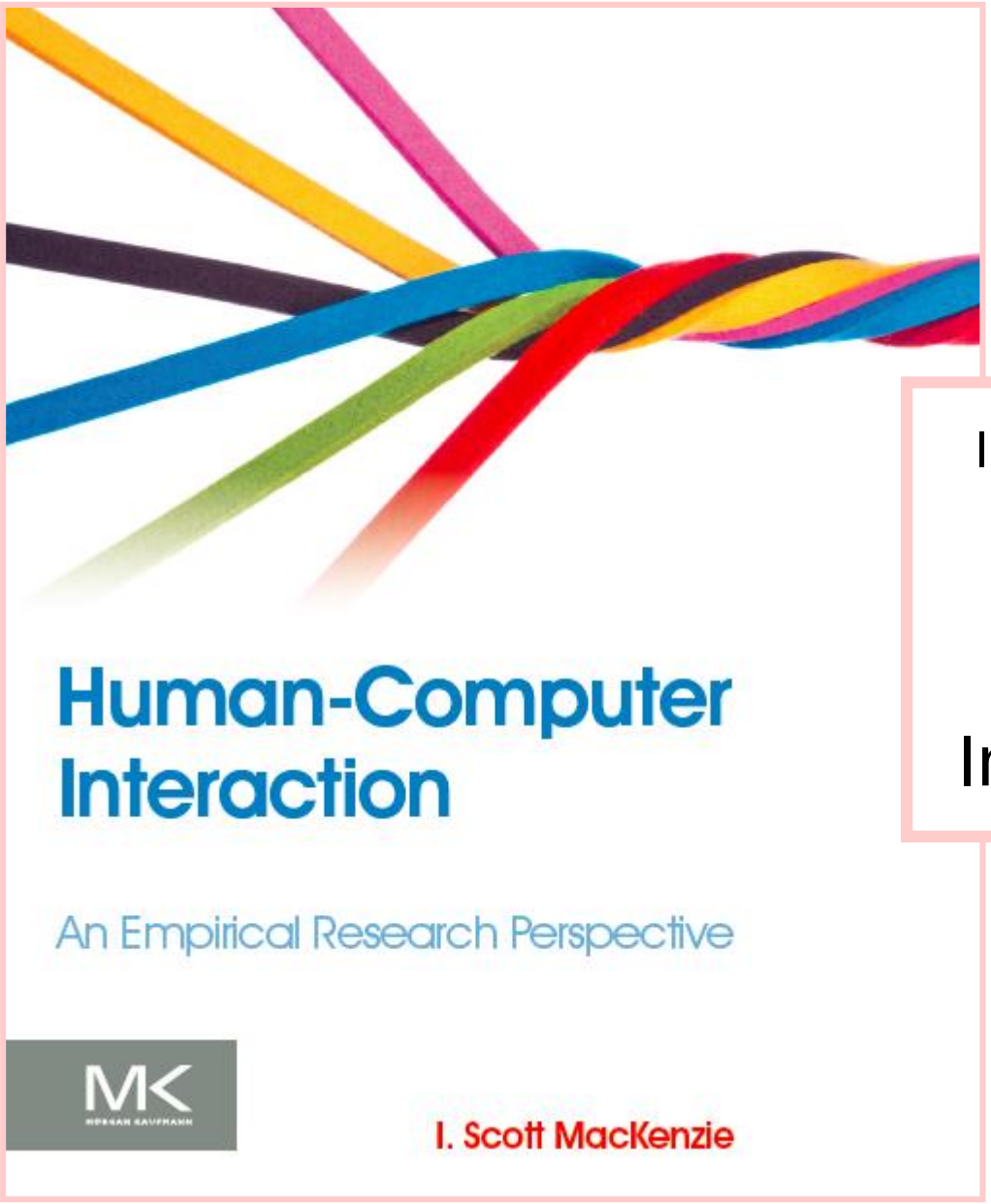
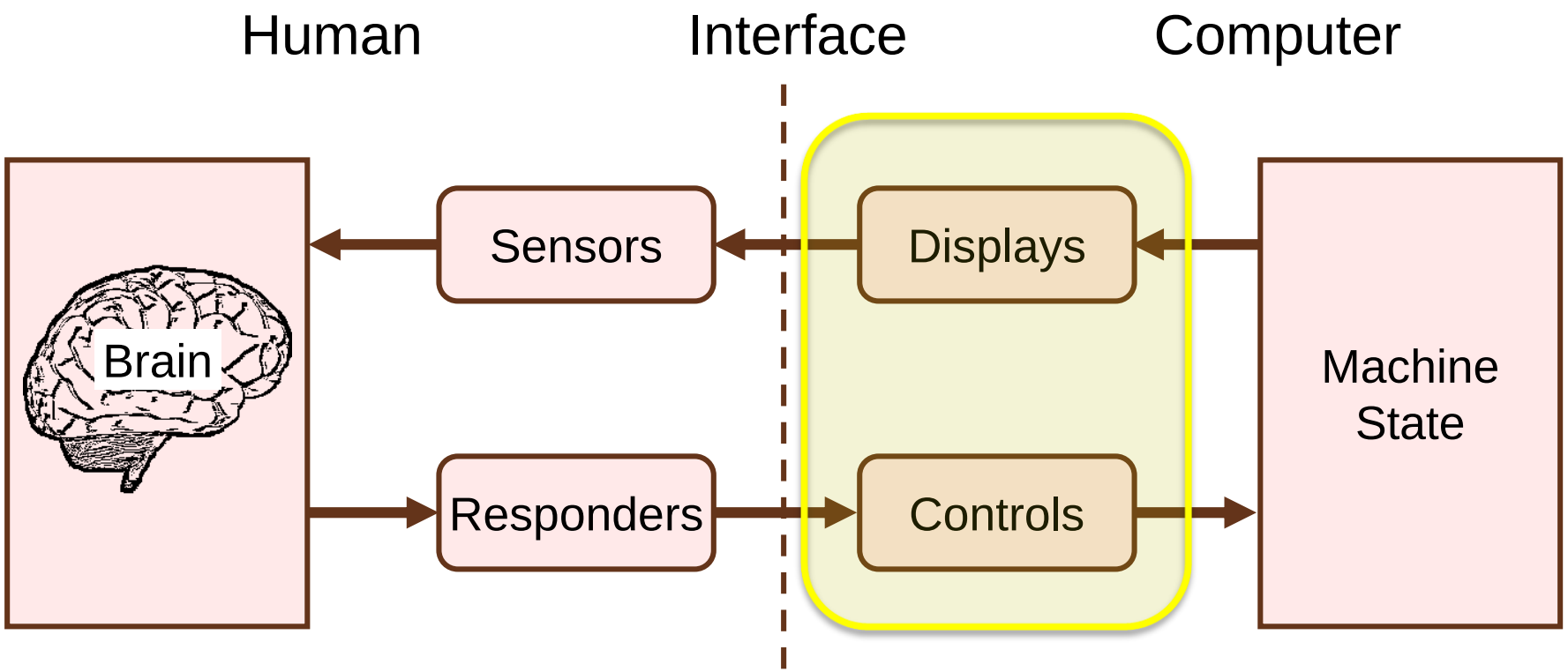


