

# Interaction Techniques

SWE 432, Fall 2019

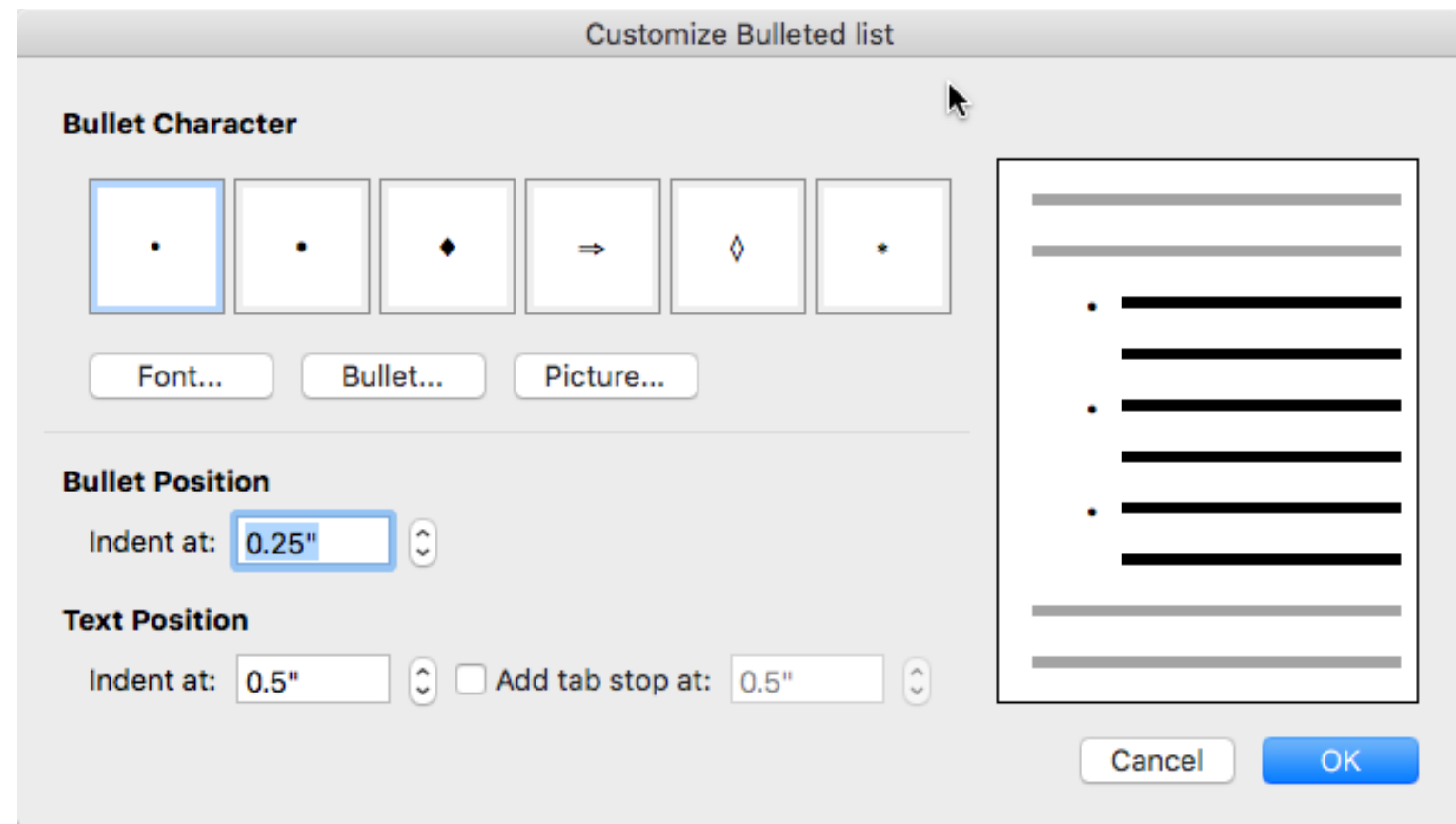
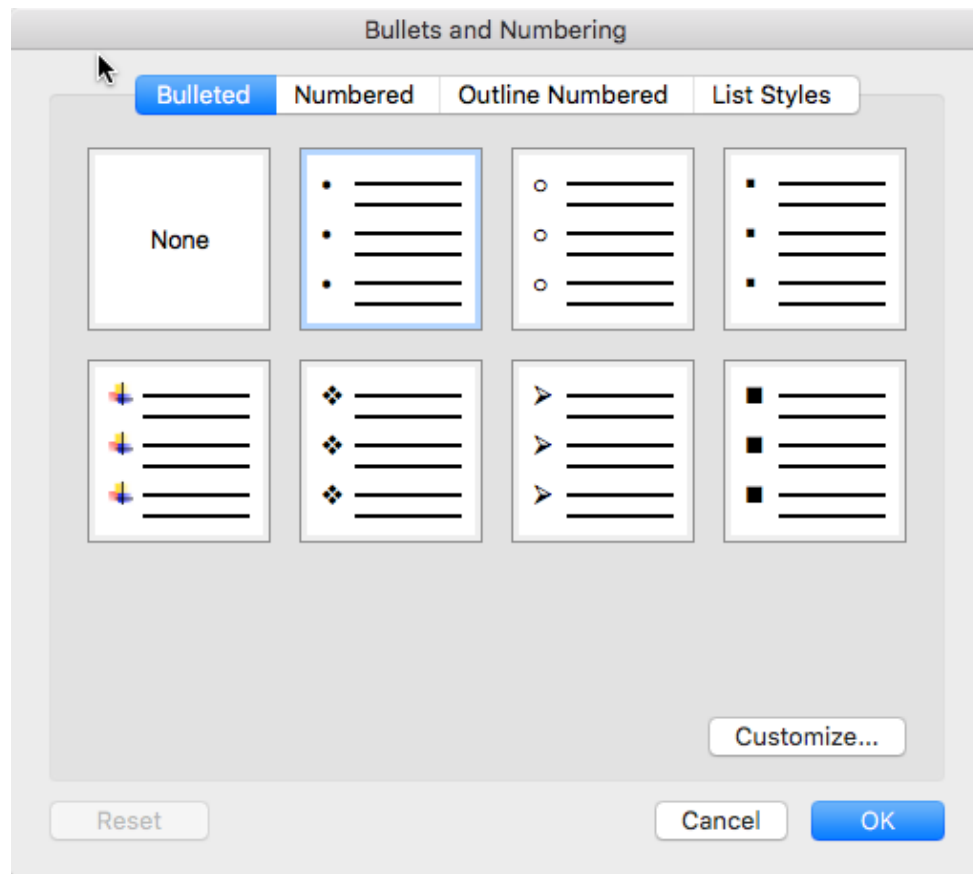
Web Application Development

# Review: Site Design vs Real World

- Challenges (differences from physical world):
  - No spatial sense of scale. 50 pages? 500 pages? 50,000 pages?
  - No sense of direction. Which way did I just go?
  - No sense of location. No spatial anchoring of where I am now and how that relates to where I could go.

# Review: Progressive disclosure

- a.k.a. details on demand
- Separate information & commands into layers
- Present most frequently used information & commands first



# Review: Separate long tasks into sequences

- Reduce short term memory demands by having user only work on one aspect of larger task at a time
- Don't interrupt users in the middle with unrelated tasks
- Provide closure of each subtask at the end

The screenshot shows the American Airlines website interface during a flight booking process. The top navigation bar includes the American Airlines logo, links for 'Plan Travel', 'Travel Information', and 'AAdvantage', along with a search bar and user account options. The main content area is titled 'Travelers' and features a progress bar with steps: 'Find Flights', 'Choose Flights', 'Travelers' (current step), 'Trip Options', 'Select Seats', 'Review & Pay', and 'Finish'. Below the progress bar, a red warning icon and text prompt the user to 'Check below for errors'. The main booking details section displays a flight from Washington to Raleigh/Durham for 1 adult on Sunday, January 10, 2016, to Monday, January 11, 2016. A 'Show Trip Details' button is located below this section. To the right, a box shows the 'Your Trip Price' as \$203.70 USD, with a link for 'Baggage and Optional Charges'. Below the main booking section, there is a promotional banner for AAdvantage cards, offering 40,000 bonus miles and a \$100 statement credit. To the right of this banner, a summary of the trip price is shown: 'Your Trip Price: \$203.70 USD', 'Statement Credit: - \$100.00 USD', and a final total of '\$103.70 USD'. At the bottom, the 'Passenger Details' section is visible, with a note to enter names as they appear on government-issued photo identification and a link to 'More details on passenger names'. A 'TSA Privacy Notice' link is also present.

American Airlines Plan Travel Travel Information AAdvantage

Home Login Hello, THOMAS English Search aa.com

Find Flights Choose Flights **Travelers** Trip Options Select Seats Review & Pay Finish

**Travelers**

! Check below for errors

Washington to Raleigh/ Durham  
1 Adult  
Sunday January 10, 2016 – Monday January 11, 2016

Show Trip Details

Your Trip Price: **\$203.70 USD**  
[Baggage and Optional Charges](#)

**Earn 40,000 bonus miles,**  
up to **\$100** in statement credits, and your **first checked bag free\***  
[Learn More](#)

Your Trip Price: \$203.70 USD  
Statement Credit: - \$100.00 USD  
**\$103.70 USD**

**Passenger Details**

Please enter all passenger names as they appear on the passenger's government-issued photo identification. [More details on passenger names](#)  
[TSA Privacy Notice](#)

