dt+UX DESIGN THINKING FOR USER EXPERIENCE DESIGN + PROTOTYPING + EVALUATION

Human Abilities: Vision & Cognition

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Autumn 2019

November 6, 2019

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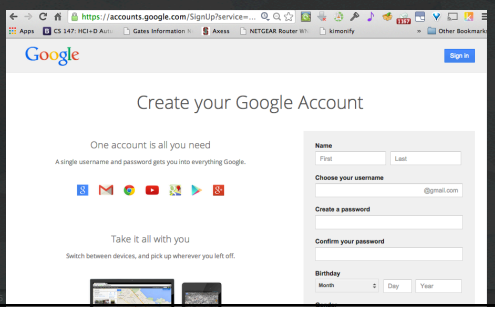
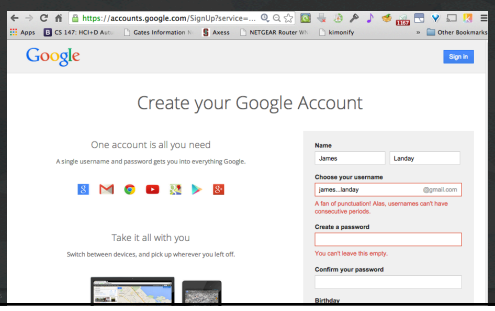
Hall of Fame or Shame?



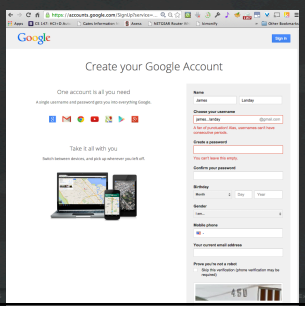
2

Hall of Fame or Shame?



3

Hall of Fame!



Clearly highlights error (red text & box)

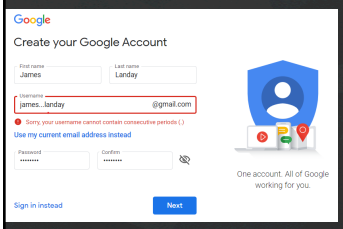
Tells me what I did wrong/how to fix it

In user's language
(but, be careful w/ humor)

Red may be an issue when used alone, more later...

4

Hall of Fame!



Clearly highlights error (red text & box)

Tells me what I did wrong/how to fix it

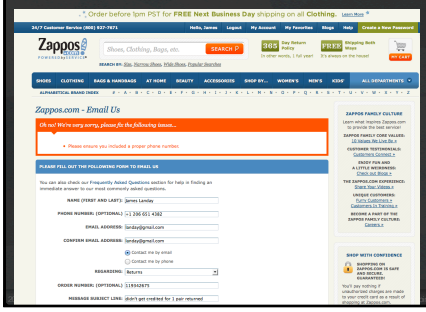
In user's language
(but, be careful w/ humor)

Red may be an issue when used alone, more later...

New version fixes these last 2 problems

5

Hall of Fame or Shame?



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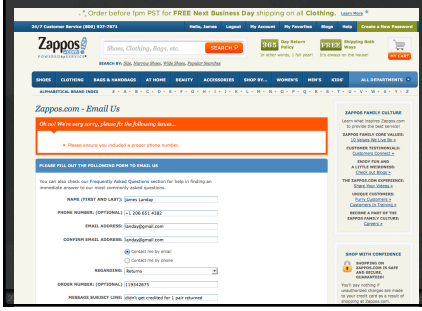
Hall of Shame!



Error Messages
- where is the error?
- what's wrong with it?
- parse & fix it yourself!

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Outline

- Human visual system
- Guidelines for design
- Team Break
- Models of human performance (MHP)
- Two in class experiments
- Memory

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Why Study Color?

