gain:



CD Gain and User Performance

- Tricky to adjust CD gain to optimize user performance
- Issues:
  - Speed accuracy trade-off (what reduces positioning time tends to increase errors)
  - Opposing relationship between gross and fine positioning times:



Latency

- **Latency** (aka **lag**) is the delay between an input action and the corresponding response on a display
- Usually negligible on interactive systems (e.g., cursor positioning, editing)
- May be “noticeable” in some settings; e.g.,
  - Remote manipulation
  - Internet access (and other “system” response situations)
  - Virtual reality (VR)
- Human performance issues appropriate for empirical research

Property Sensed, Order of Control

- Property sensed
  - Position (graphics tablet, touchpad, touchscreen)
  - Displacement (mouse, joystick)
  - Force (joystick)
- Order of control (property of display controlled)
  - Position (of cursor/object)
  - Velocity (of cursor/object)

Joystick

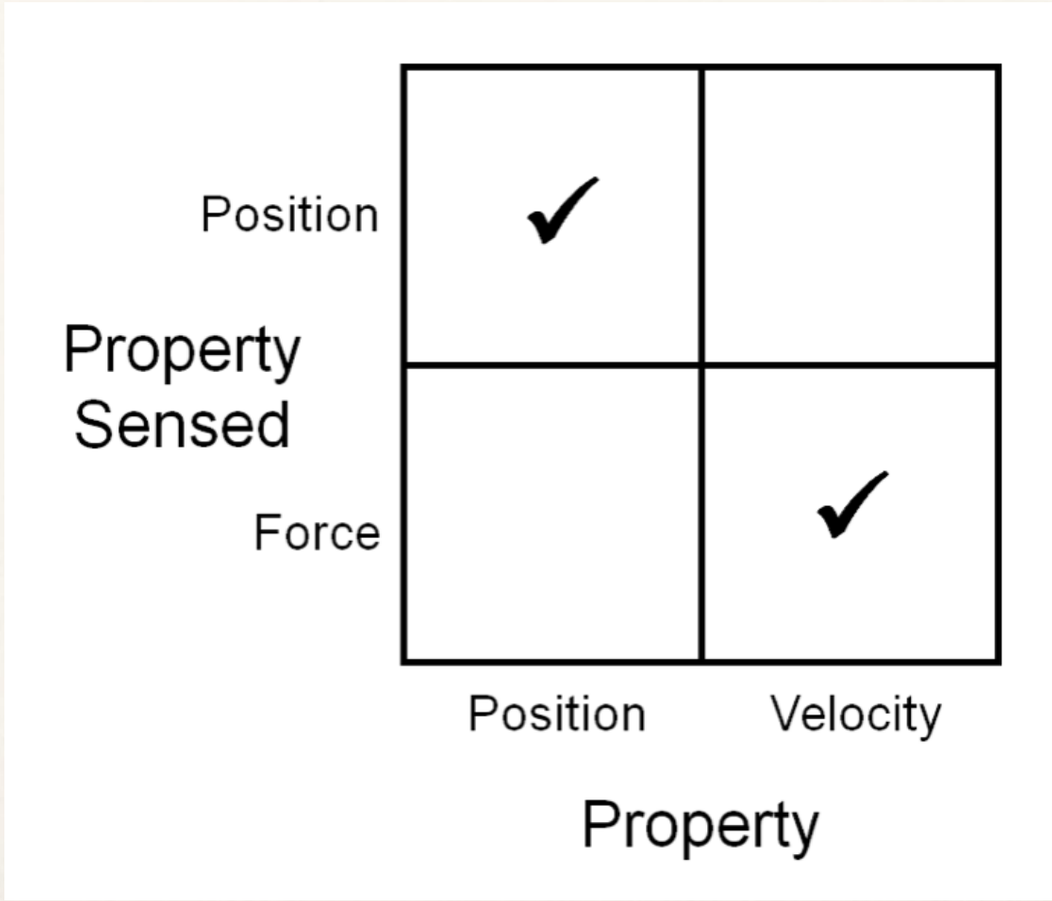
- Two types
  - Isotonic (senses displacement of stick)
  - Isometric (senses force applied to stick)

Isotonic joystick

Isometric joystick

Joystick

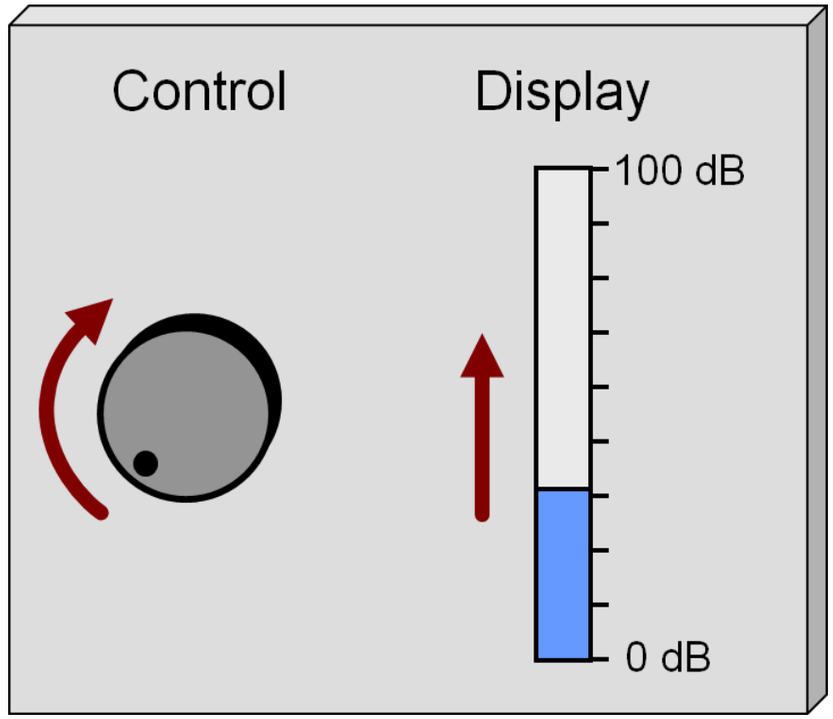
- Optimal mappings
  - Isotonic joystick → position control
  - Isometric joystick → velocity control



Natural vs. Learned Relationships

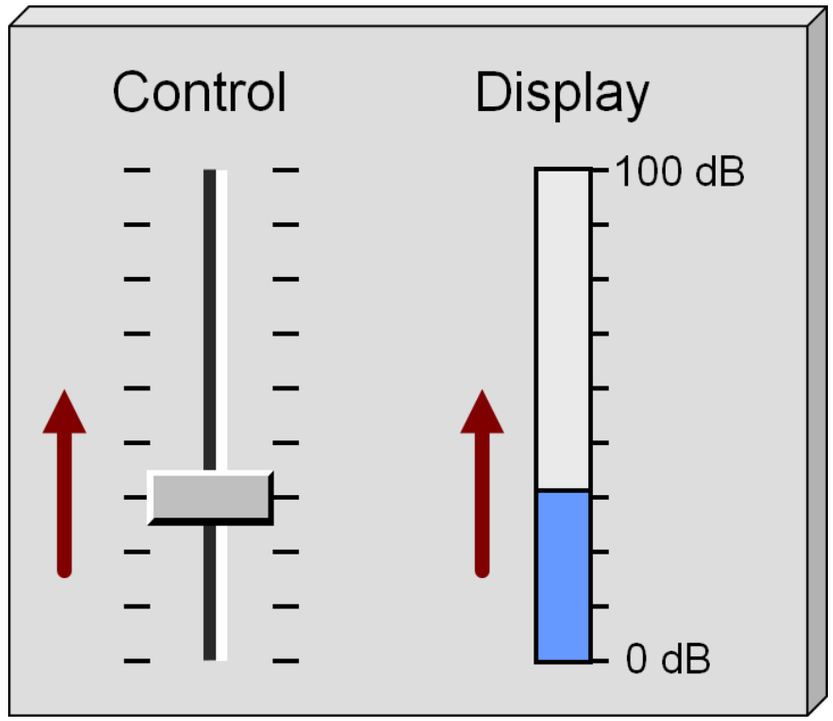
- Natural relationships → spatially congruent
- Learned relationships → spatial transformation (relationship must be learned)