Interactive Systems Design
Prof. V. Fuccella

Chapter 3
Interaction Elements

Human Factors Model (revisited)



[1] Kantowitz, B. H., & Sorkin, R. D. (1983). *Human factors: Understanding people-system relationships*. New York. New York: Wiley.

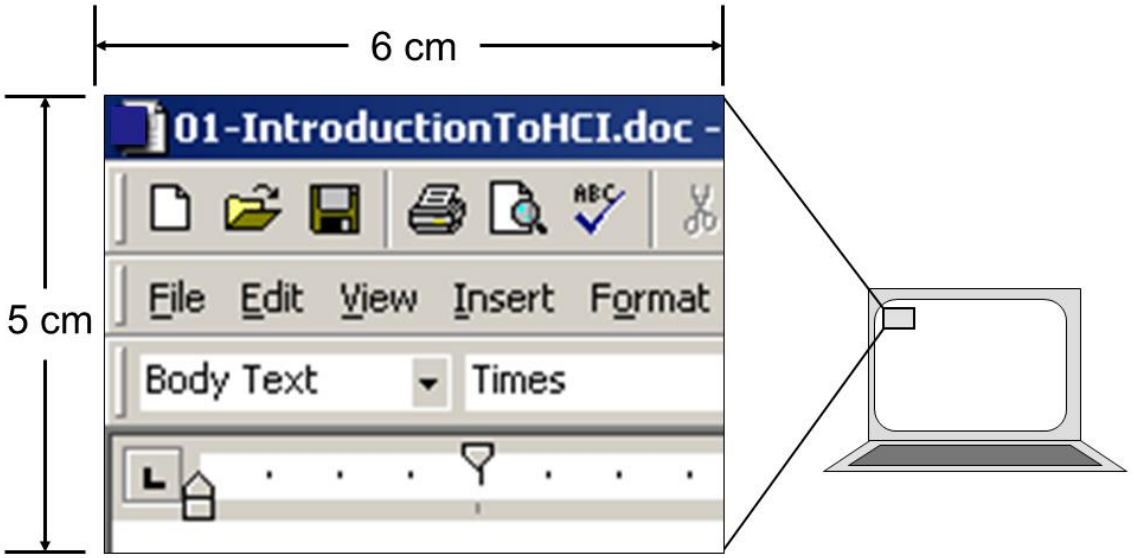
Hard Controls, Soft Controls

- 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!

GUI Malleability

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

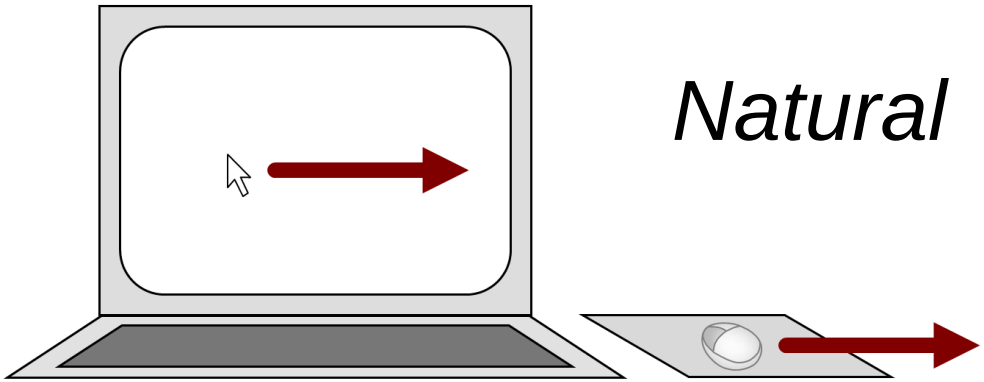


- Click a button and this space is morphed into a completely different set of soft controls/displays

Control-Display Relationships

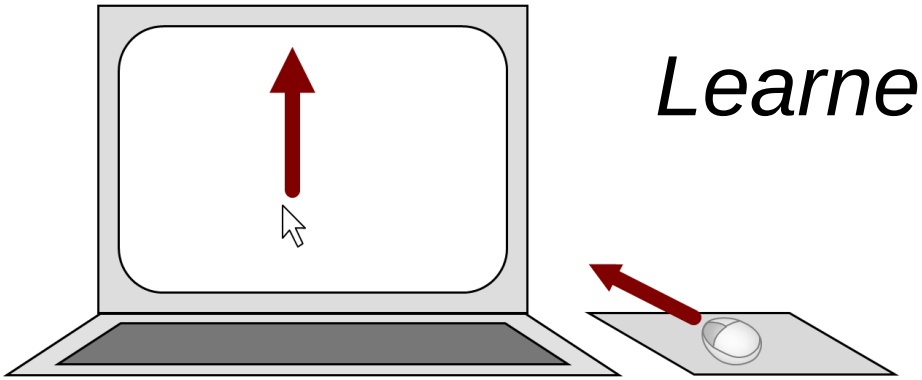
- Also called *mappings*
- Relationship between operation of a control and the effect created on a display
- At least three types:
  - Spatial relationships
  - Dynamic relationships
  - Physical relationships