1) Color can be a powerful tool to *improve* user interfaces by communicating key information

2) Inappropriate use of color can severely *reduce the performance* of systems we build

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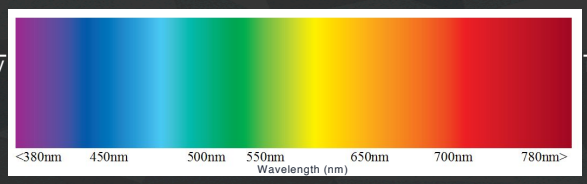
Visible Spectrum



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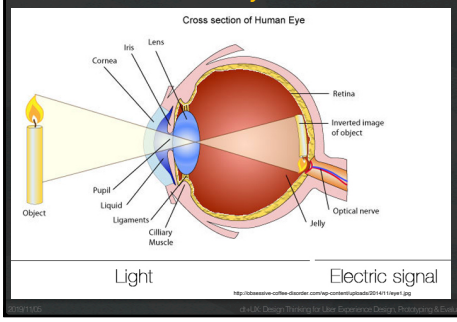
Human Visual System



- Light passes through lens
- Focused on retina

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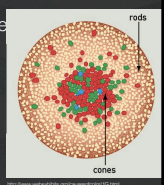
Retina

- Retina covered with two types of light-sensitive receptors called?
  - rods
    - primarily for night vision & perceiving moveme
    - sensitive to broad spectrum of light
    - can't discriminate between colors
    - sense intensity or shades of gray
  - cones
    - used to sense color



http://www.webexhibits.org/causesofcolor/1G.html

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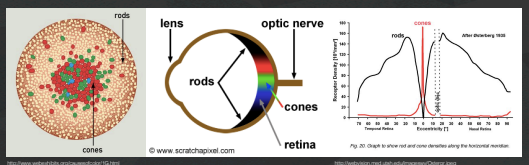
Retina

- Center of retina has most of the cones →
  - allows for high acuity of objects focused at center



http://www.webexhibits.org/causesofcolor/1G.html http://webvision.med.utah.edu/imageswv/Oster.jpeg

- Edge of retina is dominated by rods →
  - allows detecting motion of threats in periphery

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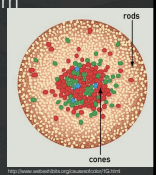
Color Perception via Cones

- "Photopigments" used to sense color
- 3 types: blue, green, "red" (really yellow)
  - each sensitive to different band of spectrum
  - ratio of neural activity of the 3 → color
    - other colors are perceived by combining stimulation



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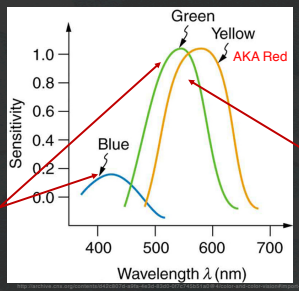
Color Sensitivity



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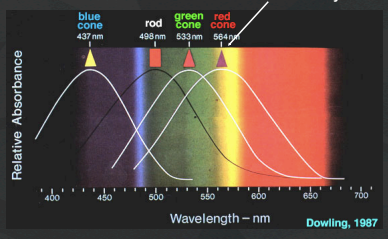
Color Sensitivity



http://retina.umh.es/webvision/imageswv/spectra.jpeg

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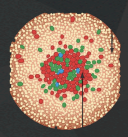
Distribution of Photopigments

- Not distributed evenly – mainly reds (64%) & very few blues (4%) →
  - insensitivity to short wavelengths (blue)
- Few blue cones in retina center (high acuity) →
  - "disappearance" of small blue objects you fixate on
- As we age lens yellows & absorbs shorter wavelengths →
  - sensitivity to blue is even more reduced
- Implication
  - don't rely on blue for text or small objects!



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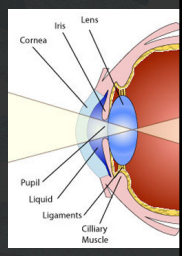
Focus

- Different wavelengths of light focused at different distances behind eye's lens
  - need for constant refocusing → ?
    - causes fatigue
  - be careful about color combinations



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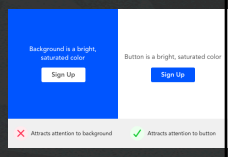
Focus

- Different wavelengths of light focused at different distances behind eye's lens
  - need for constant refocusing → ?
    - causes fatigue
  - be careful about color combinations
- Pure (saturated) colors require more focusing than less pure (desaturated)
  - don't use saturated colors in UIs unless you really need something to stand out



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Color Deficiency (Also known as "color blindness")

- Trouble discriminating colors
  - besets about 4.5% of population (~8% men, ~.5% women)
- Two main types
  - different photopigment response most common
    - reduces capability to discern small color diffs
  - red-green deficiency is best known
    - lack of either green or red photopigment → can't discriminate colors solely dependent on Red & Green

Difficult pairs for severe red deficient person to discern

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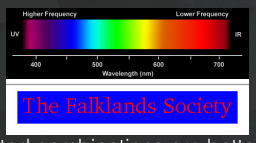
Color Guidelines

Avoid simultaneous display of highly saturated, spectrally extreme colors

- e.g., no cyans/blues at the same time as reds, why?
  - refocusing!