Learned relationship



DOF	Control	Display
x		
y		+
z		
θ_x		
θ_y		
θ_z	+	

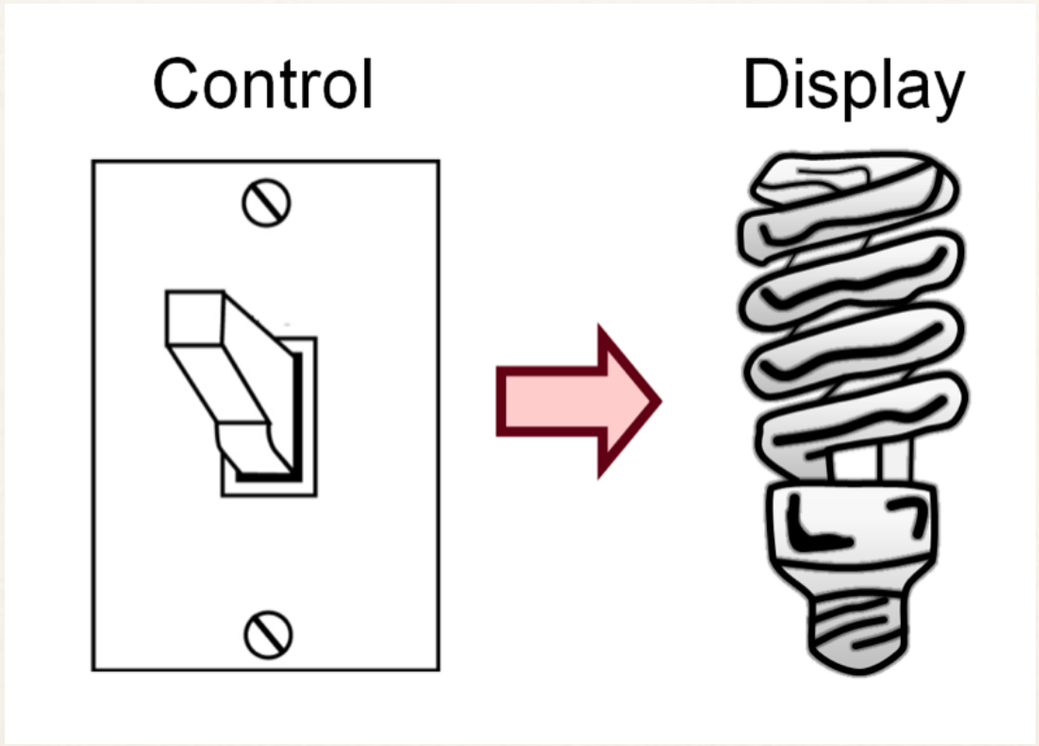
Natural relationship



DOF	Control	Display
x		
y	+	+
z		
θ_x		
θ_y		
θ_z		

Learned Relationships

- Learned relationships seem natural if they lead to a **population stereotype or cultural standard**
- A control-display relationship needn’t be a spatial relationship…



Is the display on or off?

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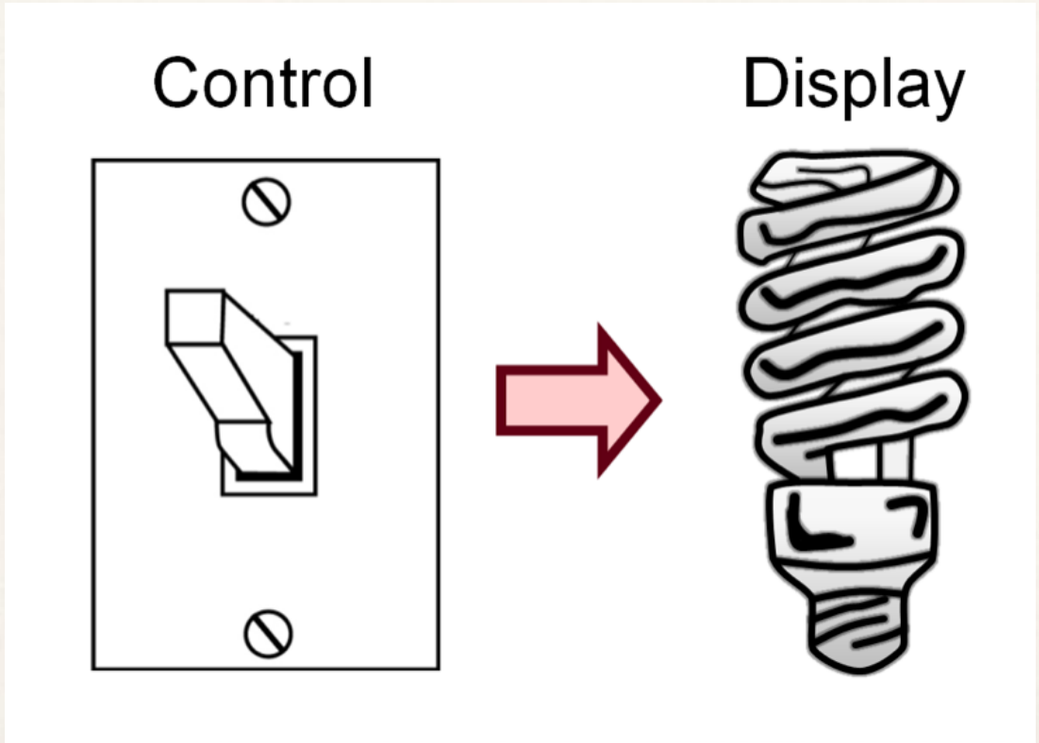


Is the display on or off?

Answer:

On (in Korea, U.S., Canada)

Off (in U.K.)

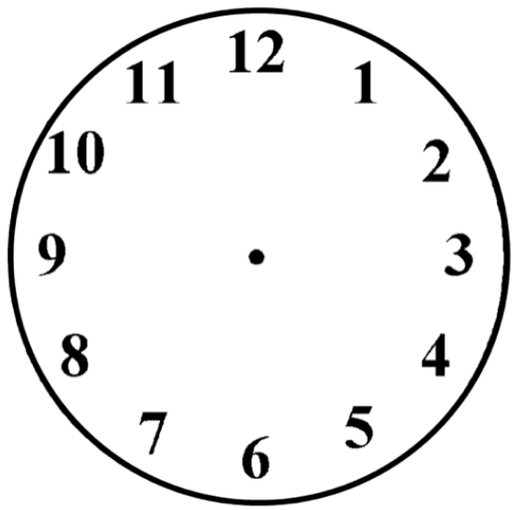
Mental Models

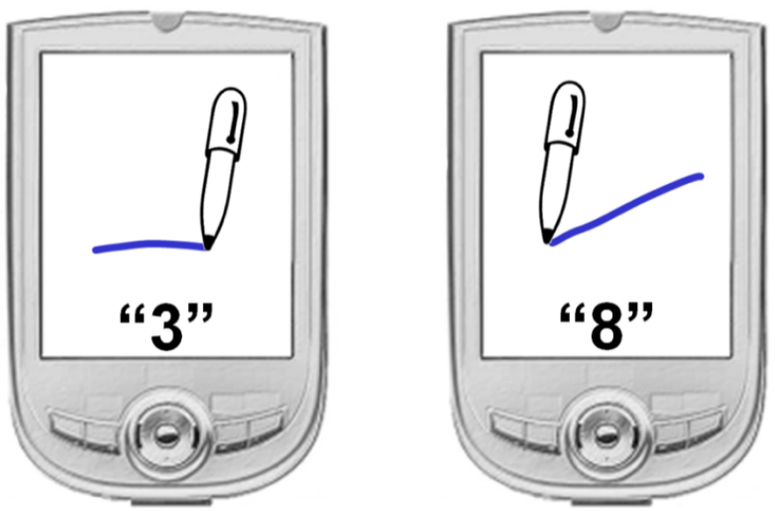
- Related terms: **physical analogy, metaphor, conceptual models**
- Definition: a physical understanding of an interface or interaction technique based on real-world experience
- Scroll pane: slider up, view up (“up-up” is a conceptual model that helps our understanding)
- **Desktop metaphor** is most common metaphor in computing
- Other commonly exploited real-world experiences:
- Shopping, driving a car, calendars, painting
- Icon design, in general, strives to foster mental models

Graphics and Paint Applications

- Icons attempt to leverage real-world experiences with painting, drawing, sketching, etc.'