Spatial Relationships



Natural

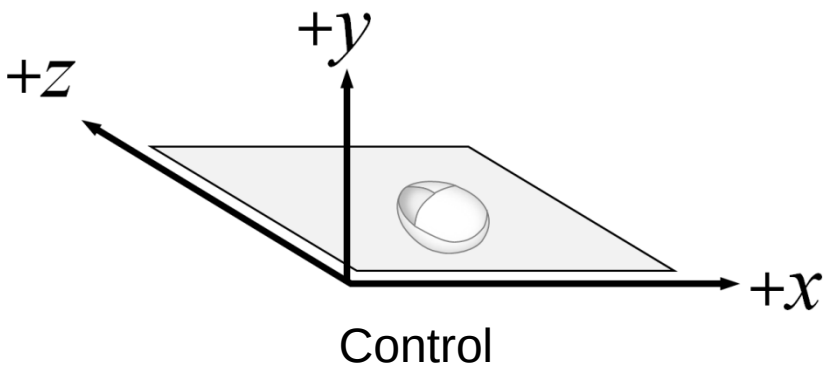
Spatial congruence
Control: right
Display: right



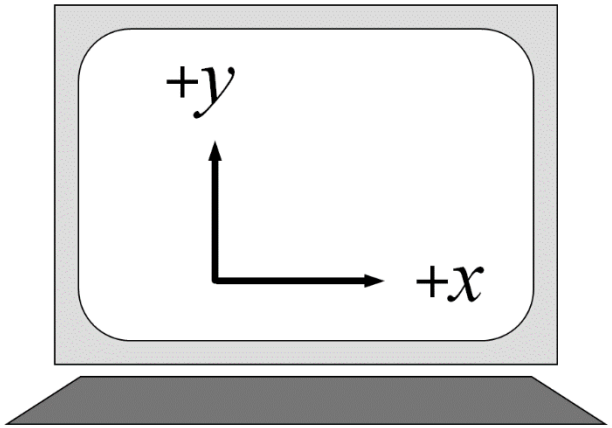
Learned

Spatial transformation
Control: forward
Display: up

Axis Labeling



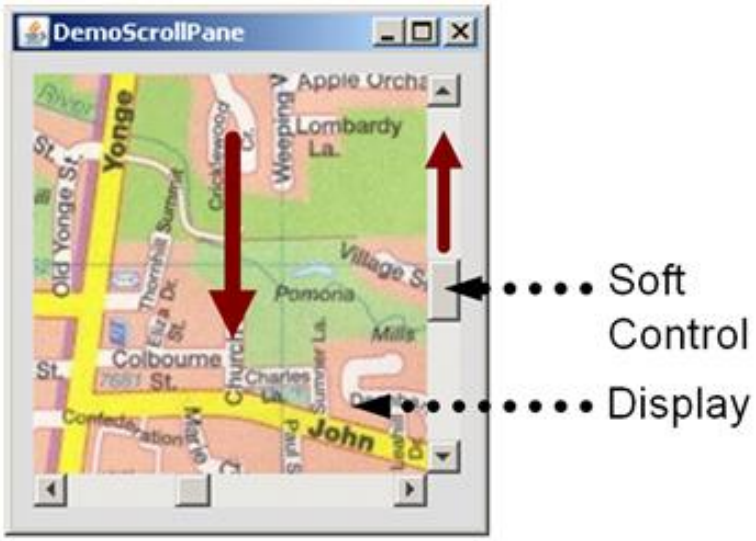
Control



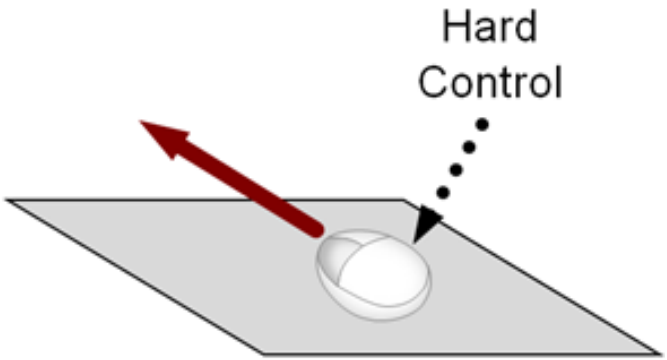
Display

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

Third Tier



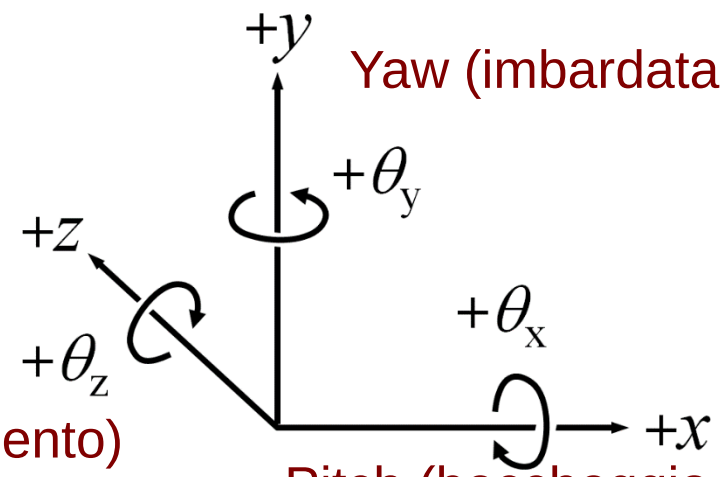
DOF	Hard Control	Soft Control	Display
x			
y		+	-
z	+		



3D

- In 3D there are 6 degrees of freedom (DOF). DOF are the number of variables needed to represent its position in the space
  - 3 DOF for position (x, y, z)
  - 3 DOF for orientation (θ_x, θ_y, θ_z)