The Falklands Society

- desaturated combinations are better → pastels

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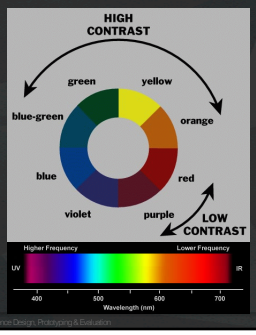
Use the Hue Circle

Pick non-adjacent colors

- opponent colors go well together
  red & green
  or
  yellow & blue



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Color Guidelines (cont.)

- Avoid pure blue for text, lines & small shapes
- Avoid adjacent colors that differ only in blue
- Blue makes a great background color

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Color Guidelines (cont.)

- Size of detectable changes in color varies
  - hard to detect changes in reds, purples, & greens
  - easier to detect changes in yellows & blue-greens
  - older users need higher brightness levels
- Hard to focus on edges created by only color
  - use both brightness & color differences
- Avoid single-color distinctions
  - mixtures of colors should differ in 2 or 3 colors
  - helps color-deficient observers

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Administrivia

- React Native workshop for Monday, Nov. 11th, 5-7pm, location TBD

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Administrivia

Day	Date	Lecture	Reading	Out	Due	Studio
Wed	11/6/2019	Human Abilities (PPT)	Pages 66-99 of "Cognitive Aspects in Interaction Design", from *Interaction Design*, 3rd Edition by Rogers, Sharp, & Preece Listen to 99% Invisible Podcast on Progress / Waiting	#8 Hi-fi Prototype (group)	#7 Heuristic Evaluation (individual)	hoc group) Group Heuristic - Graded activity *ATTENDANCE REQUIRED* Template
Mon	11/11/2019	Conceptual Models and Interface Metaphors (PPT)	"The Psychology of Everyday Things" (Ch. 1), from *The Design of Everyday Things* by Donald Norman			
Wed	11/13/2019	1) Usability Testing (PPT) 2) Midterm Review (PPT)				Project Work and Feedback
Mon	11/18/2019	Midterm (in class)				
Wed	11/20/2019	Guest Lecture: "Design in Industry", Irene Au, Khosla Ventures Design Patterns (PPT)	*The Design of Sites*, by van Duyne, Hong, & Landay: 1) "Making the Most of Web Design Patterns" (Ch 2) 2) "Up-Front Value Proposition" (Pattern C2) 3) "Process Funnel" (Pattern H1) 4) "Meaningful Error Messages" (Pattern K13)	#10 Poster and Pitch Slide (group)	#3 Web Site (group) #8 Hi-fi Prototype Midway Milestone (group)	Presentation #4: Hi-Fi Prototype Midway Milestone Project Work and Feedback

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Administrivia

Day	Date	Lecture	Reading	Out	Due	Studio
Mon	11/25/2019	Thanksgiving Break				
Wed	11/27/2019	Thanksgiving Break				
Mon	12/2/2019	Smart Interfaces to Tackle Global Grand Challenges (PPT)			#10 Poster and Pitch Slide (group) Mon (12/2): First Draft Wed (12/4): Final	
Wed	12/4/2019	Guest Lecture: "New Devices/UX Interactions", Joe Belfiore, Microsoft			#8 Hi-fi Prototype (group)	30-second Pitch and Demo Practice (group)
Fri	12/6/2019	**Project Expo (PPT)** **(6:30-9:30PM)** **@ d.school attrium (building 550)**				

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TEAM BREAK

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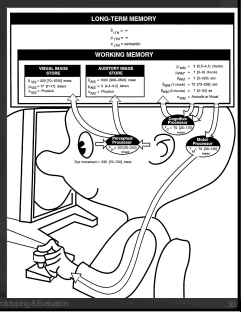
The Model Human Processor

Developed by Card, Moran & Newell ('83)