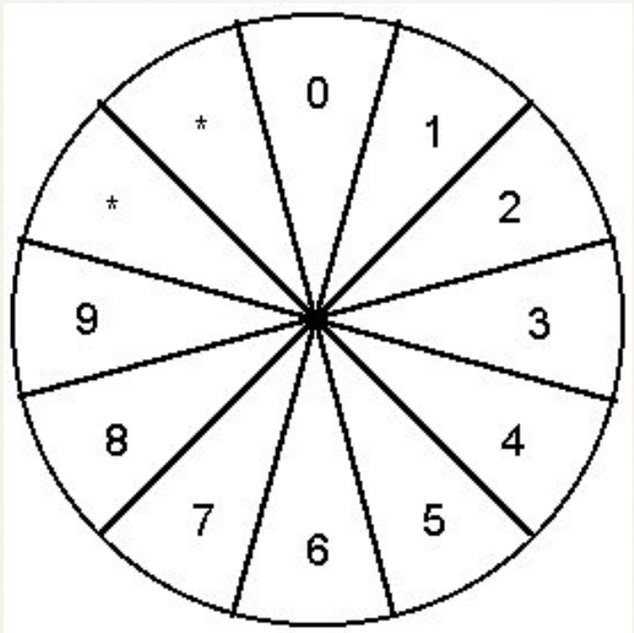
- Clock Metaphor

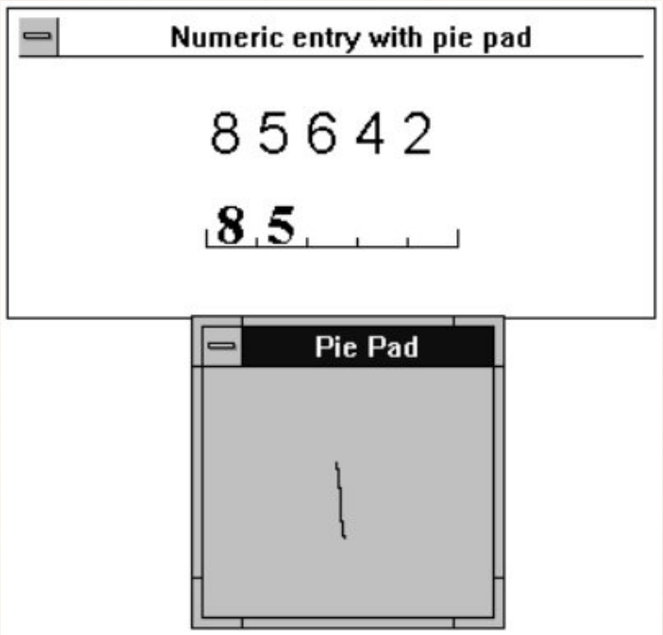


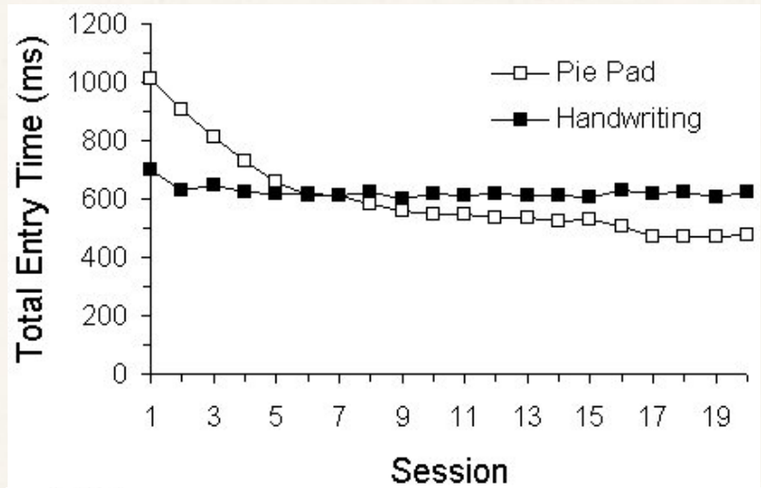


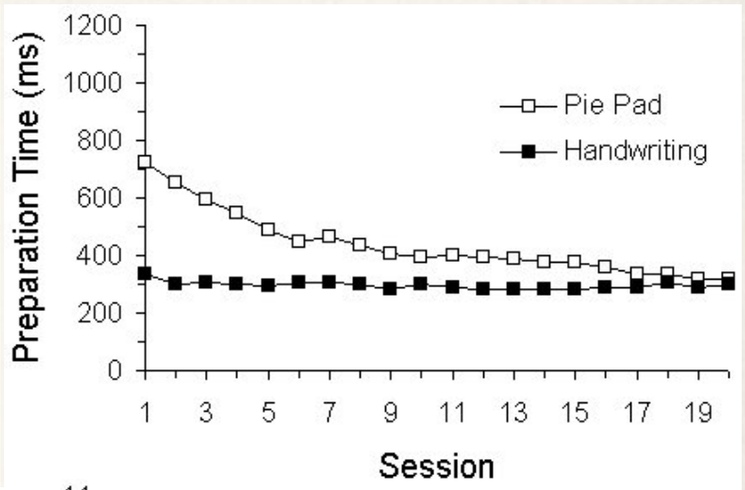
[1] McQueen, C., MacKenzie, I. S., & Zhang, S. X. (1995). An extended study of numeric entry on pen-based computers. *Proceedings of Graphics Interface '95*, 215-222, Toronto: Canadian Information Processing Society.

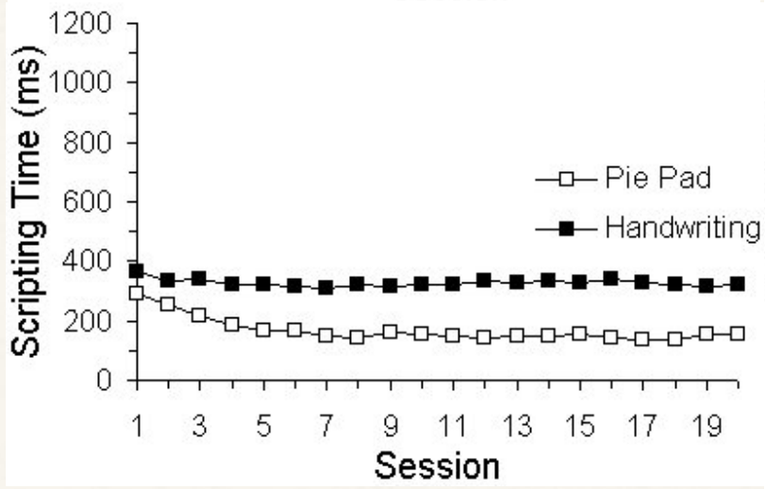
Clock metaphor cont.