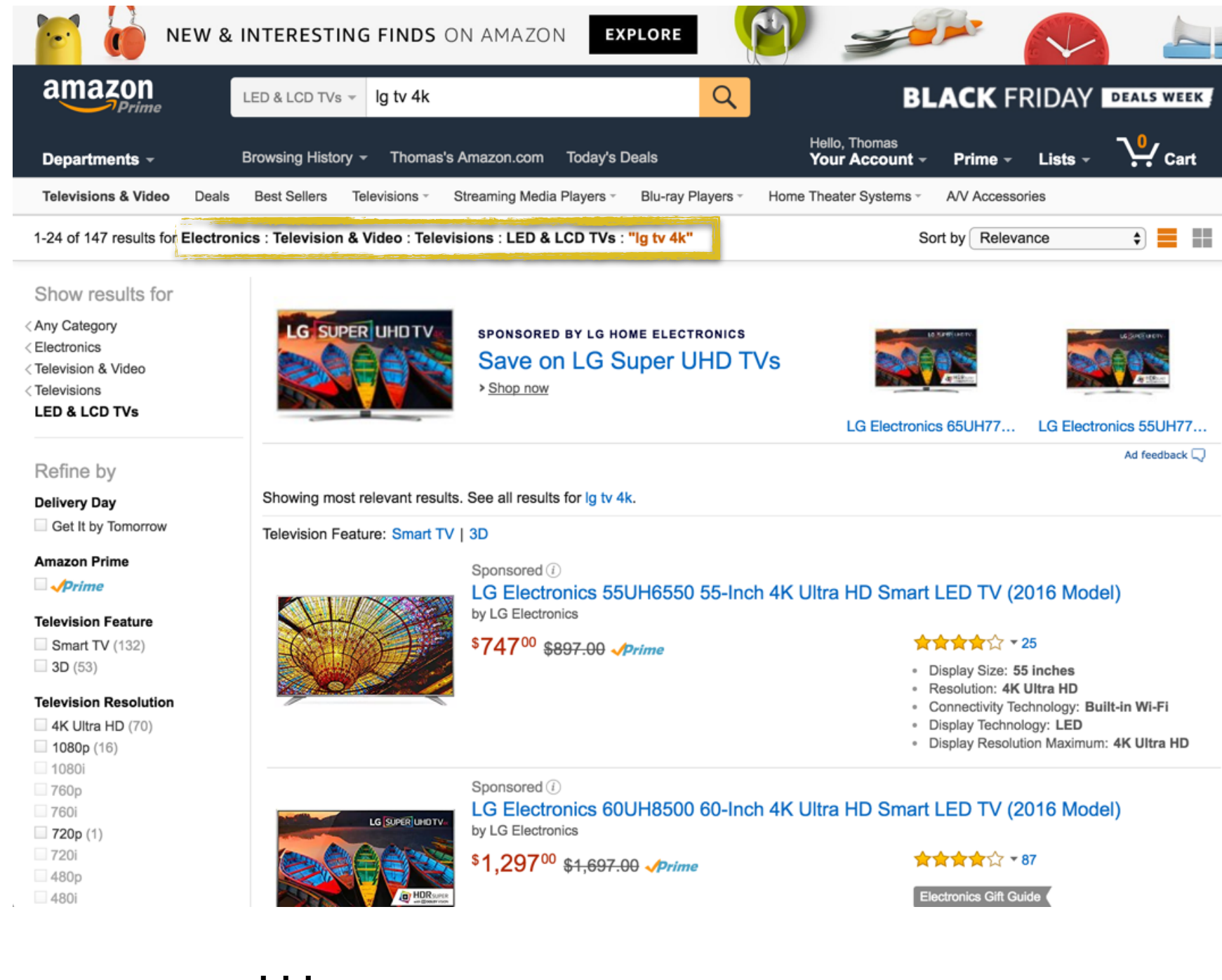
\*Required

# Review: Idioms

- A consistent mental model of how something works
  - e.g., Files: open / close / save / save as
- Offers intuitive understanding of affordances & interactions
- Provides consistent vocabulary for describing interactions
- Only have to learn it **once**
- Might have originated in real world, but thought of in terms of mental model for UI interactions

# Review: Breadcrumbs

- Offer trail of where the user has been and how they got there
- Shows hierarchy of information space
- Shows current location



...

# Today

- What principles guide the design of usable interaction techniques?
- How can interaction designs help support making plans, taking action, and interpreting feedback?
- How does a direct manipulation interface make complex tasks easier?

# HW5: User Experience Design



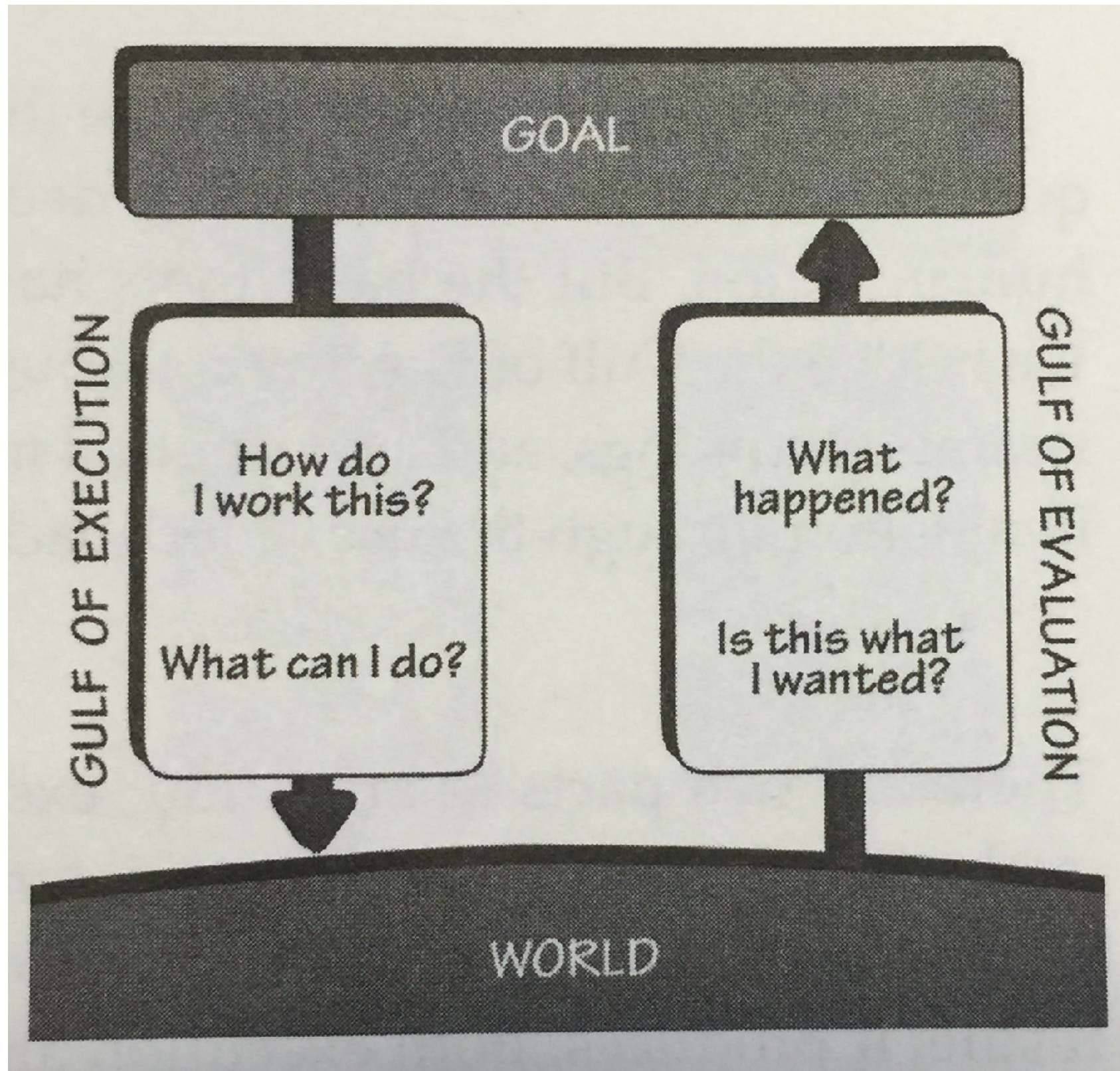
# Interaction technique

- A method by which a user can perform an action or sequence of actions with a computer.
- Might encompass **software** (e.g., accelerators on a menu) and/or specialized **hardware** (momentum scrolling on iOS)
- What makes a good interaction technique?
  - Usability: task performance, discoverability, learnability, ...

# Example: Filtering

- [www.target.com](http://www.target.com)

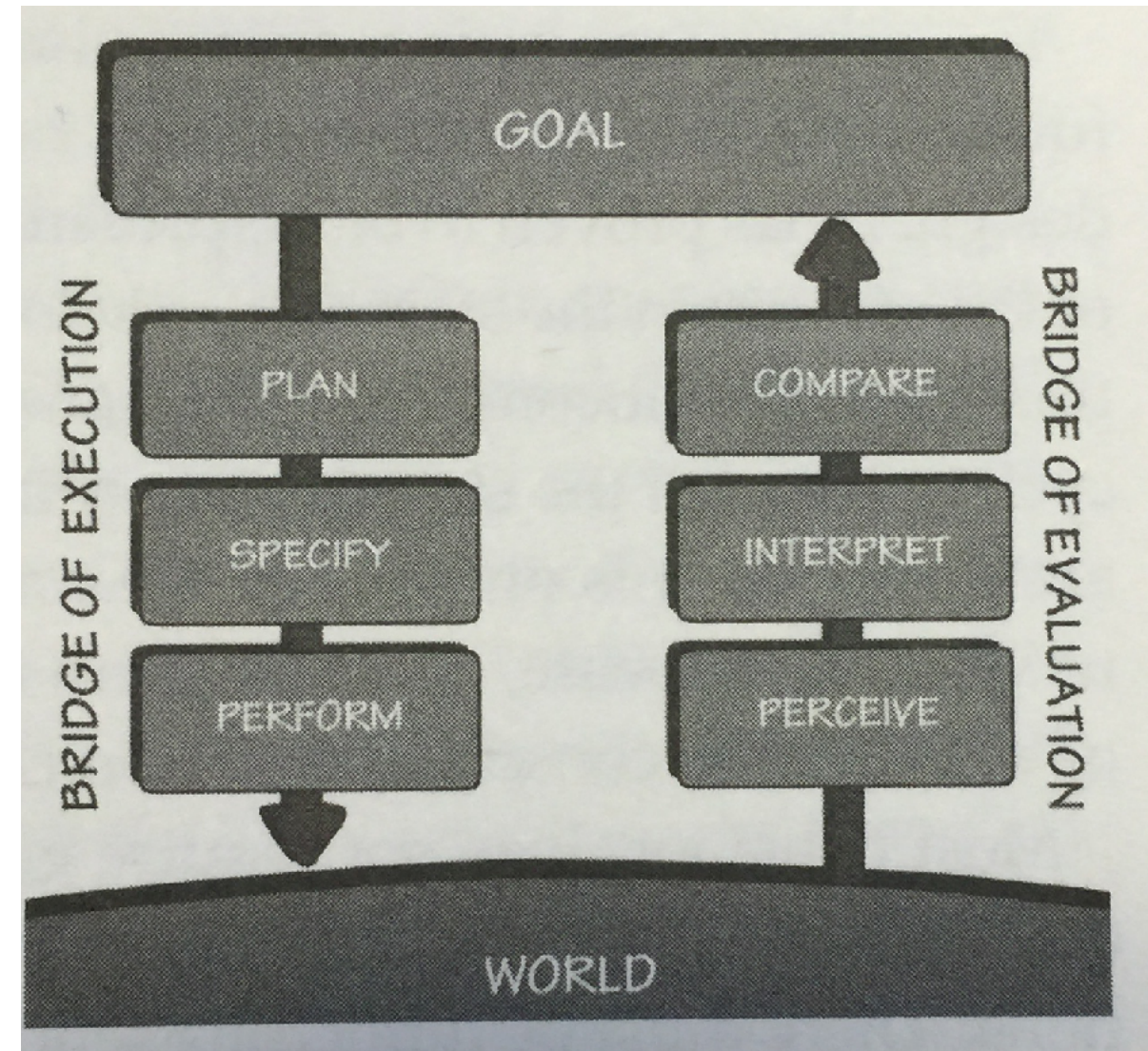
# Gulfs of execution and evaluation





# Norman's 7 stages of action

1. Goal (form the goal)
2. Plan (the action)
3. Specify (action sequence)
4. Perform (action sequence)
5. Perceive (the state of the world)
6. Interpret (the perception)
7. Compare (outcome w/ goal)



# Signifiers

- a.k.a “cognitive affordances” [Hartson & Pyla]
- Goals
  - Show which UI elements can be manipulated
  - Show how they can be manipulated
  - Help users get started
  - Guide data entry
  - Suggest default choices
  - Support error recovery

# Hinting

- Indicate which UI elements can be interacted with
- Possible visual indicators
  - Static hinting - distinctive look & feel
  - Dynamic hinting - rollover highlights
  - Response hinting - change visual design with click
  - Cursor hinting - change cursor display

# Help users predict outcome of actions

- What does this do?
- Should I click it?