In aeronautics…



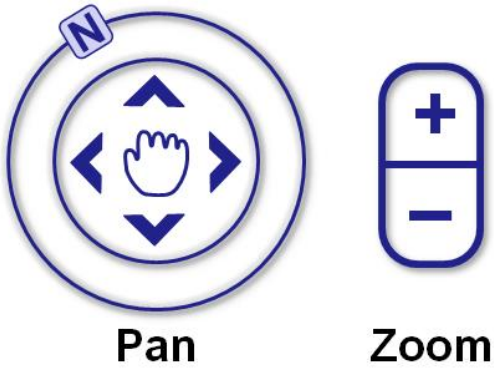
Yaw (imbardata o serpeggiamento)

Roll (rollio o coricamento)

Pitch (beccheggio o impennata)

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



Panning in Google StreetView

- (Switch to Google StreetView and demonstrate panning with the mouse)
- Spatial transformations:

DOF	Control	Display
x		
y		
z		
θ_x		
θ_y		
θ_z		

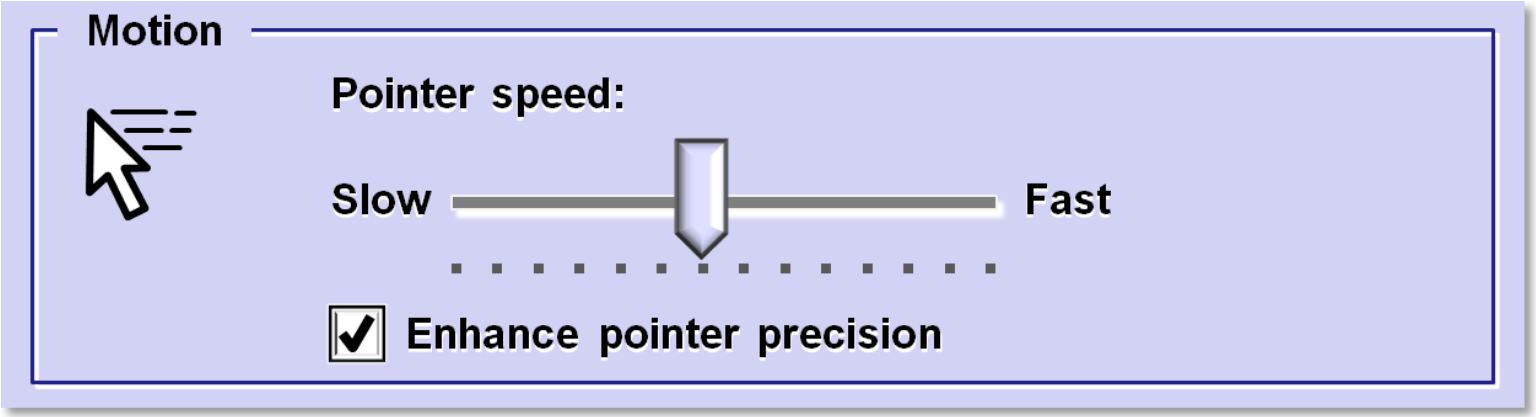
Panning in Google StreetView

- (Switch to Google StreetView and demonstrate panning with the mouse)
- Spatial transformations:

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

CD 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
- 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

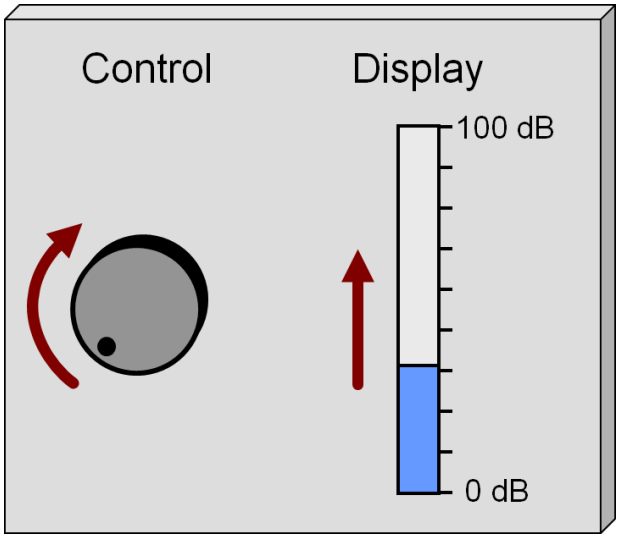
- Property sensed (property of control)
  - Position (graphics tablet, touchpad, touchscreen)
  - Displacement (mouse, joystick)
  - Force (joystick, pointing stick)
- Order of control (property of display)
  - Position (of cursor/object)
  - Velocity (of cursor/object)