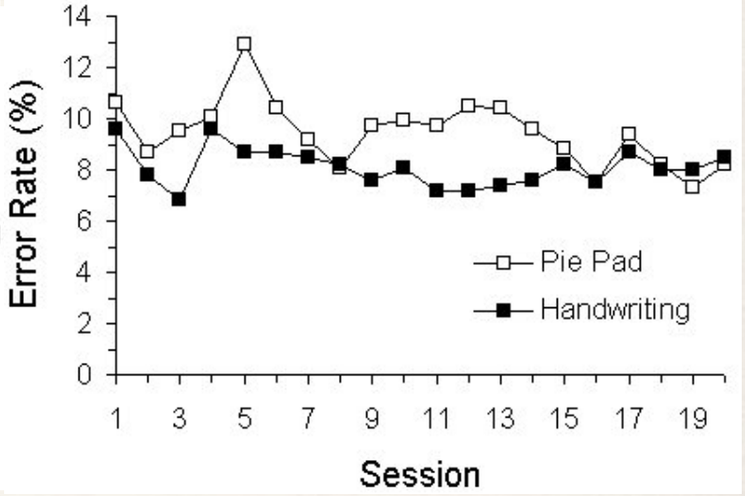












Modes

- A **mode** is a functioning arrangement or condition
- Modes are everywhere (and in most cases are unavoidable)
  - Office phone light:
    - on = message waiting, off = no messages
  - Computer keyboards have modes
    - ≈100 keys + SHIFT, CTRL, ALT, CMD → ≈ 800 key variations

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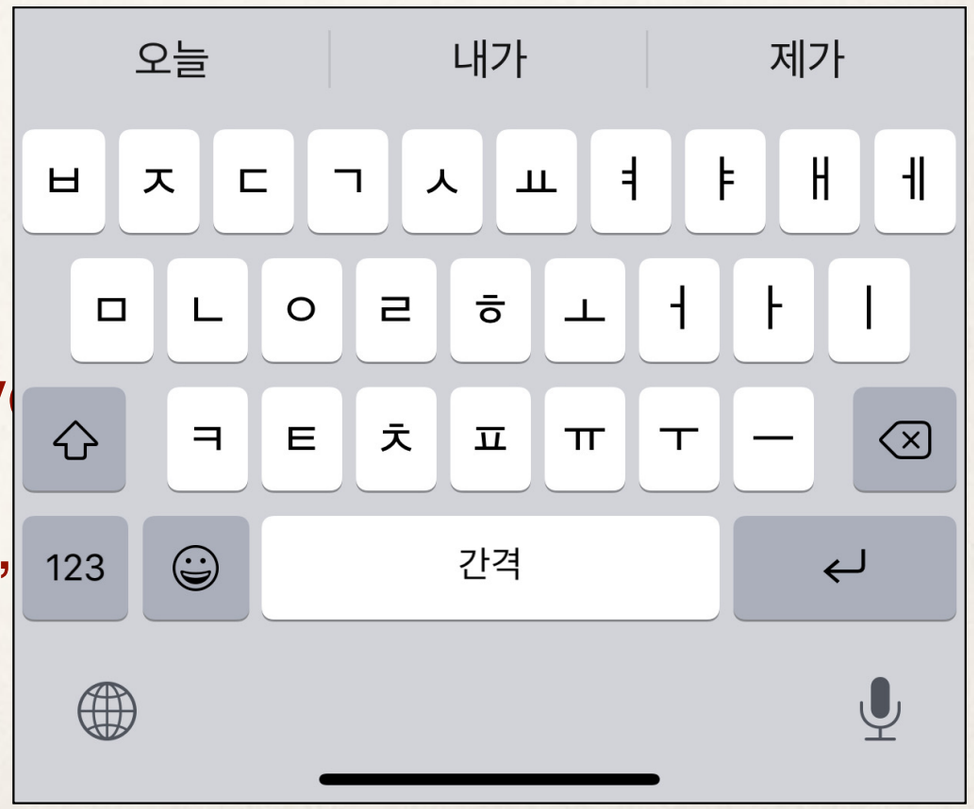

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Example: F9 Key – Microsoft Word (2010)

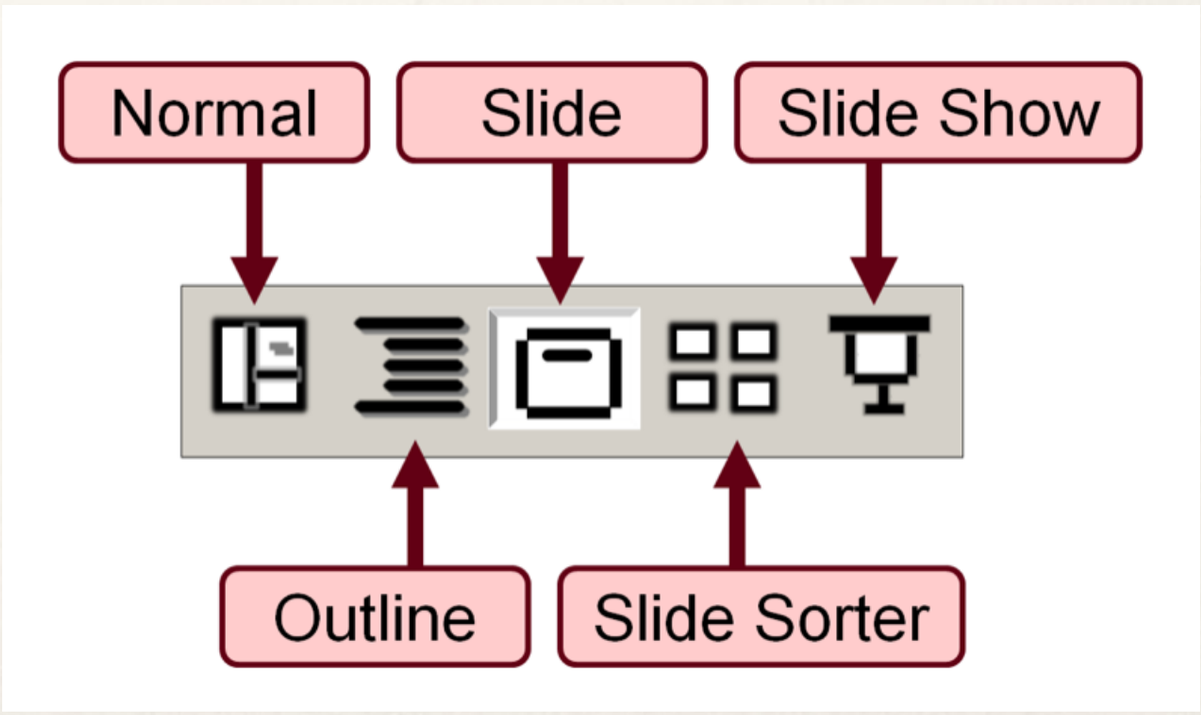
- At least six interpretations, depending on mode:
  - F9 → Update selected fields
  - SHIFT+F9 → Switch between a field code and its result
  - CTRL+F9 → Insert an empty field
  - CTRL+SHIFT+F9 → Unlink a field
  - ALT+F9 → Switch between all field codes and their results
  - ALT+SHIFT+F9 → Run GOTOBUTTON or MACROBUTTON from the field that displays the field results

Mobile Phone Example

- Navi key (first introduced on Nokia 3210)
- Mode revealed by word above
- At least 15 interpretations: Menu, Select, Answer, Call, End, OK, Options, Assign, Send, Read, Use, View, List, Snooze, Yes

Mode Switching

- PowerPoint: Five view modes
- Switch modes by clicking soft button
- How to exit Slide Show mode?
  - PowerPoint → ESC
  - Chrome → ?