- based on empirical data



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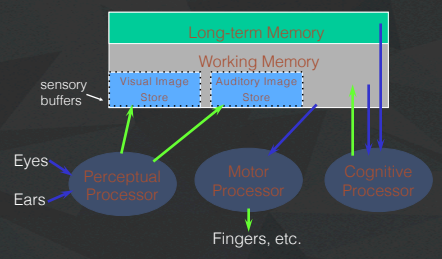
The Model Human Processor



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MHP Basics

- Sometimes serial, sometimes parallel
  - serial in action & parallel in recognition
    - pressing key in response to light (serial)
    - driving, reading signs & hearing at once (parallel)
- Parameters
  - processors have cycle time (T) ~ 100 ms
  - memories have capacity, decay time & type

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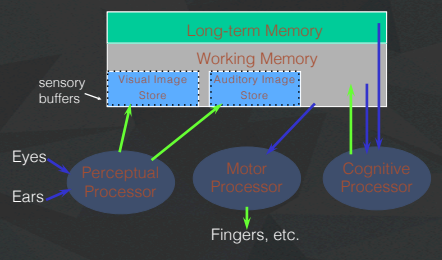
What is missing from MHP?



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What is missing from MHP?

- Haptic memory
  - for touch
- Moving from sensory memory to WM
  - attention filters stimuli & passes to WM
- Moving from WM to LTM
  - elaboration

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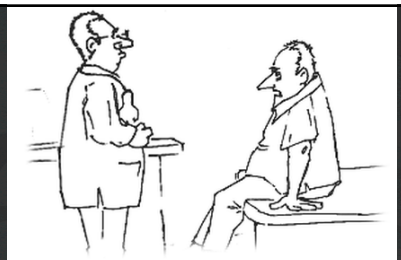

" I'm having trouble with my short term memory... ...
I'm here b'coz of my short term memory... ...
I 'd like to talk to you about my short term memory..."

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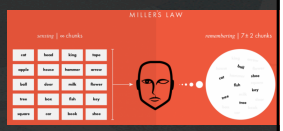
Memory

- Working memory (short term)
  - small capacity (7 ± 2 "chunks")
    - 6174591765 vs. (617) 459-1765
    - NBCIBMGMC vs. NBC IBM GMC
  - rapid access (~70ms) & decay (~200 ms)
    - pass to LTM after a few seconds of continued storage
- Long-term memory
  - huge (if not "unlimited")
  - slower access time (~100 ms) w/ little decay



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MHP Principles of Operation

- Recognize-Act Cycle of the CP
  - on each cycle contents in WM initiate actions associatively linked to them in LTM
  - actions modify the contents of WM

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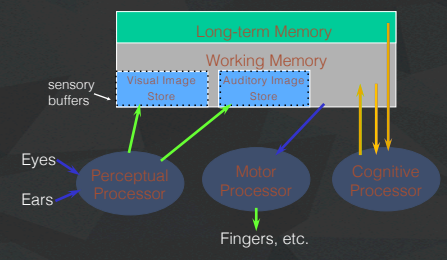
MHP Principles of Operation



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MHP Principles of Operation

- Recognize-Act Cycle of the CP
  - on each cycle contents in WM initiate actions associatively linked to them in LTM
  - actions modify the contents of WM
- Discrimination Principle
  - retrieval is determined by candidates that exist in memory relative to retrieval cues
  - interference by strongly activated chunks

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Experiment

- Task:
  Quickly tap each target 50 times accurately
- Conditions:
  - Two ½" diameter targets 6" apart
  - Two ½" diameter targets 24" apart
  - Two 2" diameter targets 24" apart
  - Two 2" diameter targets 24" apart (no accuracy required)
- Turn to neighbor: discuss what will happen

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Experimental Results

- Task:
  Quickly tap each target 50 times accurately

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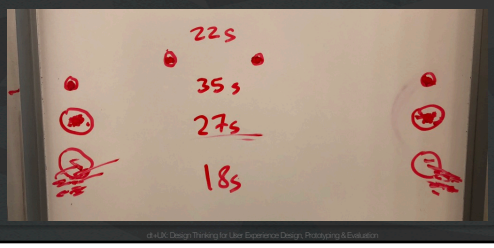
Experimental Results (last year)

- Task:
  Quickly tap each target 50 times accurately



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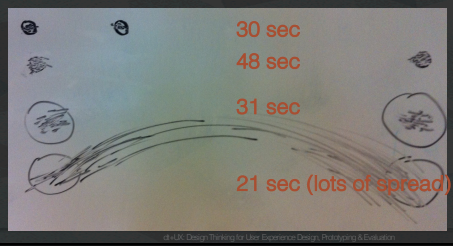
Experimental Results (2 years ago)