# Clarity of wording (Example)

- Design for clarity & precision

**Implement Function Behavior (10 Pts)**

Implement a behavior for this function

← Back Dispute this test Inspect code Run Tests

STATUS	failed
DESCRIPTION	it should throw an exception if the parameters are invalid
EXECUTION TIME	6ms
MESSAGE	expected 4 to equal 3
DIFF	3 - 4
CODE	1 expect(calculate('+',[1,2])).to.equal(3);

**Function Editor**

```
11 * @return {Number}
12 */
13 function calculate(command,numbers){
14     if( ['*','/','+','-'].indexOf(command) == -1 )
15         throw 'command not recognized'
16
17     if( !(numbers instanceof Array) || numbers.length === 0 )
18         throw 'numbers not valid';
19
20     switch( command ){
21     case '+':
22         var res = sum(numbers[0],numbers[1]);
23         return res;
24     case '*':
25         var res = prod(numbers[0],numbers[1]);
26         return res;
27     default:
28     }
```

1. Line 15: Missing semicolon.

sum(numbers[0],numbers[1]) X  
4  
stub this function call

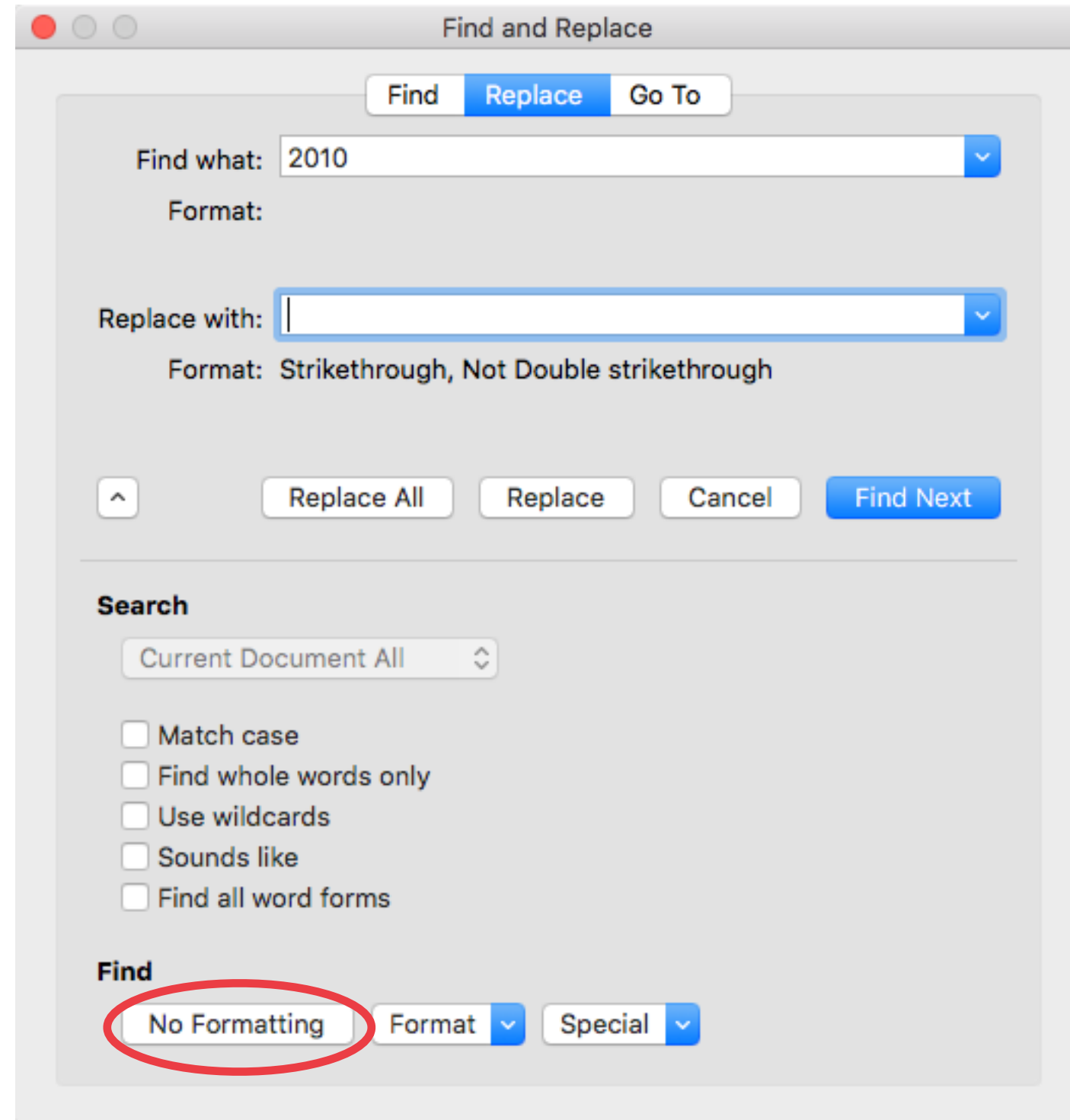


# Clarity of wording

- Choose words carefully
- Speak the user's language
- Avoid vague, ambiguous terms
- Be as specific as possible
- Clearly represent domain concepts

# Consistency

- In use of **terms**
  - e.g., do not use “revise” and “edit” interchangeably
- In how commands **map** to UI interactions



# Likely & useful defaults

- Default text, if relevant (e.g., date)
- Default cursor position
- Avoid requirements to retype & re-enter data

# Avoid using modes

- Modes create inconsistent mapping
  - E.g., control S sometimes saves, sometimes sends email
  - Especially dangerous for frequent interactions that become highly automatic actions
- Avoid when possible
- Clearly distinguish if necessary

Physical actions

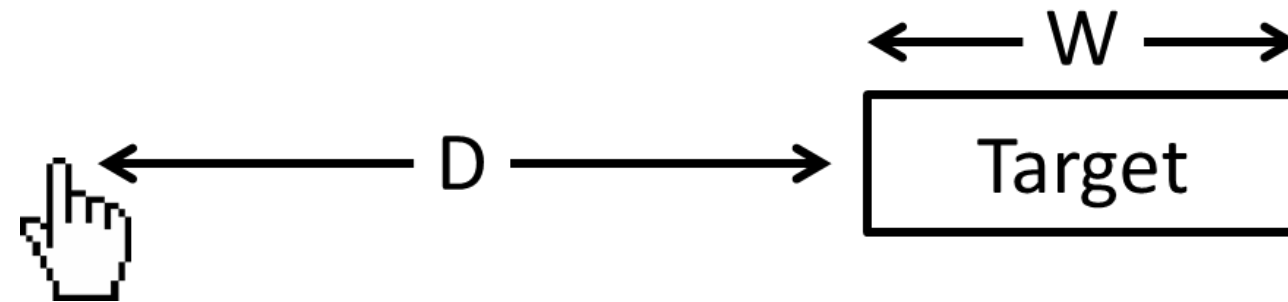
# Provide intermediate feedback during interactions

- As user is interacting with objects, provide feedback on interactions
- Examples
  - While dragging object, show new position
  - As selecting text, show selection
  - While clicking on button, show button changing

# Avoid physical awkwardness

- Switching between input devices takes time
- Avoid forcing user to constantly switch between input devices (e.g., keyboard & mouse)
  - e.g., Effective tab order between fields
- Avoid awkward keyboard combinations

# Fitt's law



- Time required to move to a target **decreases** with target **size** & **increases** with **distance** to the target
- Movements typical consist of
  - one large quick movement to target (**ballistic** movement)
  - fine-adjustment movement (**homing** movements)
- Homing movements generally responsible for most of movement time & errors
- Applies to rapid pointing movements, not slow continuous movements



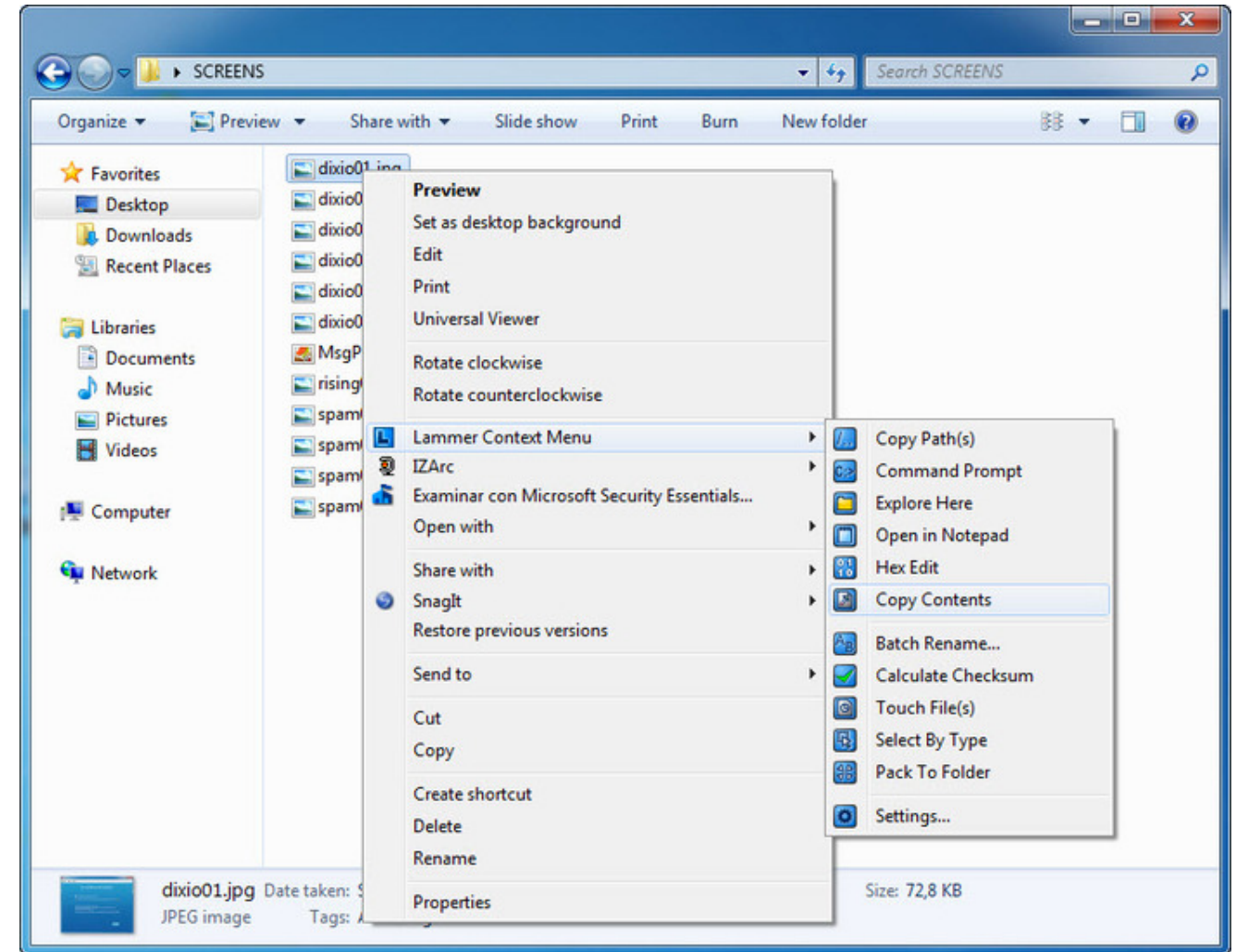
# Design implications of Fitt's law

- **Constraining** movement to one dimension dramatically increases speed of actions
- e.g., scroll bars are 1D