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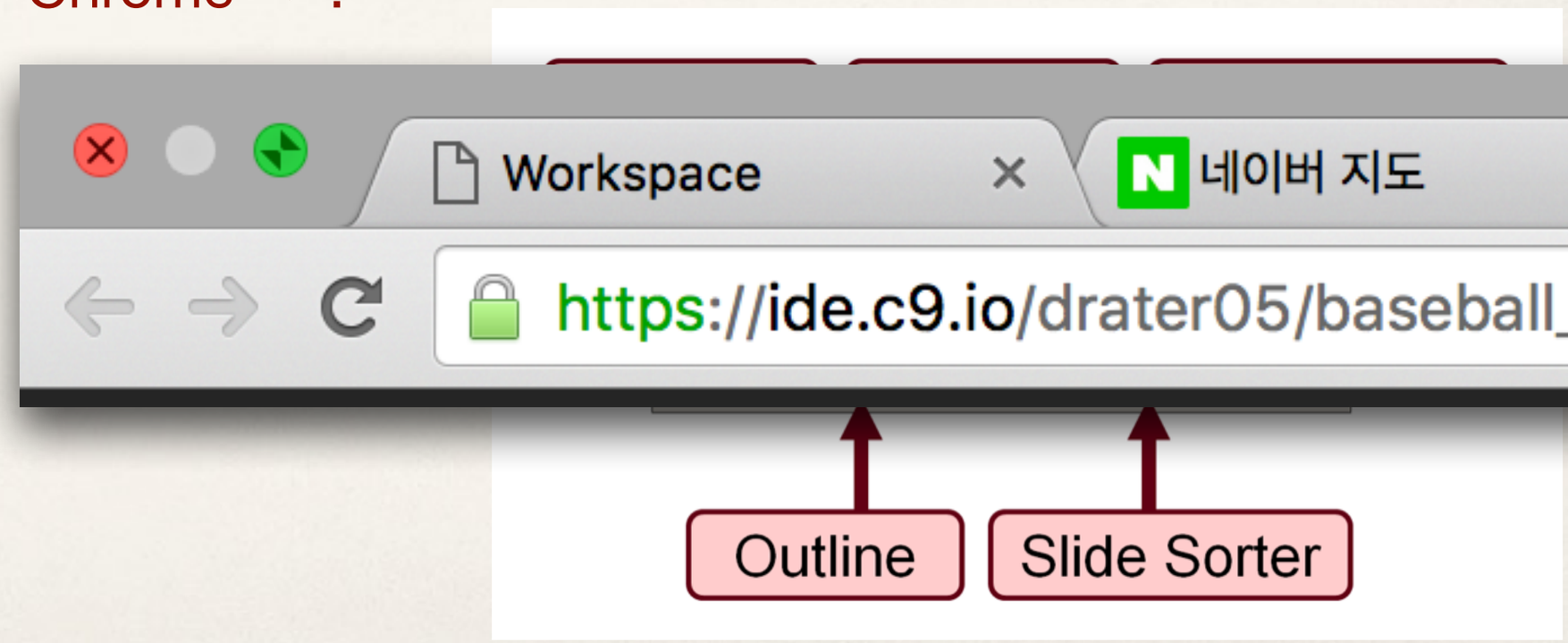
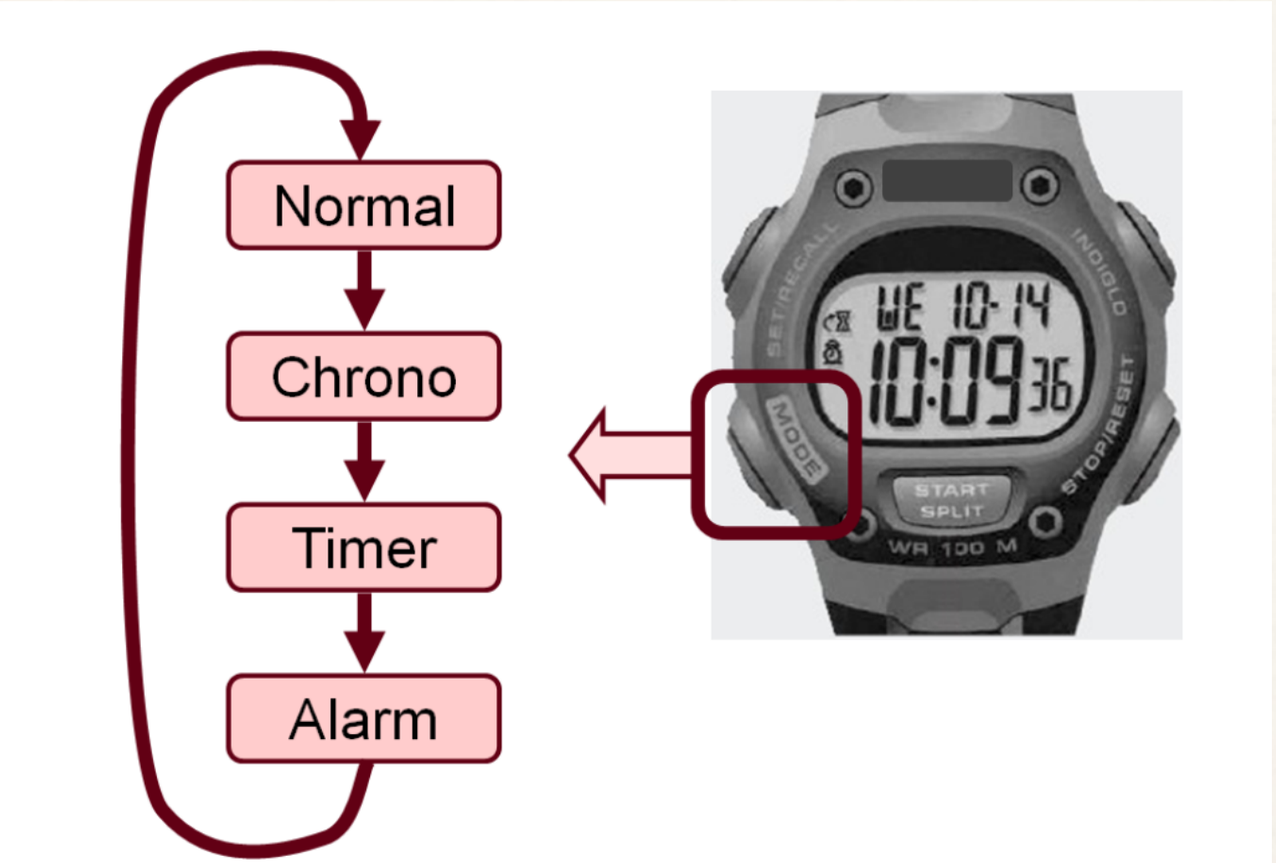


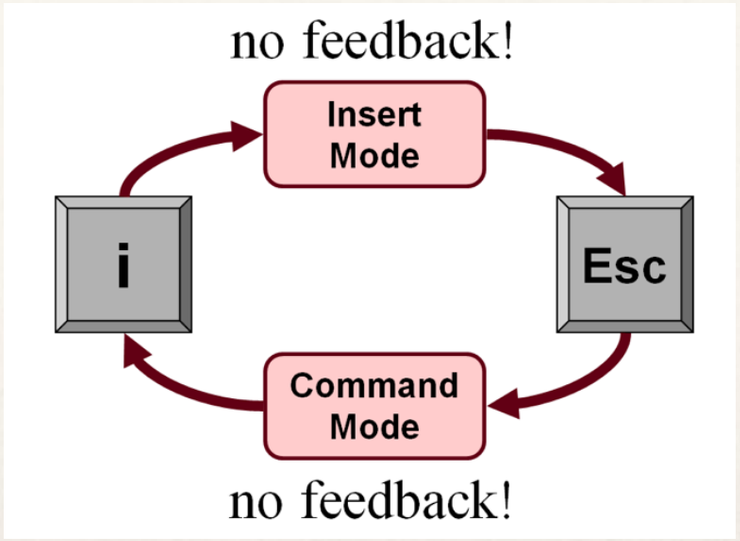
Mode Switching

- Sports watch
- Single button cycles through modes



Mode Visibility

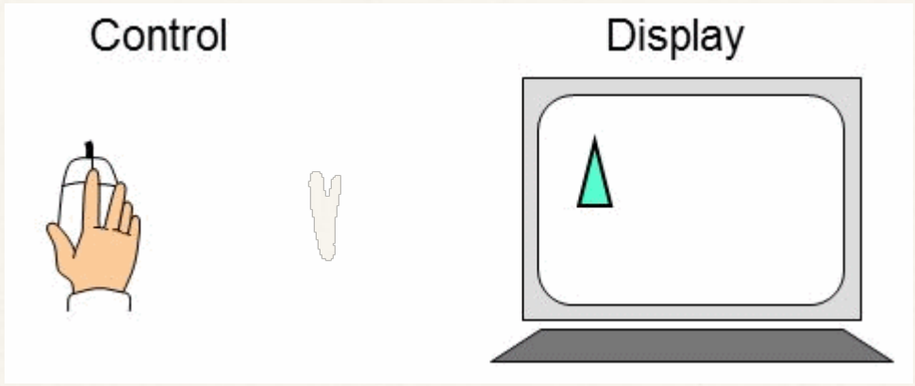
- Shneiderman: “offer information feedback”
  - Shneiderman, B., & Plaisant, C. (2005). Designing the user interface: Strategies for effective human-computer interaction. (4th ed.). New York: Pearson.
- Norman: “make things visible”
  - Norman, D. A. (1988). The design of everyday things. New York: Basic Books.
- unix vi editor: Classic example of no mode visibility:



Modes and Degrees of Freedom

- If control DOF < display DOF, modes are necessary to fully access the display DOF
- Consider a mouse (2 DOF) and a desktop display (3 DOF)

- x-y control (no problem):

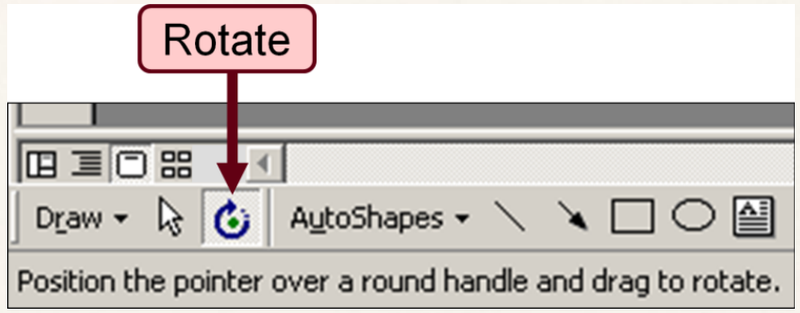


→ **Solution?**

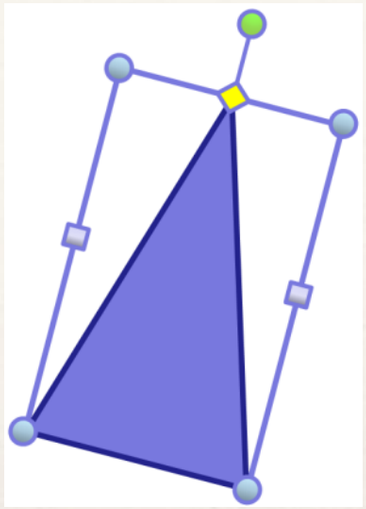
Rotation has issue!

Rotate Mode

- The solution: Rotate mode
- Two approaches
  - Separate rotate mode:



  - Embedded rotate mode:



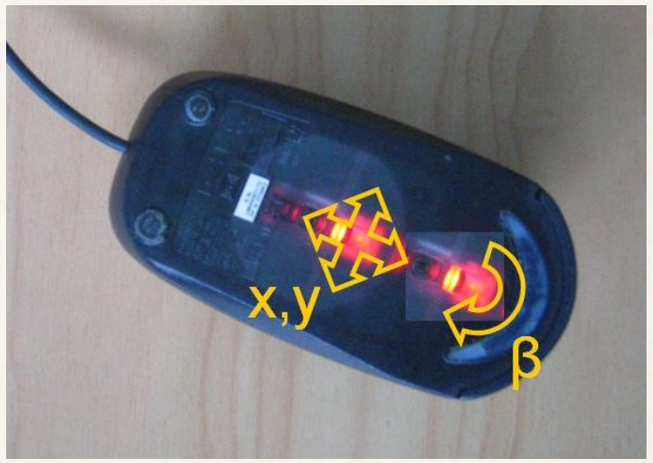
(maybe) use with modifier keys

3 DOF Mouse

- Lots of research (but not commercial products yet)

1

2



3

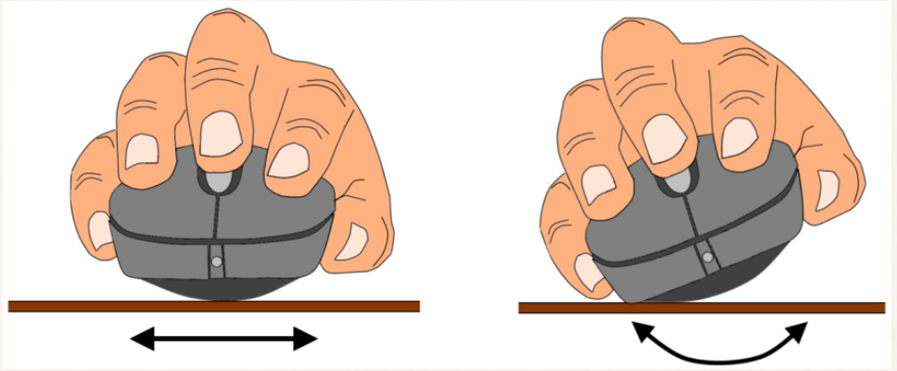
1. Almeida, R., & Cubaud, P. (2006). Supporting 3D window manipulation with a yawing mouse. Proc NordiCHI 2006, 477-480, New York: ACM.

2. MacKenzie, I. S., Soukoreff, R. W., & Pal, C. (1997). A two-ball mouse affords three degrees of freedom. Proc CHI '97, 303-304, New York: ACM.

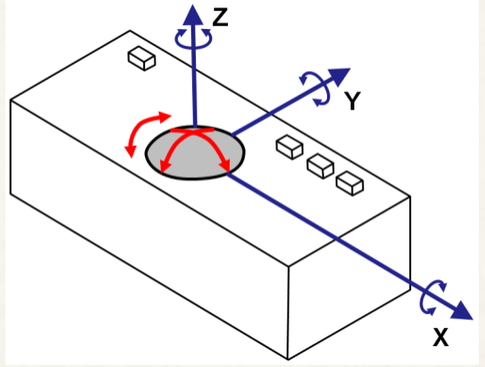
3. Hannagan, J., & Regenbrecht, H. (2008). TwistMouse for simultaneous translation and rotation. Tech Report. HCI Group. Information Science Department. University of Otago, Dunedin, New Zeland.

> 2 Degrees of Freedom

- Examples in the HCI research literature
  - 4 DOF Rockin’ Mouse[1]
  - Three-axis trackball[2]



1



2

1. Balakrishnan, R., Baudel, T., Kurtenbach, G., & Fitzmaurice, G. (1997). The Rockin'Mouse: Integral 3D manipulation on a plane. Proc CHI '97, 311-318, New York: ACM.

2. Evans, K. B., Tanner, P. P., & Wein, M. (1981). Tablet based valuators that provide one, two, or three degrees of freedom. Computer Graphics, 15(3), 91-97.