- Task:
  Quickly tap each target 50 times accurately



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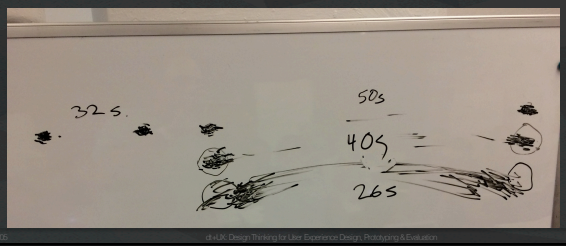
Experimental Results (3 years ago)

- Task:
  Quickly tap each target 50 times accurately



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Principles of Operation (cont.)

Fitts' Law
- moving hand is a series of microcorrections
  - correction takes Tp + Tc + Tm = 240 msec
- time Tpos to move the hand to target size S, which is distance D away is given by:
  Tpos = a + b log2 (D/S + 1)
- summary
  - time to move the hand depends only on the *relative precision* required

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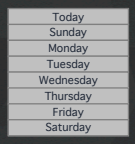
Fitts' Law Example

Pop-up Linear Menu



Pop-up Pie Menu

Which will be faster on average?
- pie menu (bigger targets & less distance)

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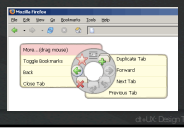
Pie Menus in Use Today

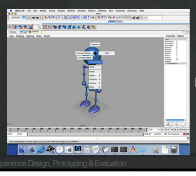
The Sims

Rainbow 6

Firefox



Maya



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Apple Watch Is a Negative Fitts' Law Example

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Simple Experiment

- Volunteer
- Start saying *colors* you see in list of words
  - when slide comes up
  - as fast as you can
- Say "done" when finished
- Everyone else time it…

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Paper
Home
Back
Schedule
Page
Change

50

Simple Experiment

- Do it again
- Say "done" when finished

51

Bandana
Forward
Home
Test
Basket
Paper

52

Simple Experiment

- Do it again
- Say "done" when finished

53

Yellow
White
Black
Blue
Red
Green

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Memory

- Interference
  - two strong cues in working memory
  - link to different chunks in long term memory
- Why learn about memory?
  - know what's behind many HCI techniques
  - helps you understand what users will "get"
  - aging population of users

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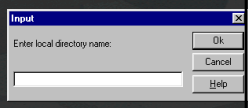
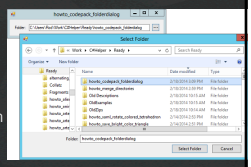
Design UIs for Recognition over Recall

- Recall
  - info reproduced from memory
  - e.g., command name & semantics



- Recognition
  - presentation of info provides knowledge that info has been seen before
    - e.g., command in menu reminds you
  - easier because of cues to retrieval
    - cue is related to item or situation learned in
    - e.g., hints, icons, labels, menu names, etc.



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Human Abilities Summary

- Color can be helpful, but pay attention to
  - how colors combine
  - limitations of human perception
  - people with color deficiency
- Model Human Processor
  - perceptual, motor, cognitive processors + memory
  - model allows us to make predictions
- Memory
  - three types: sensory, WM & LTM
  - interference can make hard to access LTM
  - cues in WM can make it easier to access LTM
- Key time to remember from MHP: ~100 ms cycle time & memory access time

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Further Reading
Vision and Cognition

- Books
  - *The Psychology Of Human-Computer Interaction*, by Card, Moran, & Newell, Erlbaum, 1983
  - *Human-Computer Interaction*, by Dix, Finlay, Abowd, and Beale, 1998.
  - *Perception*, Irvin Rock, 1995.
- Pages 66-99 of "Cognitive Aspects in Interaction Design", from *Interaction Design*, 3rd Edition by Rogers, Sharp, & Preece
- Applying Fitts' Law to Mobile Interface Design by Justin Smith

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Next Time

- Conceptual Models & Interface Metaphors
  - Read "The Psychology of Everyday Things" (Ch. 1), from *The Design of Everyday Things* by Donald Norman
- Studio
  - Ad-hoc group heuristic evaluation
  - Must be present to get credit on assignment

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