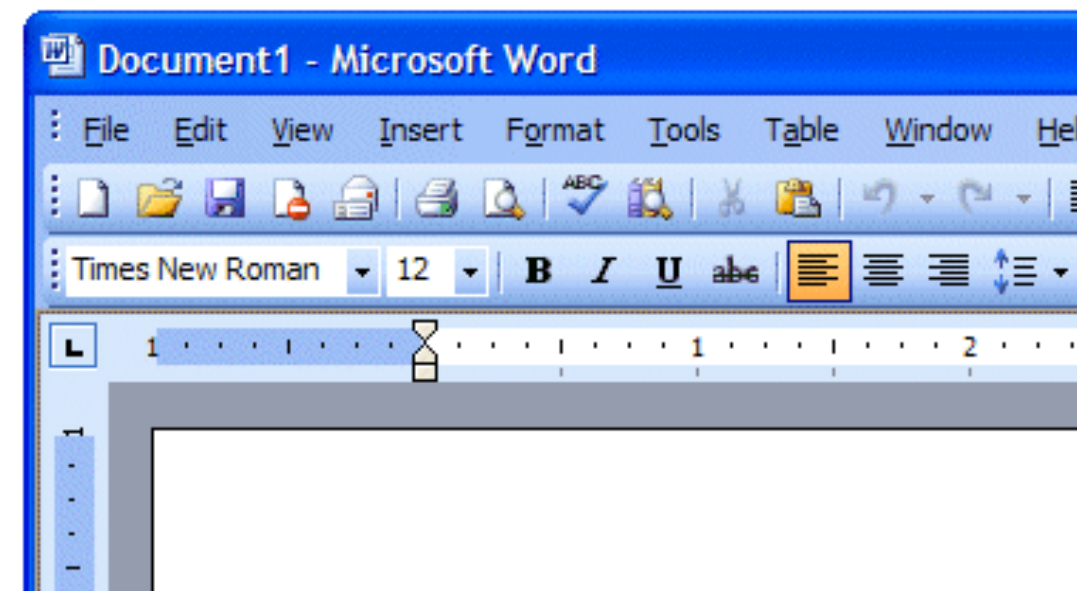
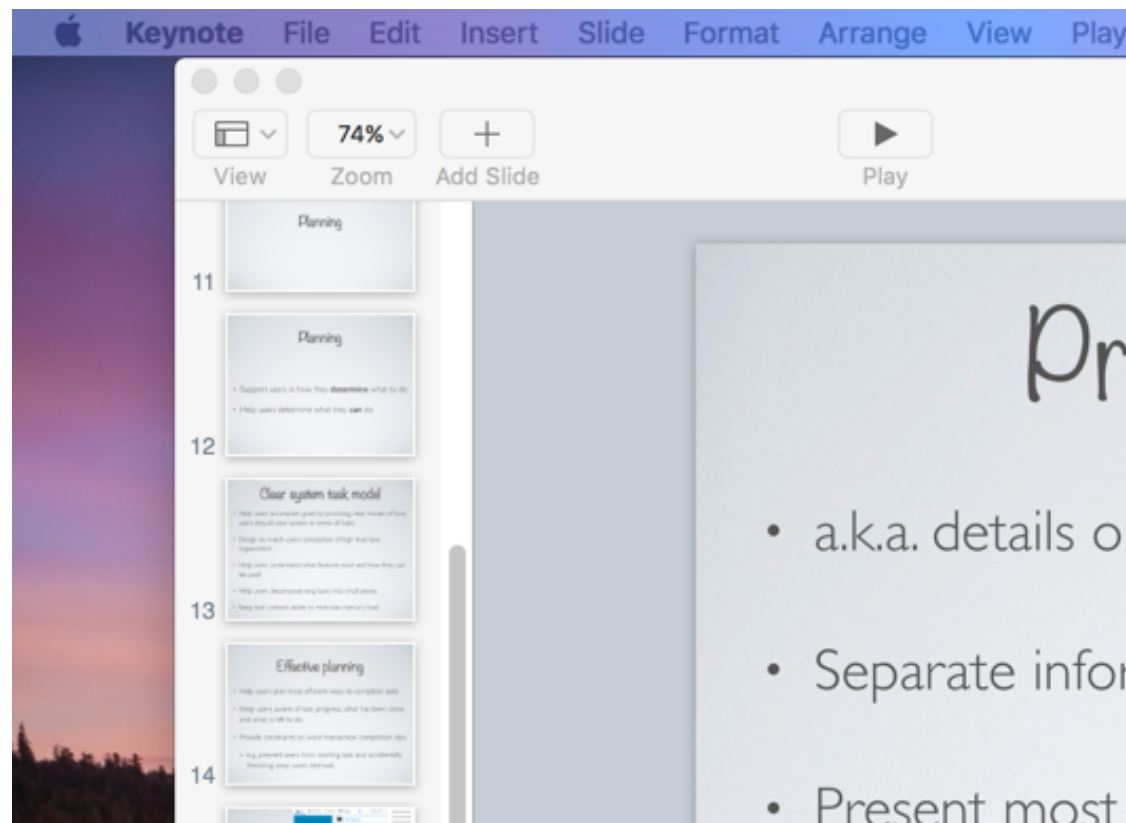
# Design implications of Fitt's law

- Making controls **larger** reduces time to invoke actions
- Locating controls closer to user **cursor** reduces time
- e.g., context menus



# Design implications of Fitt's law

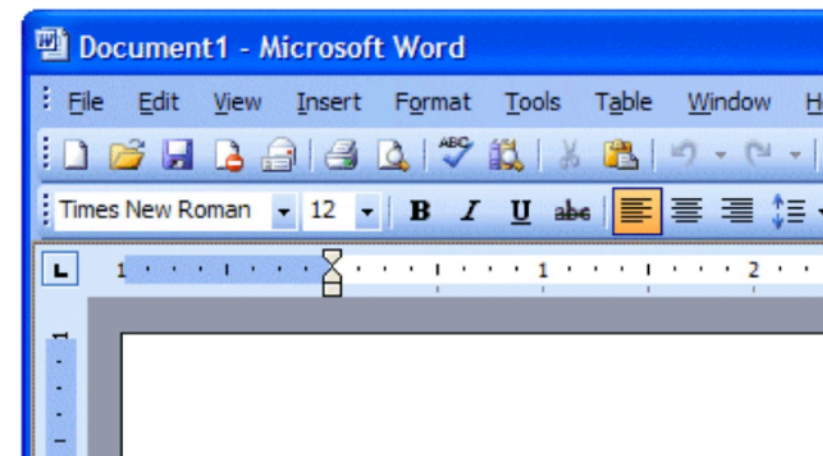
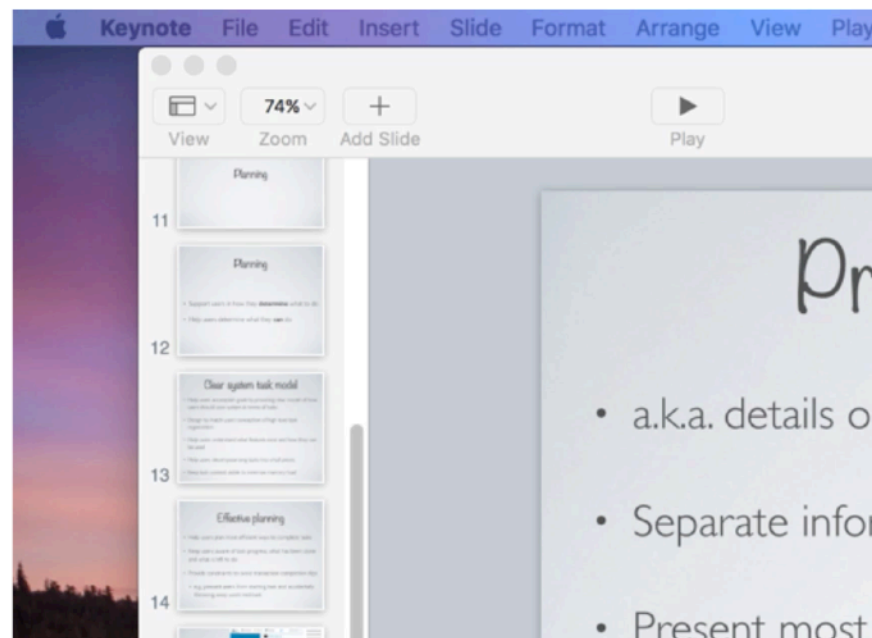
- Positioning button or control along **edge** of screen acts as barrier to movement, substantially reducing homing time & errors



# Design implications of Fitt's Law

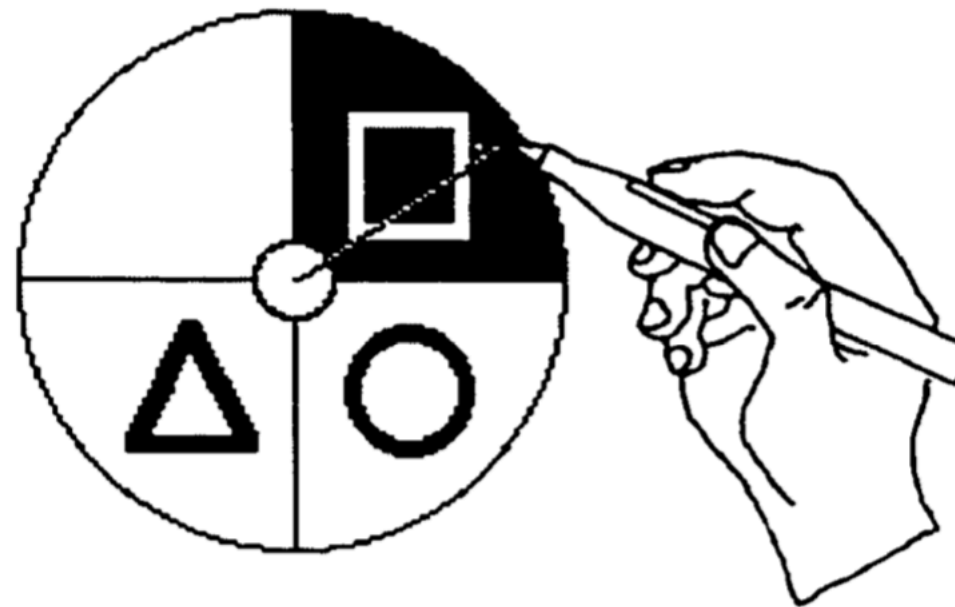
- Problem: How to benefit from both having menu near the mouse at all times AND have the barriers?