Separating the Degrees of Freedom

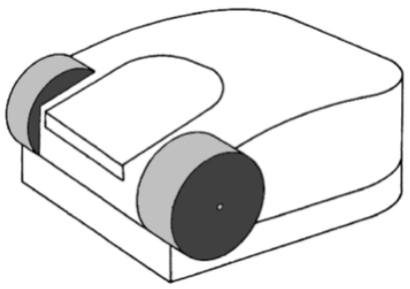
- More DOF is not necessarily better
- Must consider the context of use
- Etch-A-Sketch: separate 1 DOF x and y controllers:

Wheel Mouse

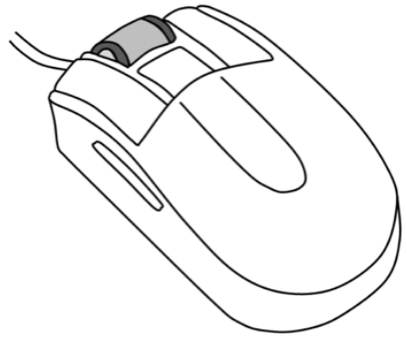
- Separate DOF via a wheel
- Successful introduction by Microsoft in 1996 with the IntelliMouse

- Preceded by…

RollerMouse[1]



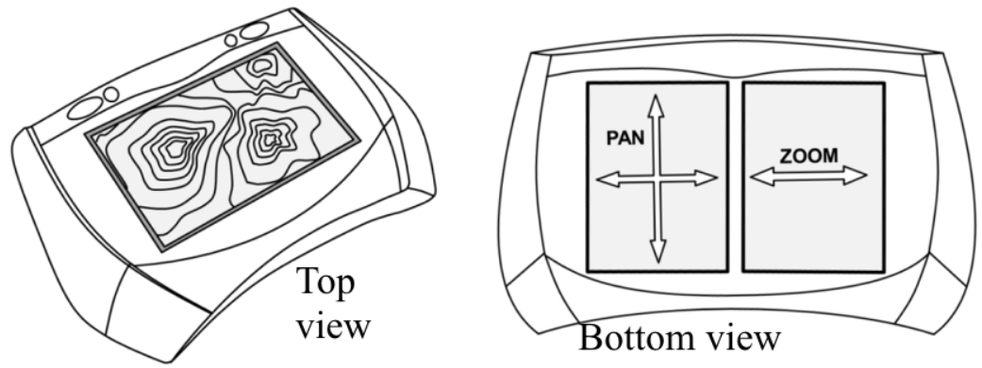
ProAgio[2]



Adding a Touch Sensor

PadMouse[1]

Panning and Zooming Display[2]



Multitouch+Mouse[3]

1. Balakrishnan, R., & Patel, P. (1998). The PadMouse: Facilitating selection and spatial positioning for the non-dominant hand. Proc CHI '98 (pp. 9-16): New York: ACM.
2. Silfverberg, M., Korhonen, P., & MacKenzie, I. S. (2003). International Patent No. WO 03/021568 A1.
3. Villar et al. (2009). Mouse 2.0: Multi-touch meets the mouse. Proc UIST '09, 33-42, New York: ACM.

Adding a Touch Sensor

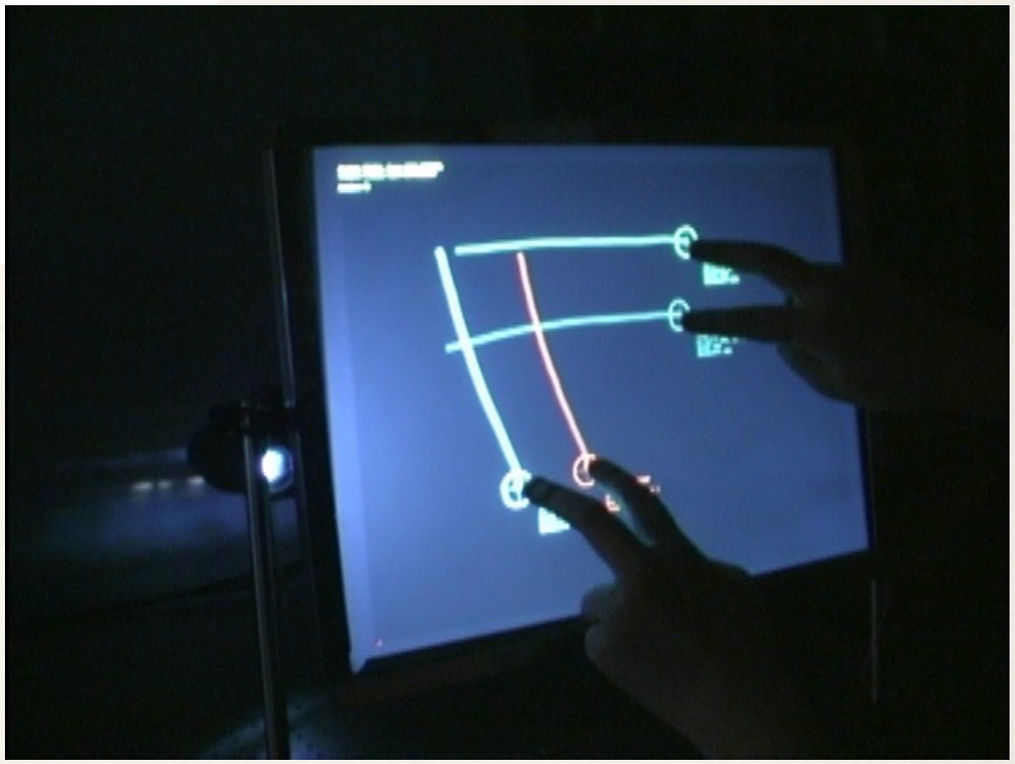
03/021568 A1.

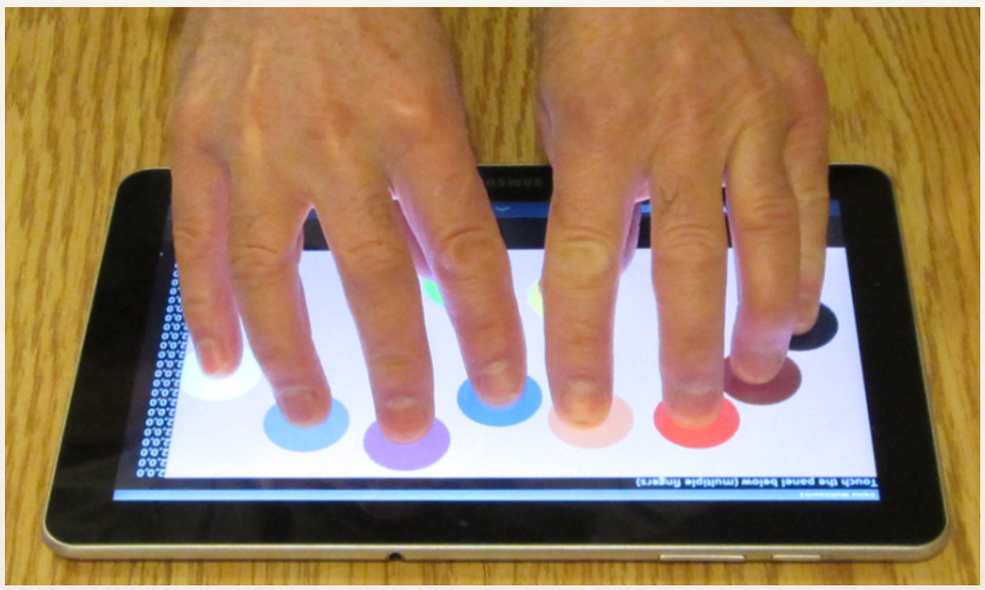
3. Villar et al. (2009). Mouse 2.0: Multi-touch meets the mouse. Proc UIST ‘09, 33-42, New York: ACM.

Mobile Context

- Touchscreens are the full embodiment of direct manipulation
- No need for a cursor (cf. indirect input)

Multitouch





Accelerometers

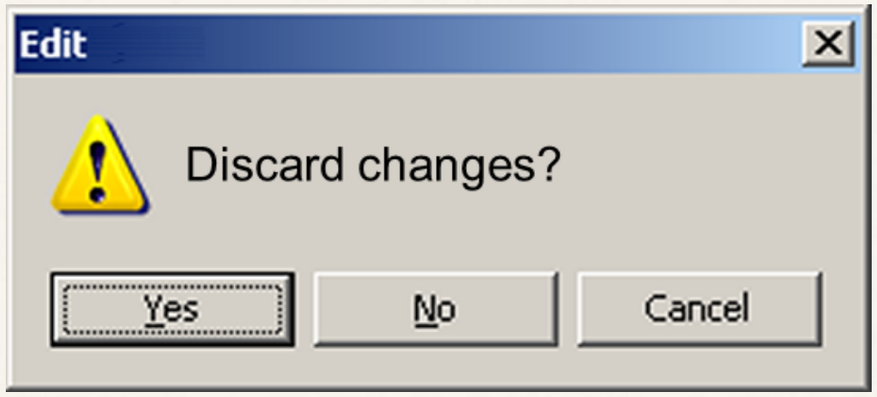
- Accelerometers enable tilt or motion as an input primitive
- Technology has matured; now common in mobile devices
- Many applications; e.g., spatially aware displays:

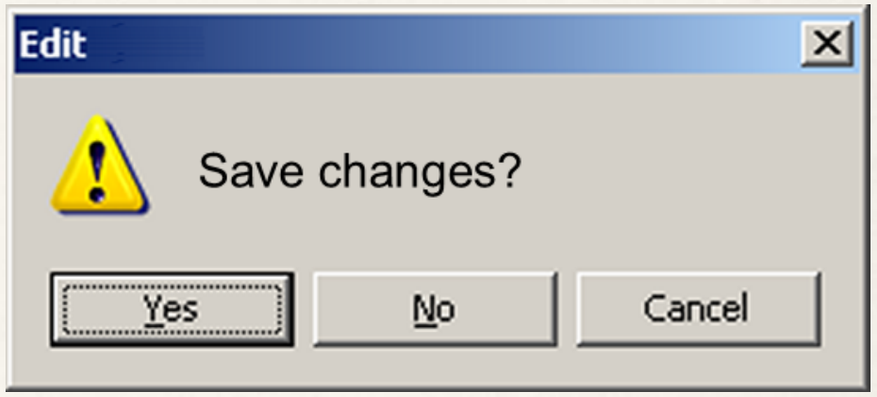
Interaction Errors

- Discussions above focused on physical properties of controllers and the interactions they enable
- Interaction involves the human (sensors, brain, responders) and the machine
- Interaction errors are unavoidable (and, hence, are akin to an “interaction element”)
- We conclude with a look at interaction errors and their consequences

Discard Changes

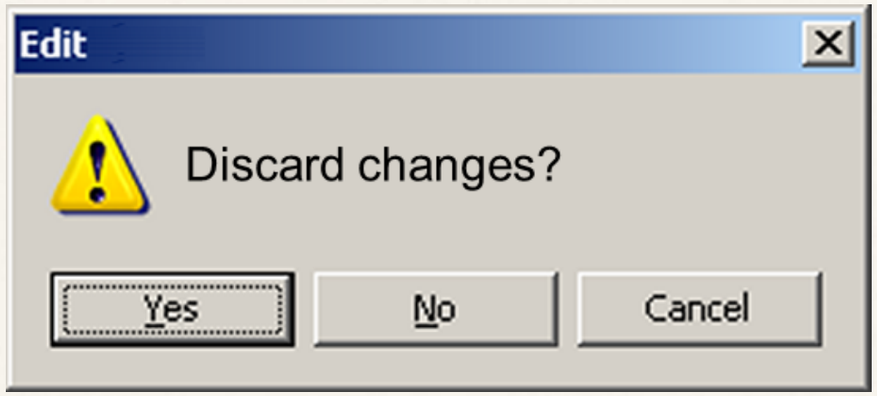
- Default dialogs to quit an application:



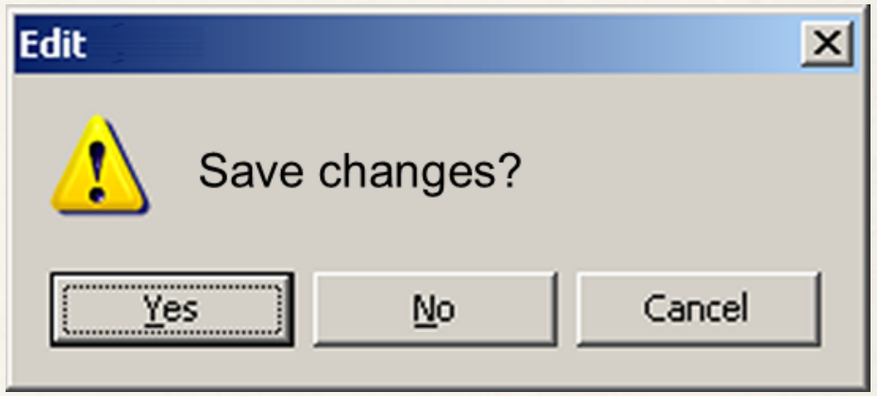


Discard Changes

- Default dialogs to quit an application:



X

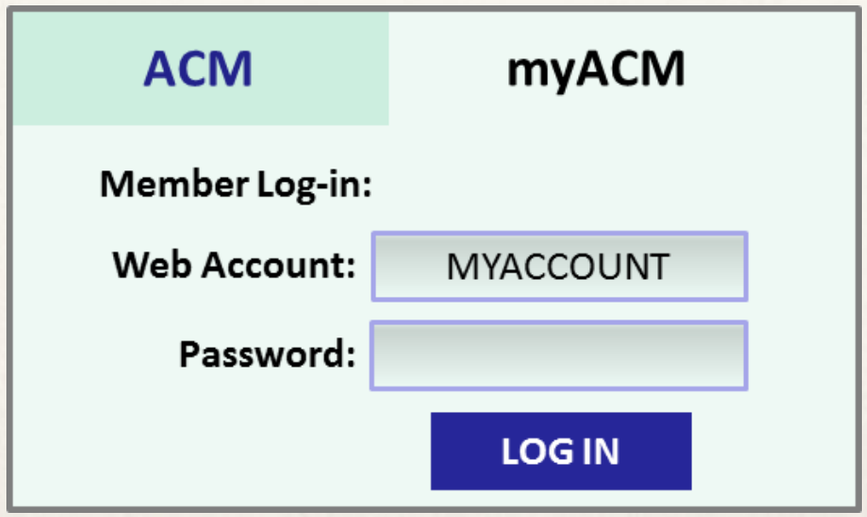


O

CAPS LOCK

- Some log-in dialogs alert the user if CAPS_LOCK is on…

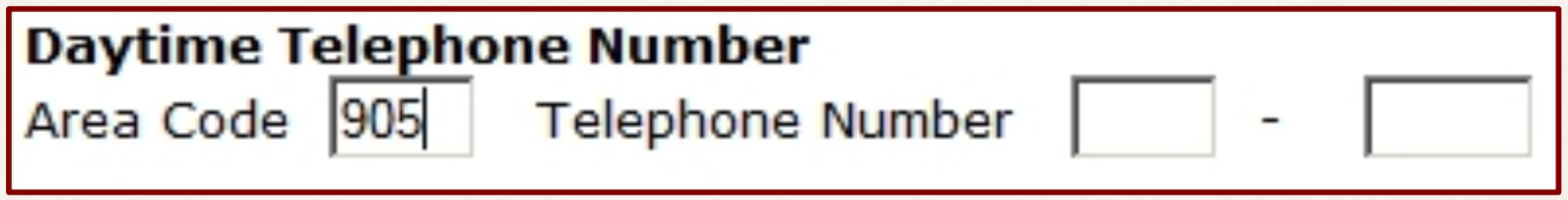
- while others do not…



Focus Uncertainty

- After entering data into a fixed-length field, some interfaces advance focus the next field…

- while others do not…



Next Week: Reading Assignments

- T1: Interaction Design
  - Chapter 4: Social Interaction
  - Chapter 5: Emotional Interaction

Next Week: Reading Assignments

- Nass, C. & Moon, Y. (2000). Machines and mindlessness: Social responses to computers. Journal of Social Issues, 56 (1): 81-103.
- Sproull, L., Subramani, M., Kiesler, S., Walker, J., & Waters, K. (1996). When the Interface Is a Face. Human-Computer Interaction, 11(2), 97-124.
- Lee, J., Jun, S., Forlizzi, J., & Hudson, S. E. (2006). Using kinetic typography to convey emotion in text-based interpersonal communication (ACM, pp. 41–49). Presented at the Proceedings of the 6th conference on Designing Interactive systems, New York, NY, ACM.
- Norman, D. (2004). Emotional design: Why we love (or hate) everyday things. New York: Basic Books. Chapter 1

Questions…?