Natural vs. Learned Relationships

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

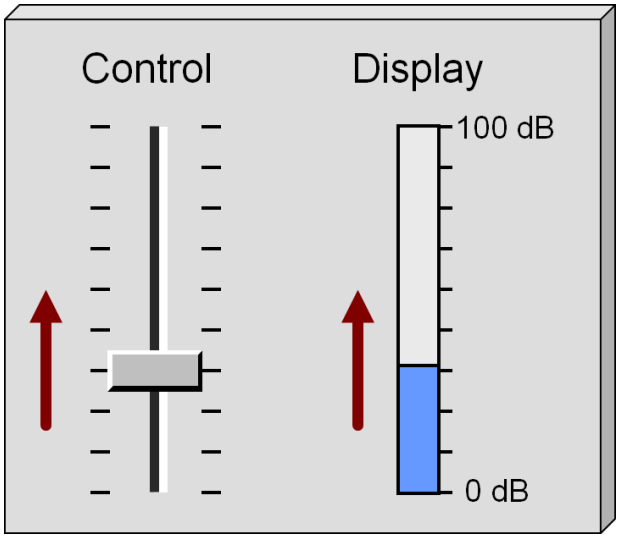
Examples

Learned relationship



DOF	Control	Display
x		
y		+
z		
θ_x		
θ_y		
θ_z	+	

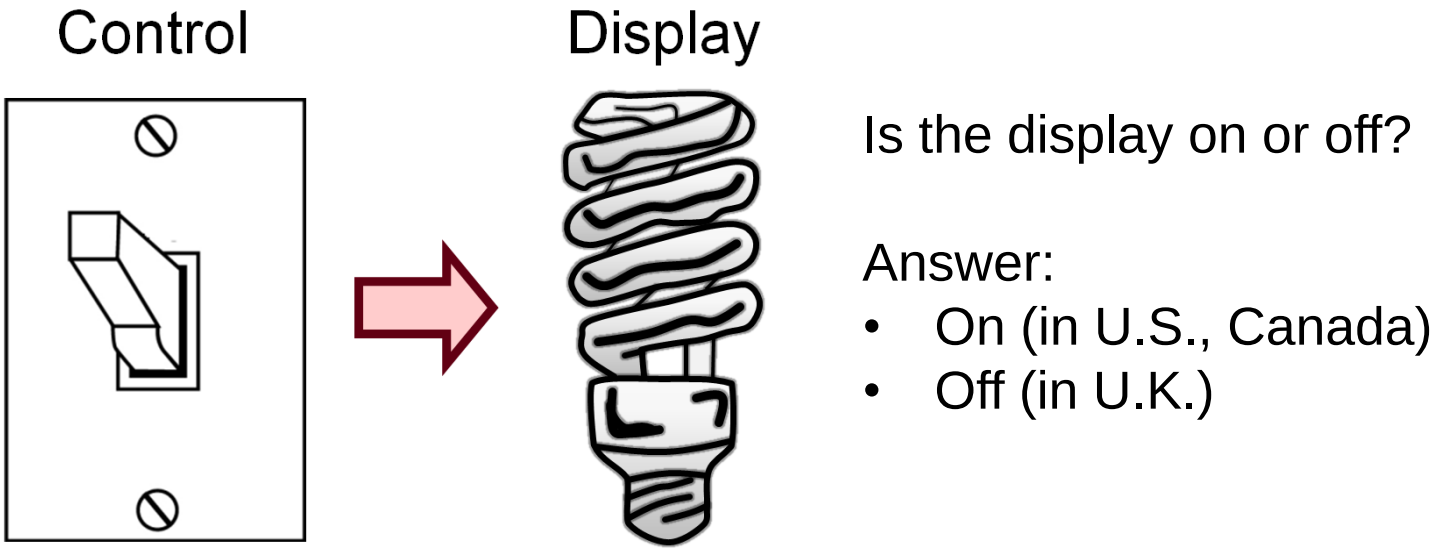
Natural relationship



DOF	Control	Display
x		
y	+	+
z		
θ_x		
θ_y		
θ_z		

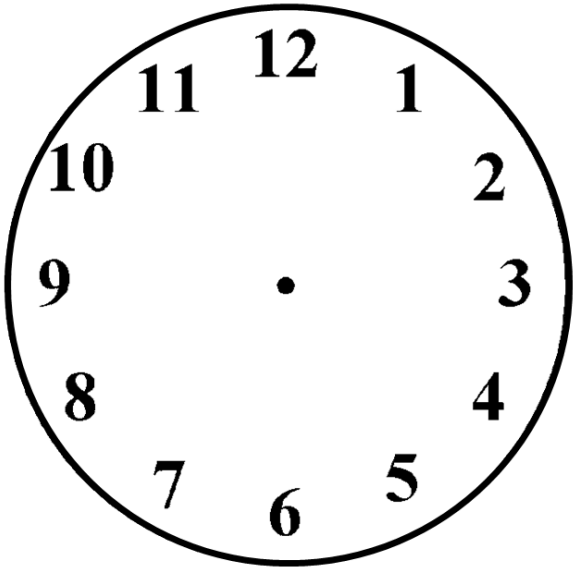
Learned Relationships

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



Clock Metaphor

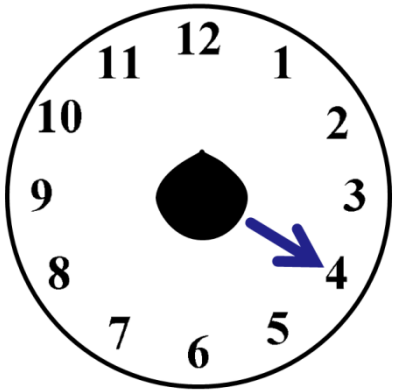
- Numeric entry on PDA[1]
- Users make straight-line strokes in direction of digit on clock face

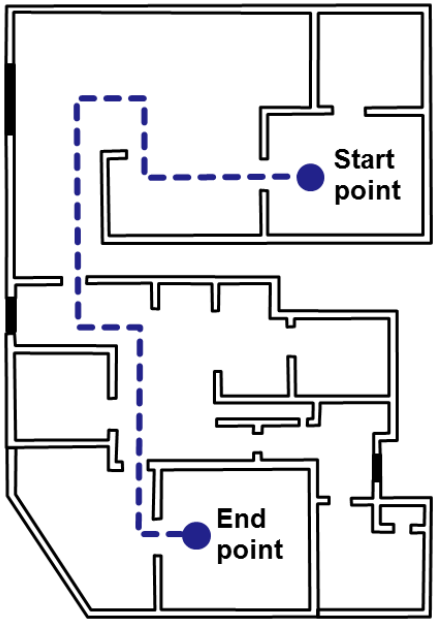


[1] McQueen, C., MacKenzie, I. S., & Zhang, S. X. (1995). An extended study of numeric entry on pen-based computers. *Proceedings of Graphics Interface '95*, 215-222, Toronto: Canadian Information Processing Society.