- Positioning button or control along **edge** of screen acts as barrier to movement, substantially reducing homing time & errors



# Alternatives: Pie menu

- Only angle matters, not distance
- Advantages:
  - Faster to select angle than distance
  - Fixed distance to travel
  - Scale independent
- Disadvantages:
  - Angle varies with number of items (can't always have shared items in same place)
  - Large?

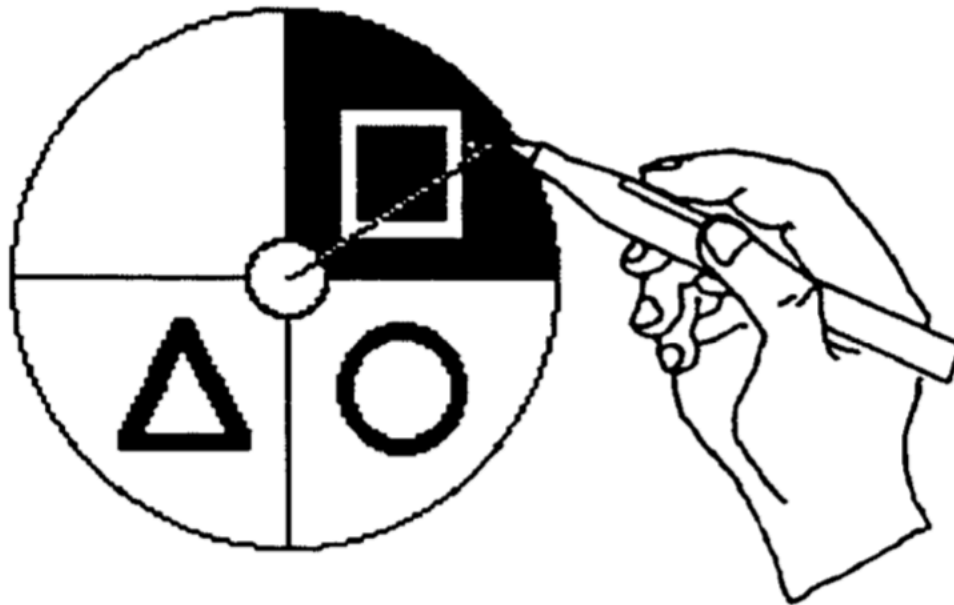


Kurtenbach '93

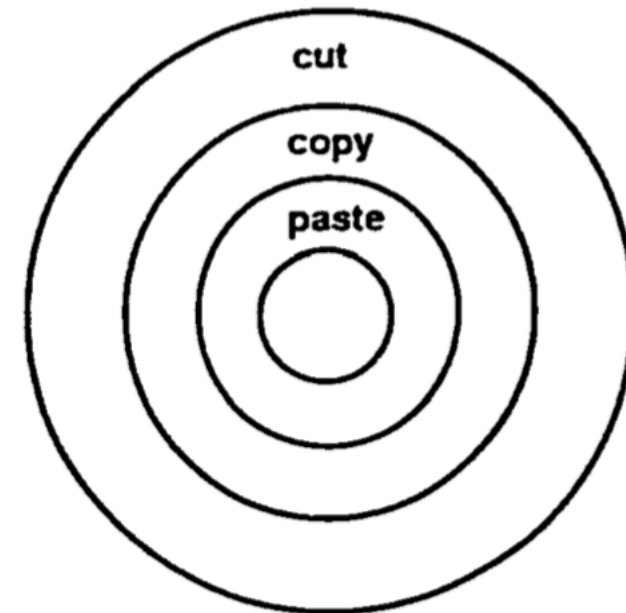
More: <https://medium.com/@donhopkins/the-design-and-implementation-of-pie-menus-80db1e1b5293>

# Alternatives: Bullseye

- Only distance matters, not angle
- Scale dependent



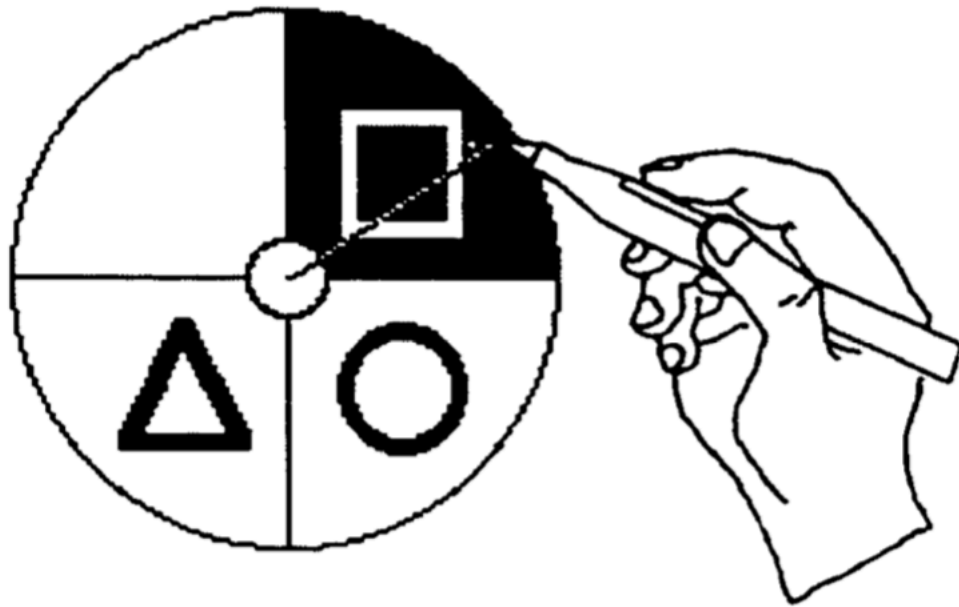
Kurtenbach '93



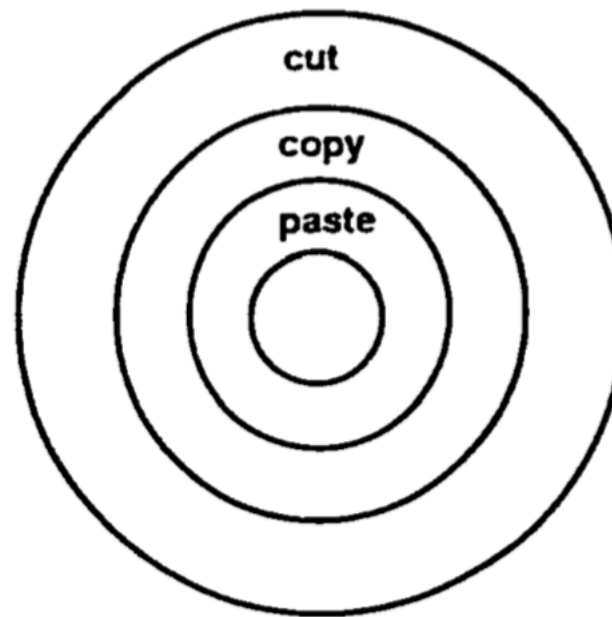


# Alternatives: Dart Board

- Angle + Distance

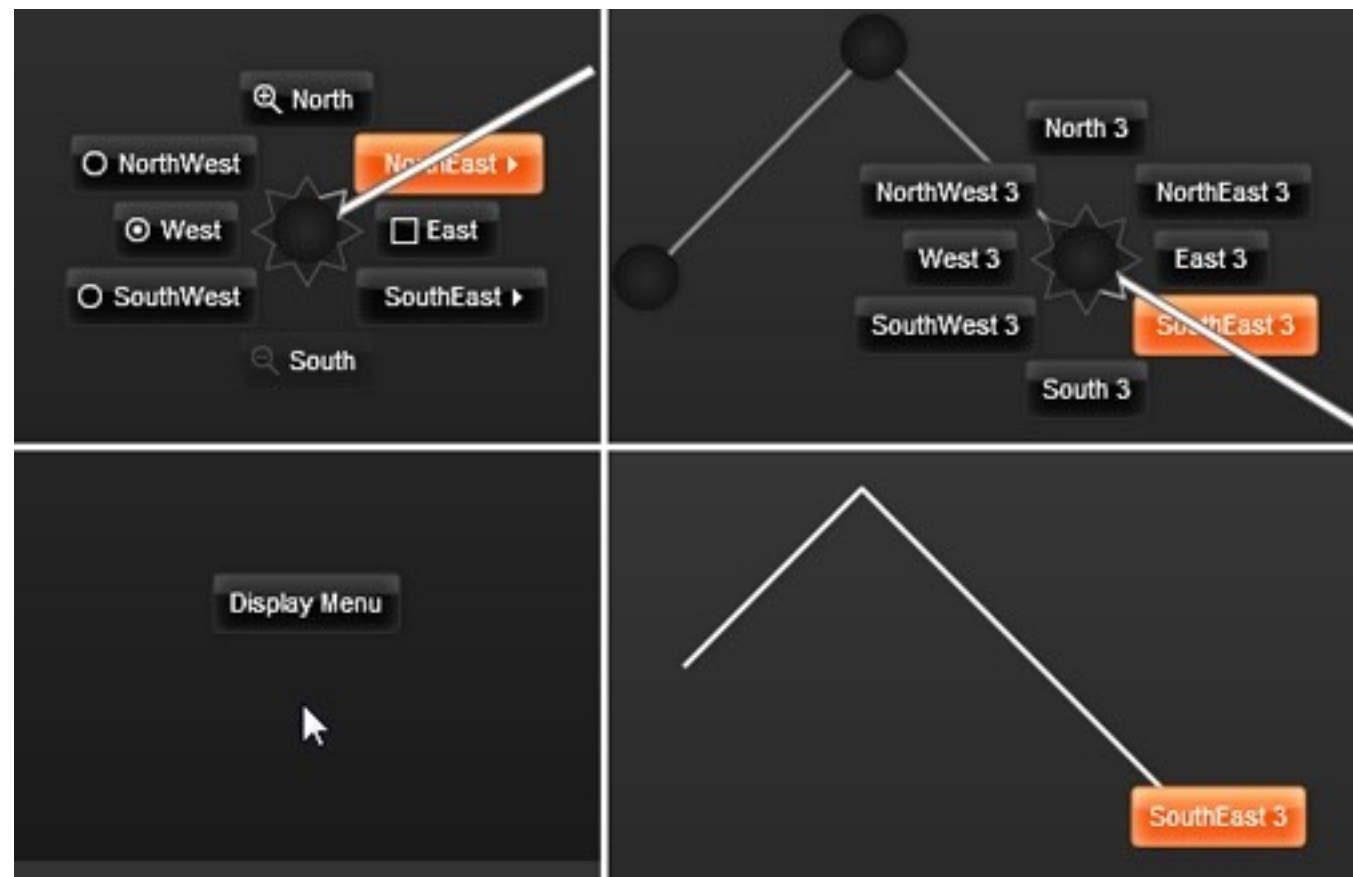


Kurtenbach '93



# Accelerating Menus - Marking Menus

- Idea: focus on the **movement** and not just the visual properties
- Just like the pie, but if you hold mouse and draw, the system interprets as a gesture
- <https://www.youtube.com/watch?v=dtH9GdFSQaw>