Clock Metaphor (2)

- Blind users carry a mobile locating device[1]
- Device provides spoken audio information about nearby objects (e.g. “door at 3 o’clock”)

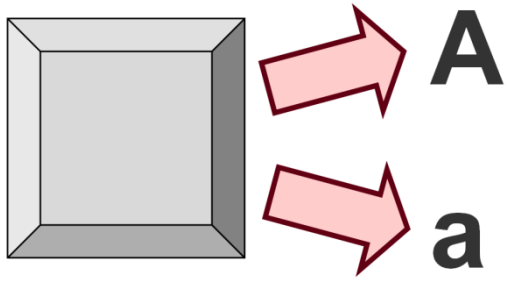




[1] Sáenz, M., & Sánchez, J. (2009). Indoor position and orientation for the blind. *Proceedings of HCI International 2007*, 236-245, Berlin: Springer.

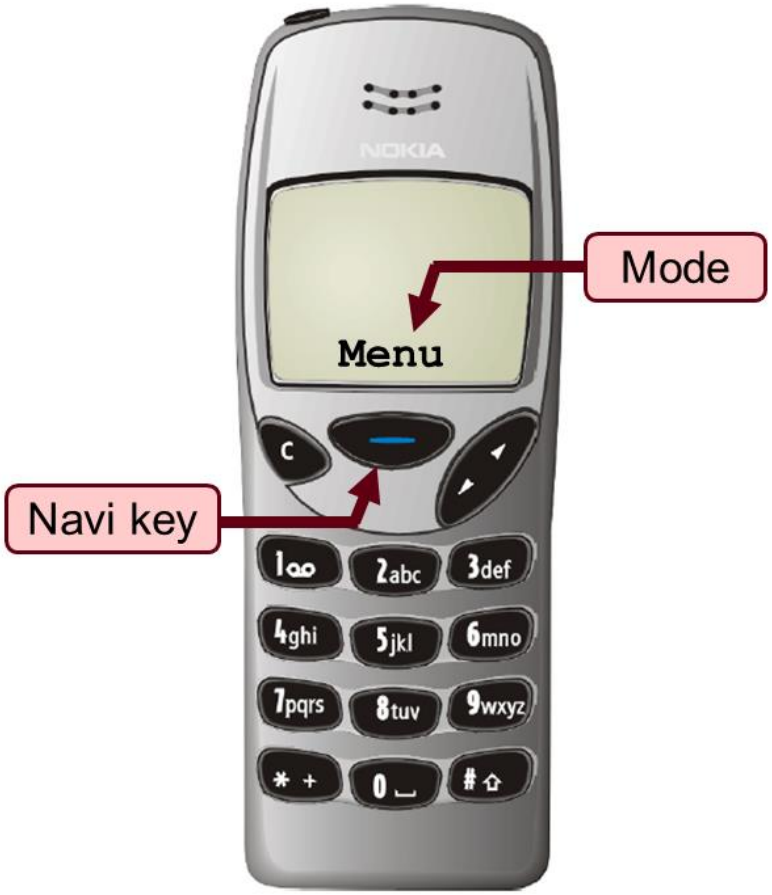
Modes

- A *mode* is a functioning arrangement or condition
- Modes are everywhere (and in most cases are unavoidable)
- Computer keyboards have modes
  - ≈100 keys + SHIFT, CTRL, ALT ➔ ≈800 key variations



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

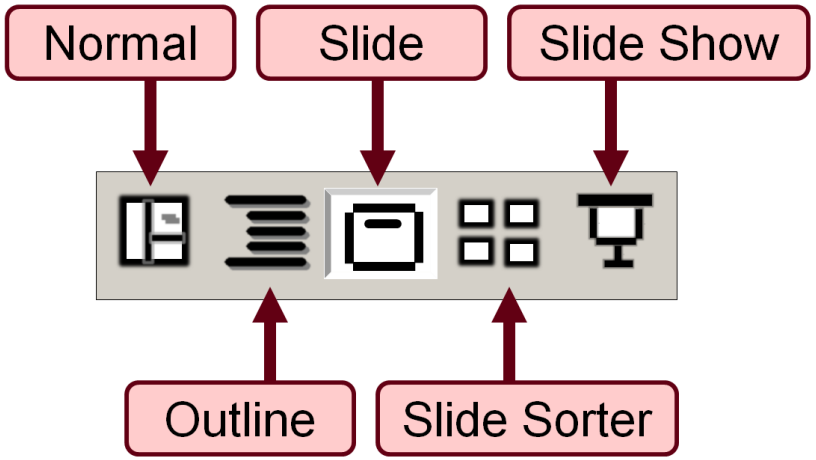


Contemporary LCD Monitor

- Similar to Navi key idea
- No labels for the four buttons above power button
- Function revealed on display when button pressed
- Possibilities explode

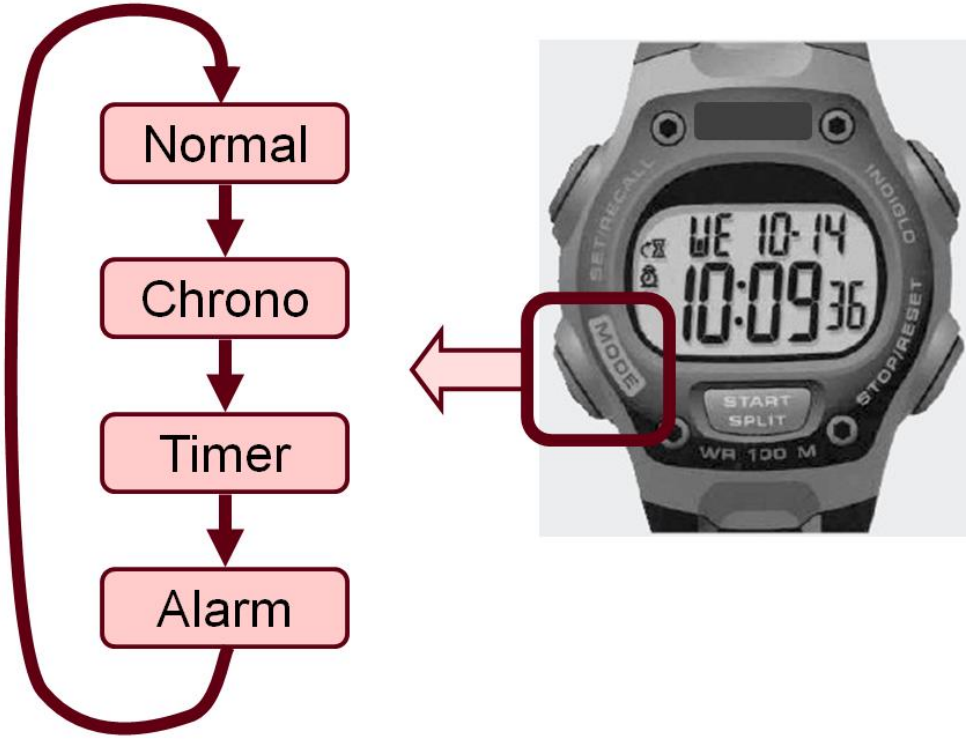
Mode Switching

- PowerPoint: Five view modes
- Switch modes by clicking soft button
- Current mode apparent by background shading
- Still problems lurk
- How to exit Slide Show mode?
  - PowerPoint → ESC
  - Firefox → ?



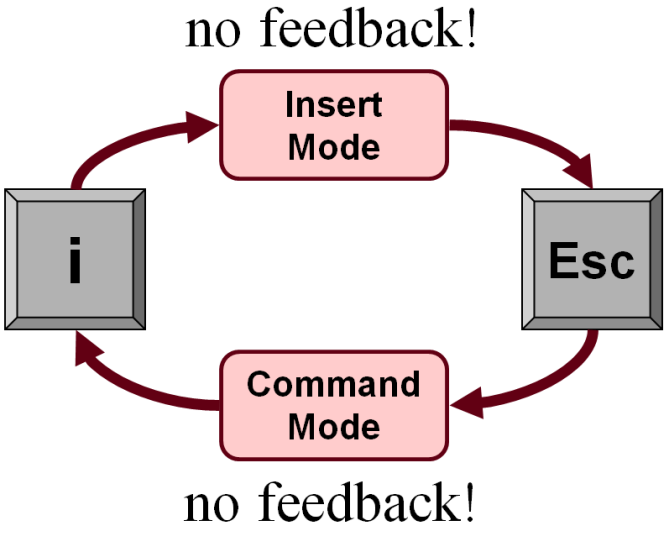
Mode Switching (2)

- Sports watch
- Single button cycles through modes



Mode Visibility

- Shneiderman: “offer information feedback”[1]
- Norman: “make things visible”[2]
- unix *vi* editor: Classic example of no mode visibility:

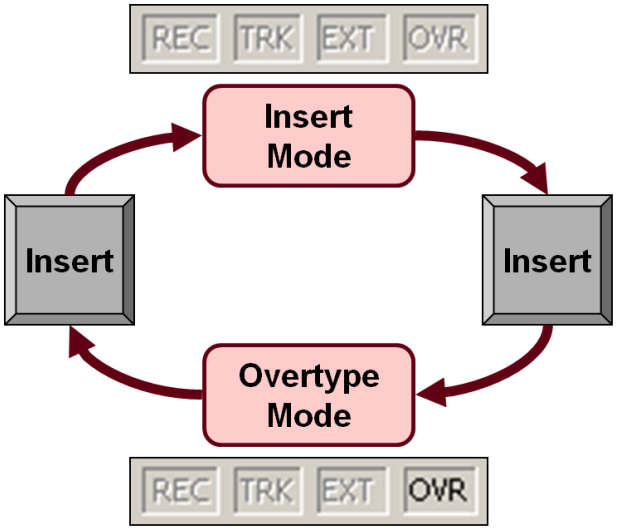


[1] Shneiderman, B., & Plaisant, C. (2005). *Designing the user interface: Strategies for effective human-computer interaction.* (4th ed.). New York: Pearson.

[2] Norman, D. A. (1988). *The design of everyday things*. New York: Basic Books.

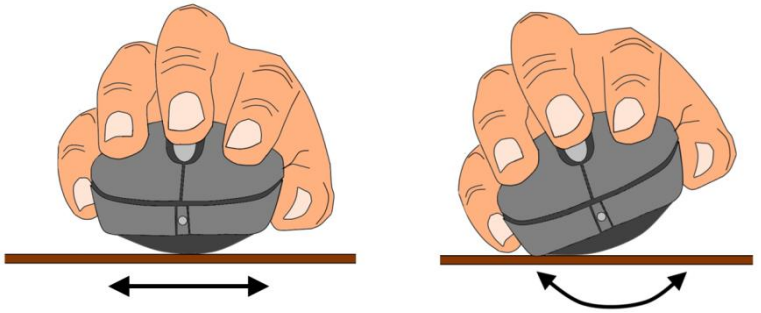
Mode Visibility (2)

- Insert vs. Overtype mode on MS/Word
- Some variation by version, but the user is in trouble most of the time

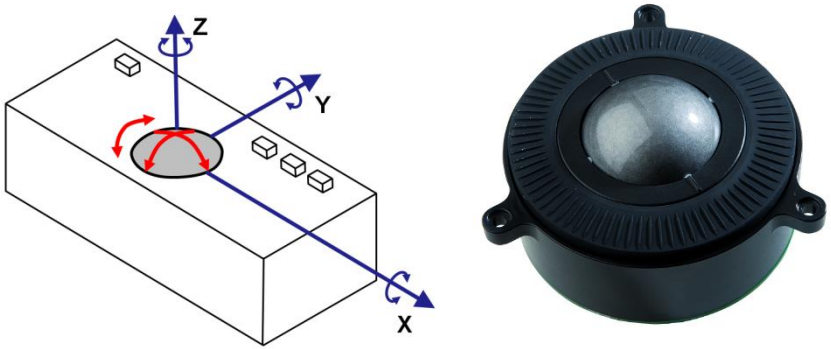


>2 Degrees of Freedom

- Examples in the HCI research literature
- 4 DOF *Rockin' Mouse*[1]