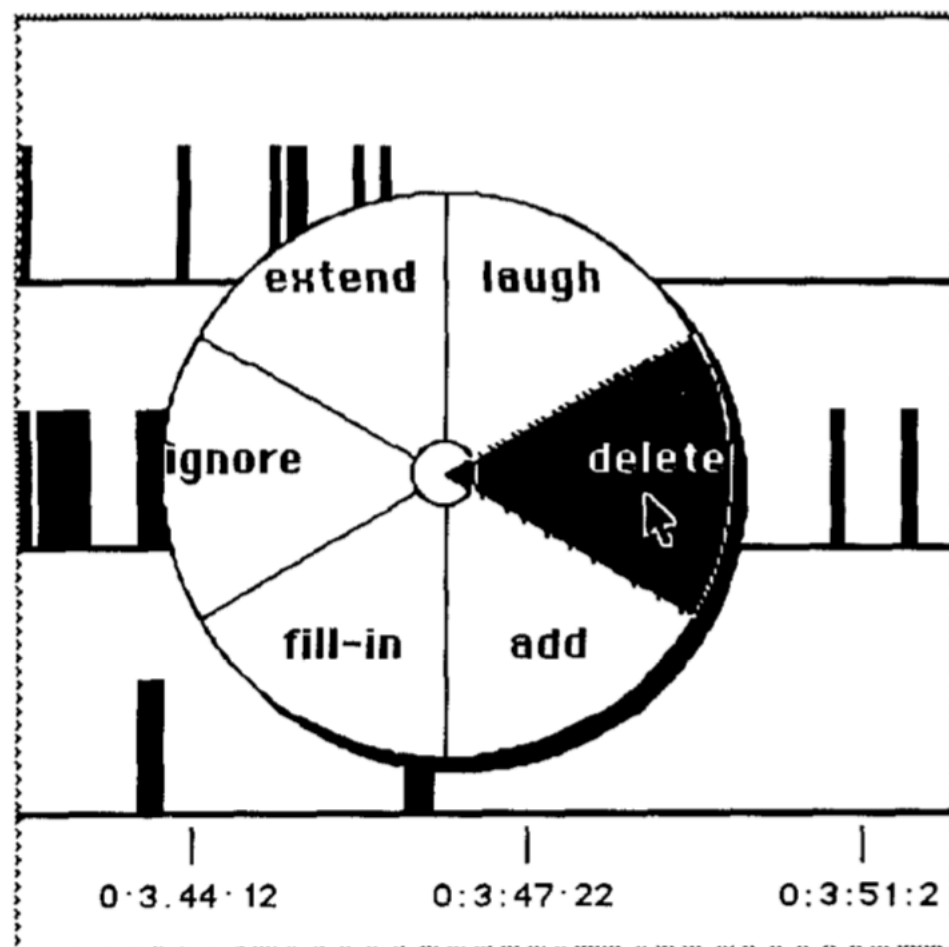


Kurtenbach and Buxton '93

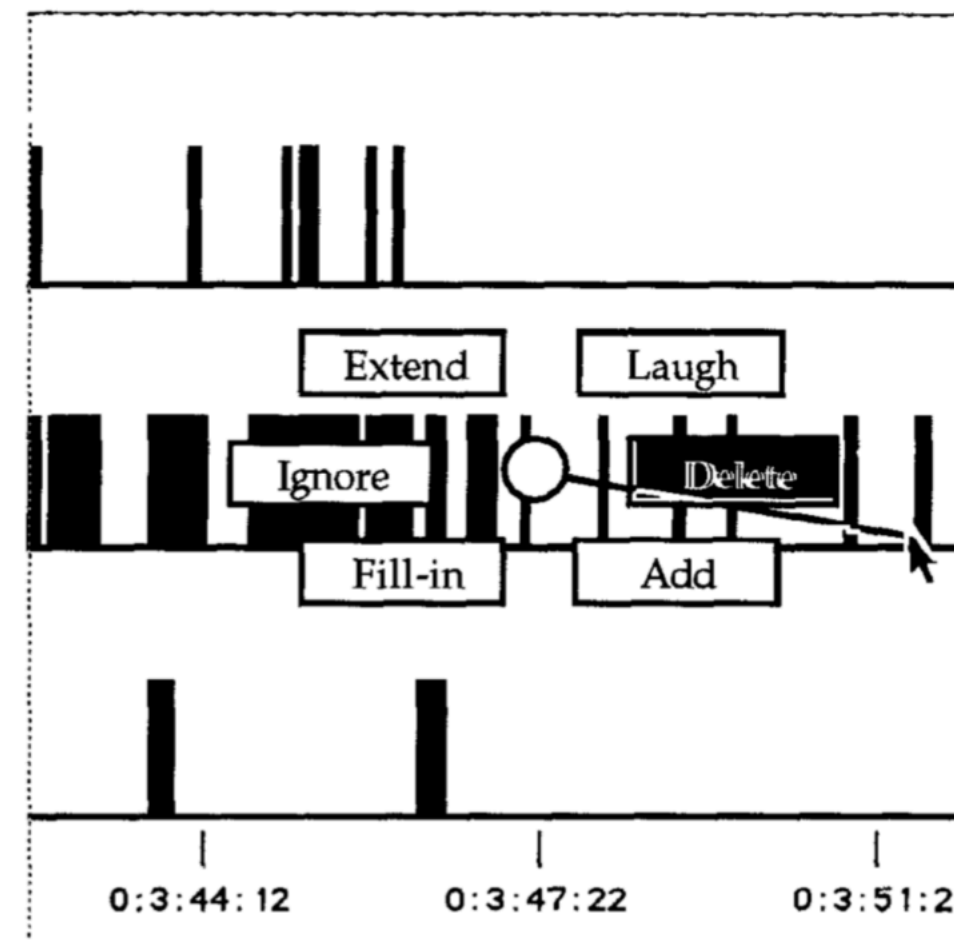


# Design Details - Marking Menus

- Principle: Should help user maintain visual context
- Problem: Pies take up space
- Refinement: show only labels



Traditional pies



Labels only

Tapia & Kurtenbach '95

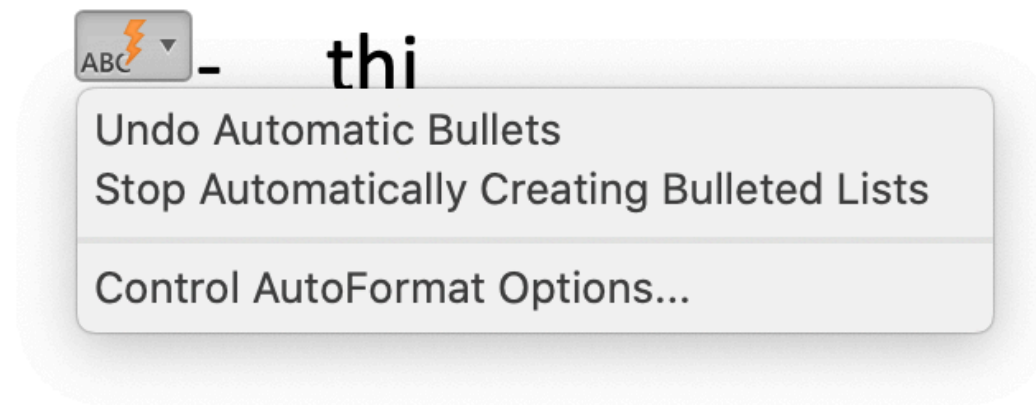
System feedback

# System response times

- 0.1second - reacting **instantaneously**
  - requiring no special feedback except displaying result
  - limit for direct manipulation of objects in UI
- 1.0 second - **freely** navigating commands
  - noticeable delay, limit for keeping user's flow of thought uninterrupted
- 10 seconds - keeping users **attention**
  - limit for keeping user's attention focus in UI
  - longer delays create task breaks
- [Nielsen, Usability Engineering, 1993]

# Automation

- Keep user in control at highest task levels
- Take control from user when need is obvious & user is busy
- Provide visibility of automation & opportunities to correct when necessary



# Provide feedback for all user actions

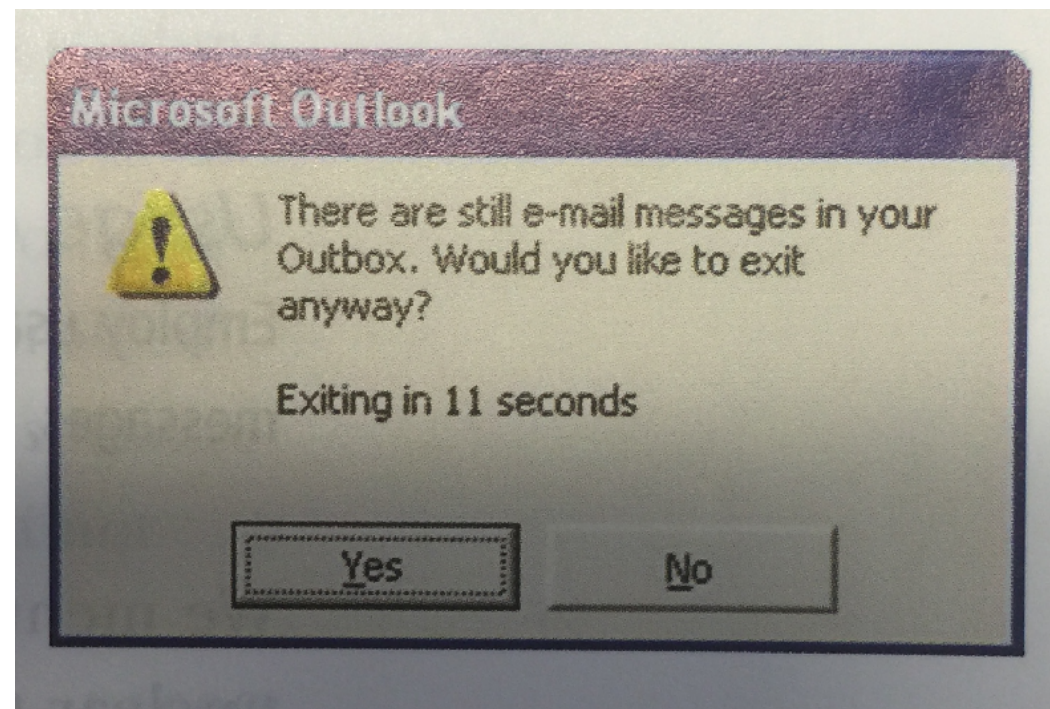
- Feedback helps keep users on track in accomplishing goals
- Request confirmation to prevent costly errors (but use sparingly)
- Make feedback visible, noticeable, legible, located w/ in users focus of attention
- Provide feedback early
- Provide feedback consistently

# Tone of feedback

- Establishes relationship with user
- Important not to take user feel “stupid”
- Make the system take blame for errors
- Be positive, to encourage
- Provide helpful messages, not cute messages
- Avoid violent, negative, demeaning, threatening terms (e.g., illegal, invalid)

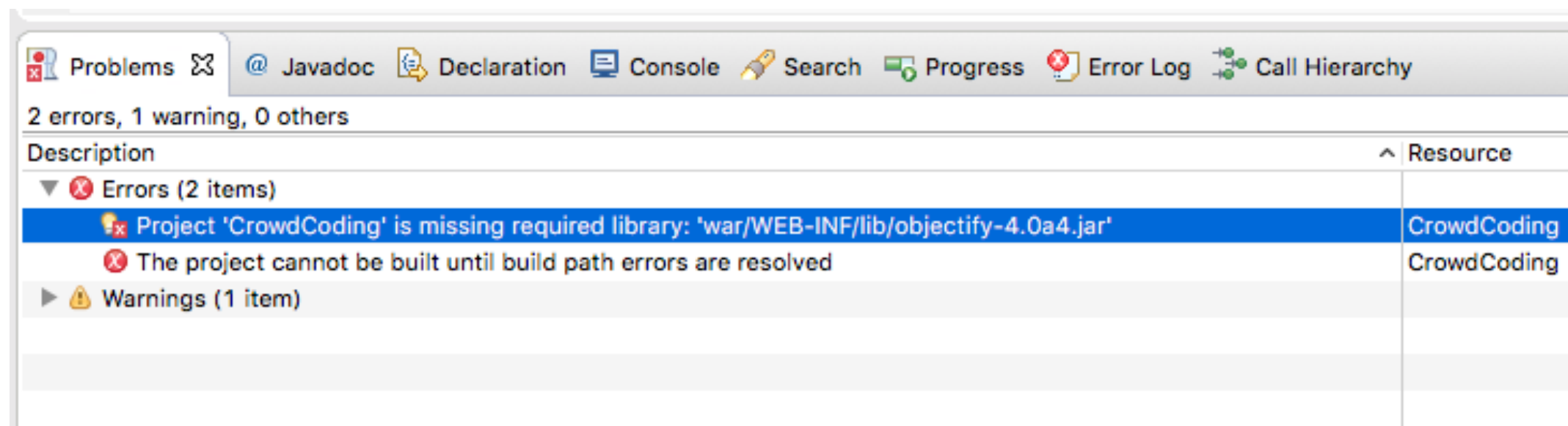
# Crafting feedback text

- Clarity - support clear understanding of outcome
- Precise wording
- Completeness - include enough information to fully understand outcomes



# Show users how to fix errors

- Good: detecting user errors
- Better: directly showing how errors can be fixed
- (Best: using constraints to prevent errors from ever occurring)





# Avoid anthropomorphism (in most contexts)

- Anthropomorphism - the attribution of human characteristics to non-human objects
  - e.g., “Sorry, but I cannot find the file you need”
- Provides a false mental model
  - leads to user thinking they can interact with system as person
  - can be over promising & condescending
- May work in spoken interaction settings, where system does match user’s mental model

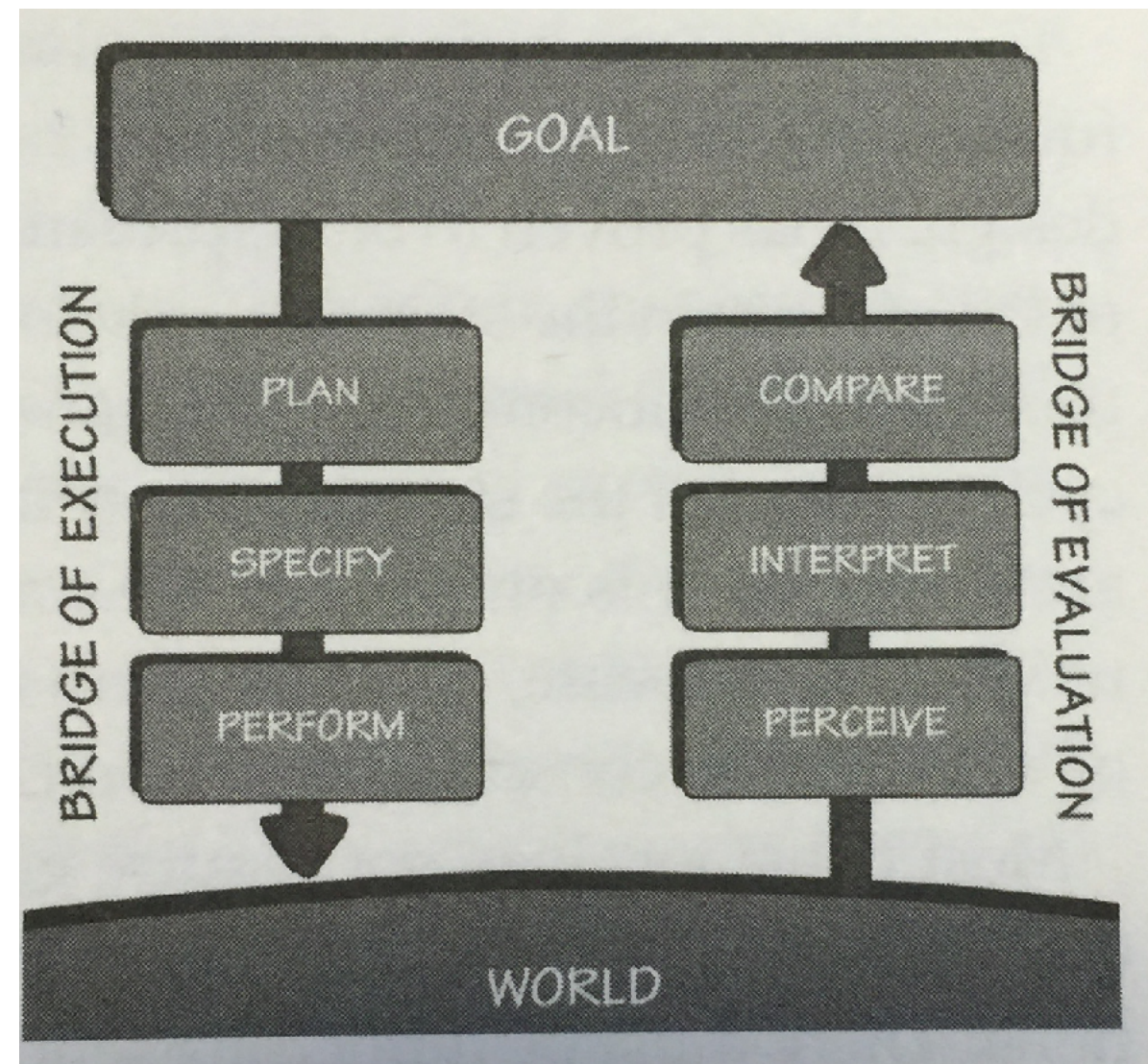
# In Class Activity

- In groups of 2 or 3:
  - Identify at least 3 separate usability issues of a web application that violates one of the interaction design principles in this lecture
  - For each issue, brainstorm ways that this usability issue might be addressed.

Direct manipulation

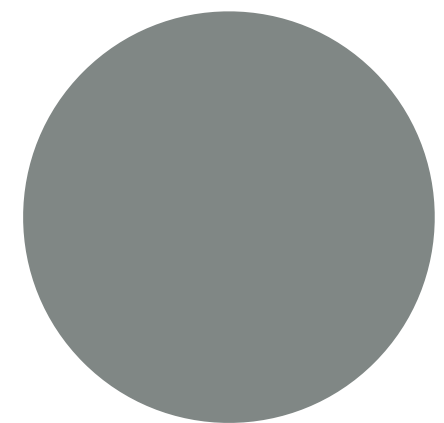
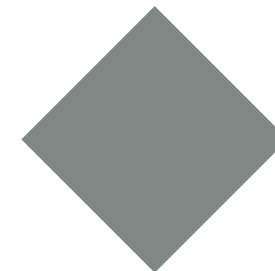
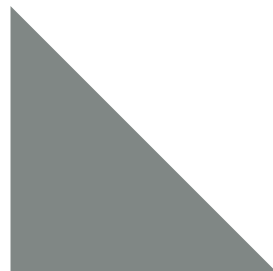
# Motivation

- User is trying to do a task, manipulating some [model] of world
- Hard to plan out long sequence of actions in advance
- Gulf of execution: hard to know if took correct action
- Gulf of evaluation: hard to understand if successfully manipulated world
- Hard to compare hidden world to desired world



# Direct manipulation

- “Rapid incremental reversible operations whose impact on the objects of interest is immediately visible” (Shneiderman, 1982)