- Three-axis trackball[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

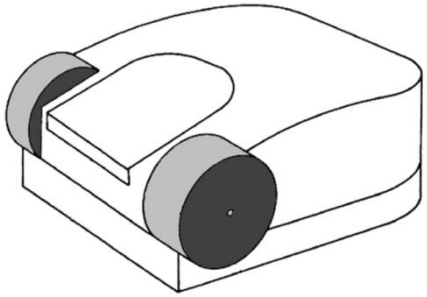
- More DOF is not necessarily better
- Must consider the context of use
- Etch-A-Sketch: separate 1 DOF *x* and *y* controllers:

Wheel Mouse

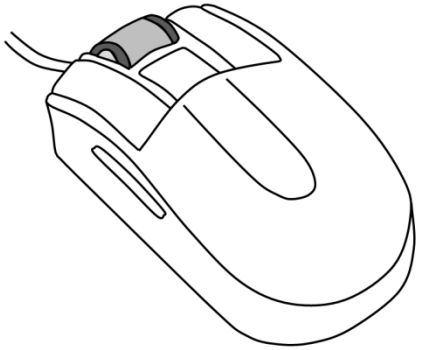
- Separate DOF via a wheel
- Successful introduction by Microsoft in 1996 with the *IntelliMouse* →

- Preceded by…

RollerMouse[1]



ProAgio[2]



[1] Venolia, D. (1993). Facile 3D manipulation. *Proc CHI '93*, 31-36, New York: ACM.
[2] Gillick, W. G., & Lam, C. C. (1996). U. S. Patent No. 5,530,455.

Mobile Context

- 1980s: born of mobile computing with PDAs
- 2007: launch of iPhone
- Touchscreens are the full embodiment of direct manipulation
  - No need for a cursor (cf. indirect input)
  - No control/display mappings (Spatial transformations, CD Gain, etc.)

Touch Input Challenges

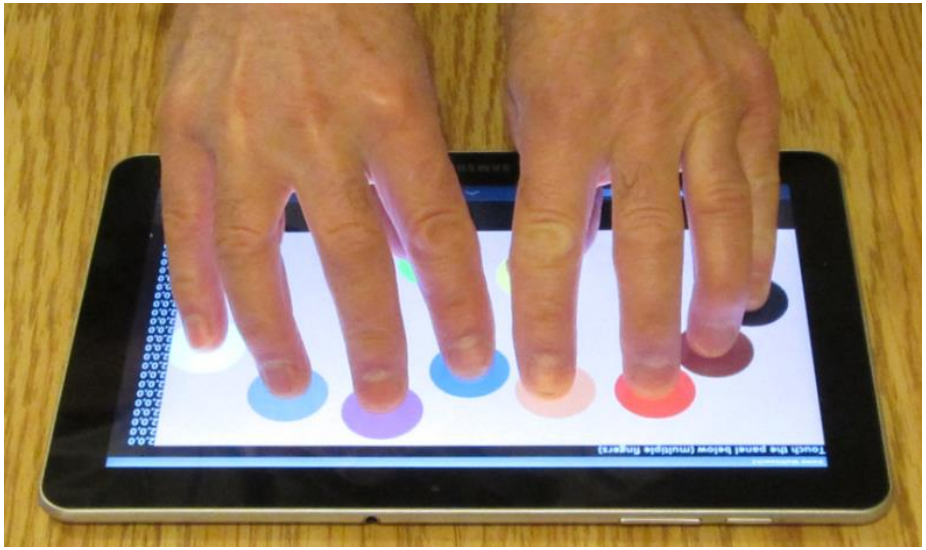
- Occlusion and accuracy ("fat finger problem")
- Early research → Offset cursor[1]
- Contemporary systems use variations; e.g., offset animation:

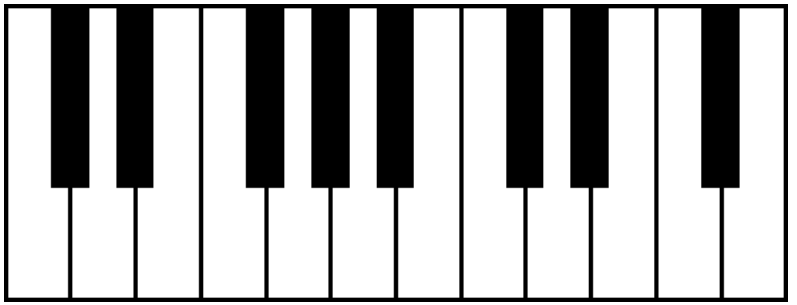
[1] Potter, R., Berman, M., & Shneiderman, B. (1988). An experimental evaluation of three touch screen strategies within a hypertext database. *Int J Human-Computer Interaction, 1* (1), 41-52.

Multitouch

Multitouch (>2)

- Piano keyboard: pressure data available





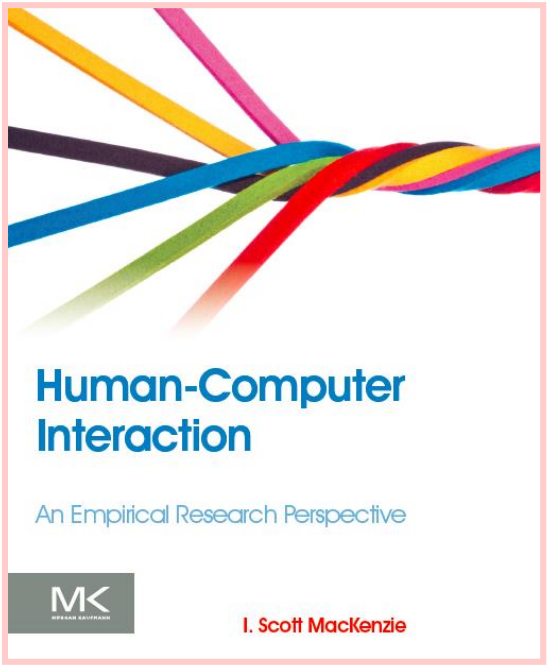
Accelerometers

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

Connect to: http://join.quizizz.com

QUESTION TIME

Thank You


Human-Computer Interaction
An Empirical Research Perspective
I. Scott MacKenzie