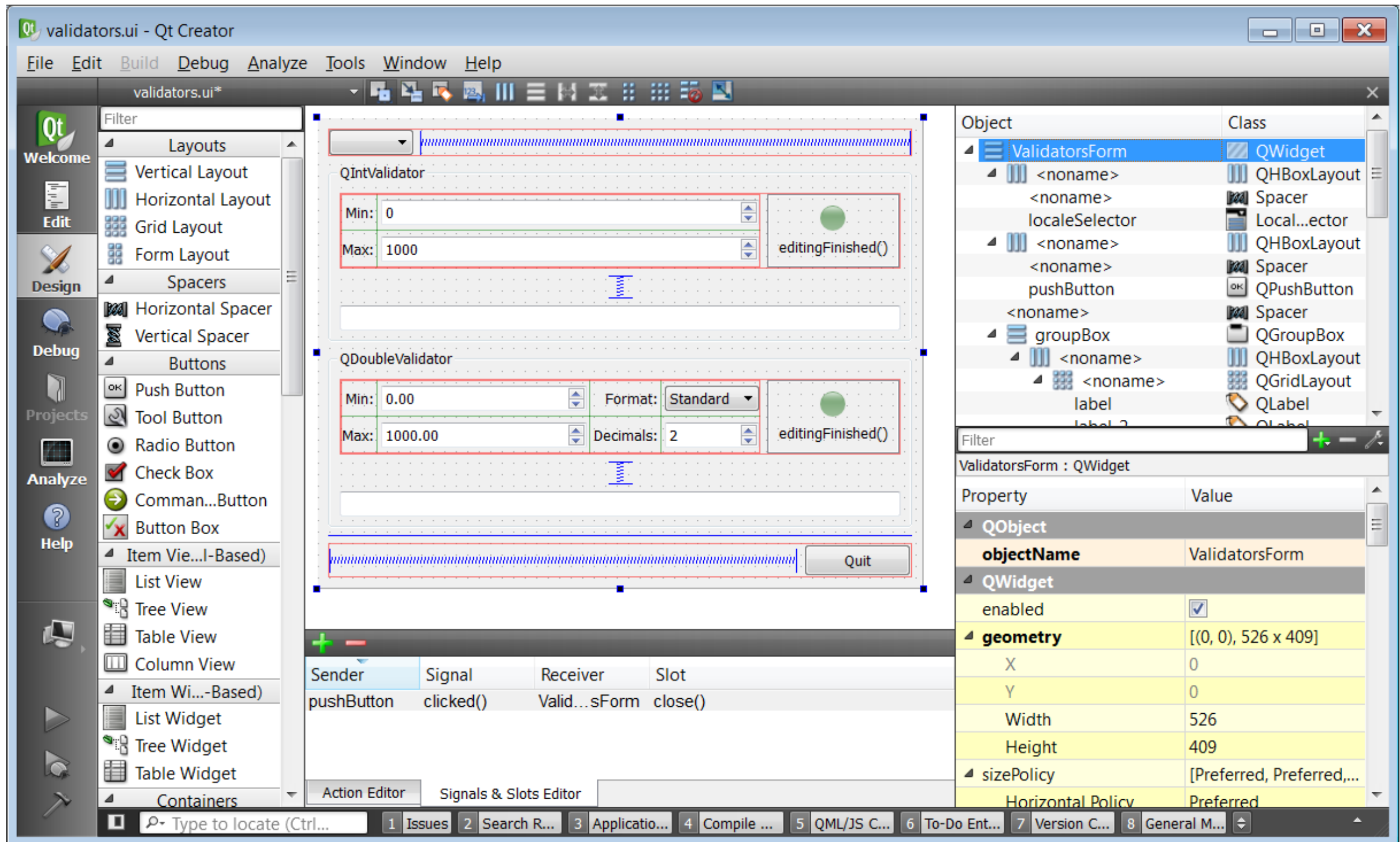


# Benefits

- Supports exploration
  - Don't plan long sequence of actions: pick an action, try it, can change mind if want to do something else instead
- Provides immediate feedback
  - Can quickly see what outcome of actions are in manipulating the world
  - Easy to compare desired state of the world to actual state of the world



# Example - GUI builder



# Example - Spreadsheets

FlyCalc - WIG2004.XLS

File Edit View Insert Format Tools ?

100% Support Chat OFF

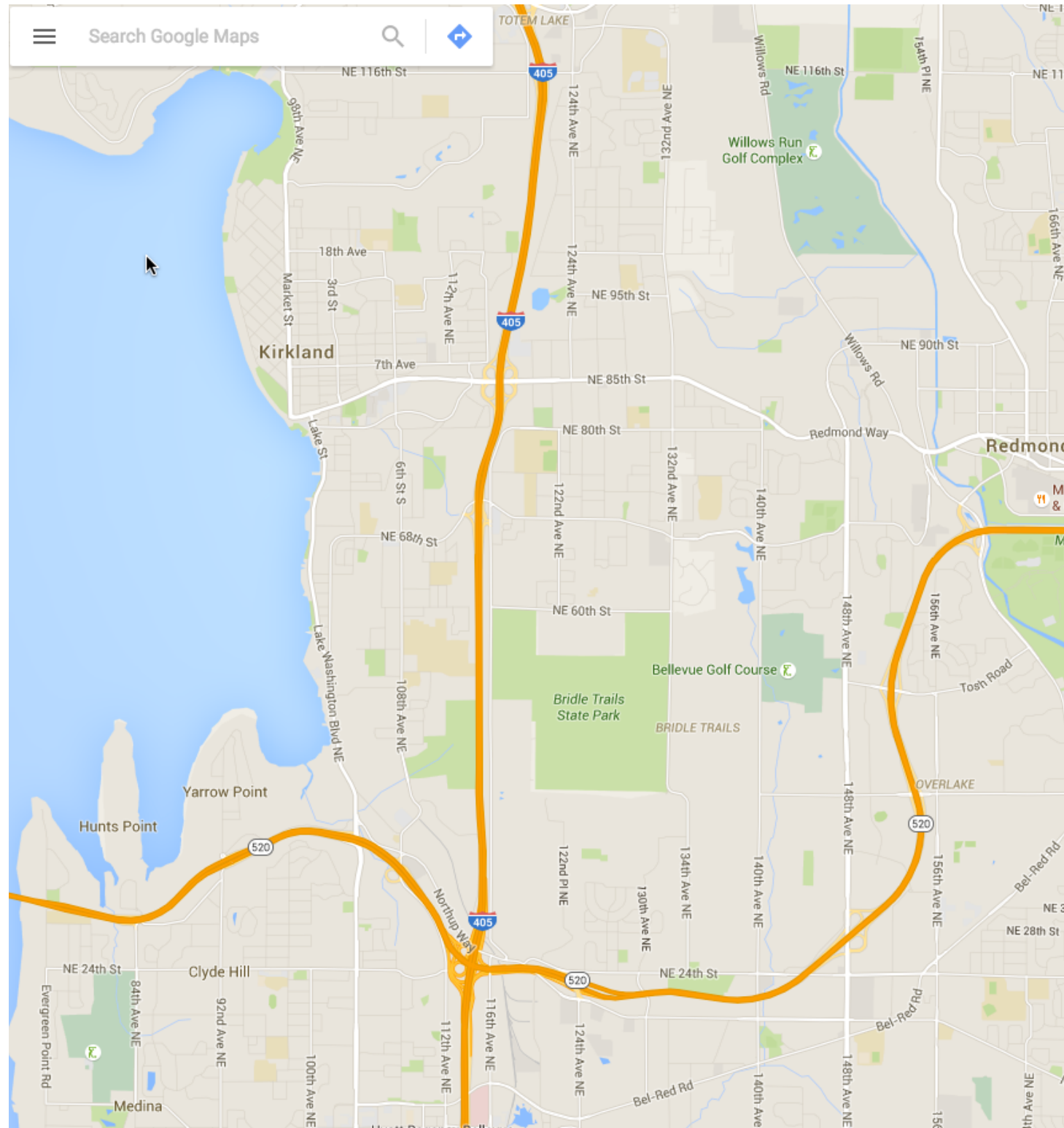
Formula :

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1		788	355	564	399	413	897	444	523	413						
2		800	923	233	307	864	355	90	877	864						
3		657	788	755	444	455	478	432	405	455						
4		599	866	233	201	413	361	455	233	413	Sep 2005	Oct 2005	Nov 2005	Dec 2005	Jan 2006	Feb 2006
5		899	755	673	311	780	400	614	754	780						
6			334	953	888	214	644	789	361	978						
7		233	644	766	446	231	977	577	453	847	455	507	690	700	788	800
8		577	533	968	897	541	977	475	358	975	355	478	361	400	355	923
9											742	267	599	700	564	233
10	Bryant Park	965	365	233	708	564	344	78	359	997	997	352	215	836	399	307
11	Keokuk	670	607	233	846	980	544	613	523	877	405	233	754		413	864
12	Westport	855	732	908	556	352	315	635	413	864	455	413	780		897	355
13	Temple	607	244	641	908	561	555	314	467	900	378	723	382		444	90
14	Lockhart	222	645	999	182	388	905	814	444	190	432	455	614		523	877
15	Stonington	344	756	600	481	339	489	144	399	307	444	201	311		413	864
16																
17	Subtotal	5455	4380	5088	5002	4521	4866	4084	4342	5687	9718	3890	5477		4796	5313
18																
19	U.K. Factories															
20																
21	Clacton	855	315	908	556	352	556	635	413	864	455	413	780		980	966
22	Perge	506	605	860	222	459	222	521	897	355	478	361	400		670	800
23	Runcorn	670	544	233	846	980	846	613	523	877	405	233	754		2242	1543
24	Worcester Park	344	489	600	481	339	481	144	399	307	444	201	311		899	900
25	Wapping	855	315	908	556	352	556	635	413	864	455	413	780		600	650
26	Tooting Bec	506	605	860	222	459	222	521	897	355	478	361	400		600	670
27	Balham	222	905	999	182	388	182	814	444	90	432	455	614		797	668
28	Wigan	670	544	233	846	980	846	613	523	877	405	233	754		800	796
29	Ashby de la Zouche	855	315	908	556	352	556	635	413	864	455	413	780		413	780
30	Bude	607	555	641	908	561	908	314	467	900	378	723	382		361	400
31	Looe	344	489	600	481	339	481	144	399	307	444	201	311		455	614
32	Scunthorpe	674	677	790	650	666	679	677	566	756	567	685	433		900	780
33																
34	Subtotal	5073	4761	5982	5078	4750	5078	4433	4478	5441	3896	3233	5086		7167	7021
35																
36	Canadian Factories															
37																
38	Deception Bay	344	489	600	600	481	339	521	897	355	478	361	233		846	613
39	Mississauga	855	315	908	600	481	339	481	855	315	908	556	352		481	144
40	WIG															

FlyCalc 1.1 - Copyright Natium 2003-2006



# Example - Google Maps



# Example - Kayak



Advice: **BUY** [Learn more](#) ⓘ

Create a price alert

## Stops

[Show all](#)

- ☒ nonstop \$127
- ☐ 1 stop \$145
- ☐ 2+ stops \$303

## Times

[Show all](#)

Take-off Washington (DCA)  
Fri 2:41p – 10:30p



Take-off Chicago (CHI)  
Mon 5:30a – 10:00p



Show landing times ▼

## Airports

[Show all](#)

☐ Depart/Return same

Washington

- ☒ DCA: Reagan-Nati... \$127
- ☐ BWI: Baltimore/Wa... \$207

DCA ↔ CHI  
108 of 1115 flights

Dec 16  
Friday ↔ Dec 19  
Monday

Economy 1  
cabin traveler

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**\$207**

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Ad

**\$227**

American Airlines



American Airlines



**8:12p** DCA → **9:26p** ORD 2h 14m nonstop  
**3:25p** ORD → **6:12p** DCA 1h 47m nonstop

[View Deal](#)

[Show details](#)

Economy

**\$227**

American Airlines



American Airlines



**8:12p** DCA → **9:26p** ORD 2h 14m nonstop  
**11:55a** ORD → **2:42p** DCA 1h 47m nonstop

[View Deal](#)

[Show details](#)

Economy

# In Class Activity: Direct Manipulation Programming Interactions

- In groups of 2
- Design a GUI building for creating React apps through direct manipulation
  - Create sketches showing key screens
  - Should support
    - Nesting one component inside another component
    - Hooking up components to events that occur
    - Should make it easier to get feedback on if program works