



**CSCI 4550/6550 Interactive Visualization**

<https://www.cs.rpi.edu/~cutler/classes/visualization/S24/>

# **Lecture 6: Interaction & Design Storyboarding**

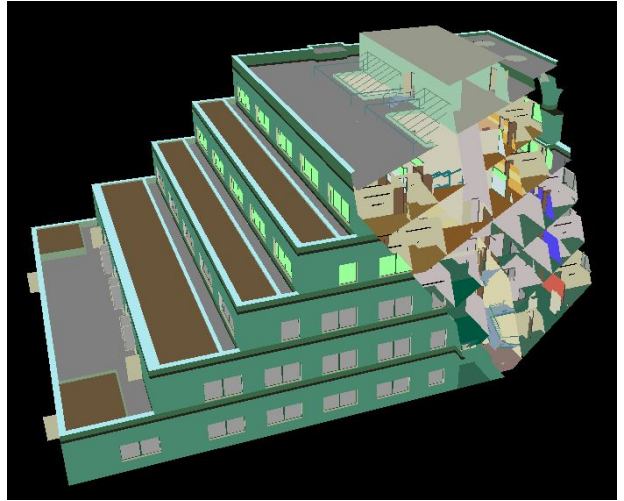
## Today

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- **What is Interaction? Camera vs. Data Manipulation**
- Interaction Devices
- Object Selection & 3D “Picking”
- Papers for Today
  - “D3: Data-Driven Documents”
  - “Interaction Techniques for Selecting and Manipulating Subgraphs in Network Visualizations”
- HW4 Preview
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# What is Interaction?

- Manipulating objects in a scene
  - Moving
  - Rotating
  - Selecting
  - Deleting
- Manipulating your view of the scene (manipulating the camera)
  - Pan
  - Tilt
  - Zoom



Berkeley Soda Hall walkthrough

## Manipulating the Camera

*Choose the right camera model!*

Are you selling an object?

- What is the scale of object?
- Is this the natural viewpoint?

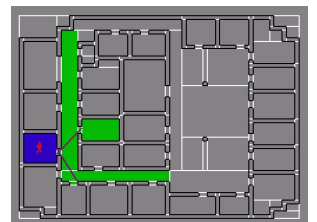
→ *Fixed camera, manipulate the object*



Are you selling an immersive experience?

- E.g., 1st person video game navigation?

→ *Move the camera within the scene*



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## Interaction Devices

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*At brainstorming phase... be creative, open-minded, consider all possibilities*

- Keyboard
  - Press a key
  - Hold a key
- Mouse
  - Left button
  - Middle button
  - Right button
  - Single click
  - Double click
  - Scroll wheel
  - Trackball?
- Joystick
  - vibration

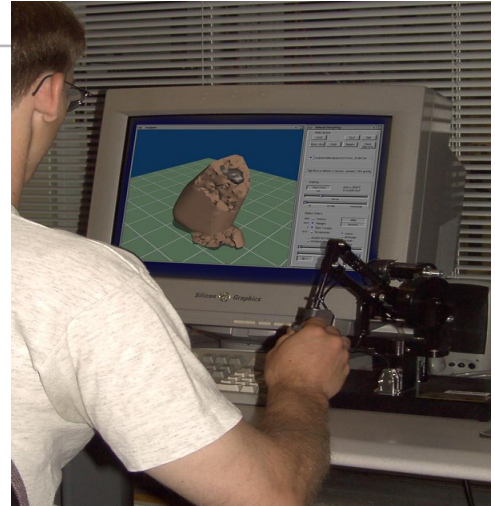


- “3D mouse”  
(e.g. 3D Connexions Space Navigator)
- Pen (Wacom)
- Touch or Multi-Touch
- Haptics
  - 3D position
  - 3D direction
  - Directional force feedback



## Haptic Device

- “3D mouse” + force feedback
- 6 DOF (position & orientation)
- *requires 1000 Hz refresh*  
(visual only requires ~30 Hz)



Sensable's Phantom  
<http://www.sensable.com/>

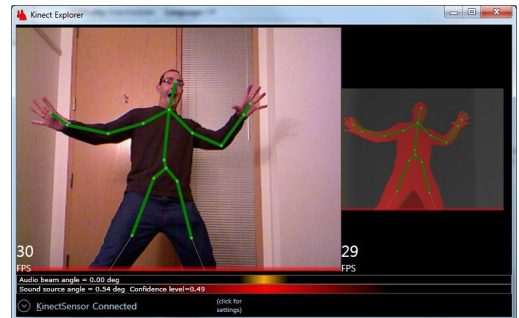
## More Interaction Devices

- Application-specific input devices  
(musical instruments, steering wheel, light gun, etc.)
- Microphone (voice control, translation)
- Brain computer interface, stress sensor, muscle sensors
- General video input, tracking (kinect)

Wii



Kinect



## Choosing the Right Device

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*During prototyping phase...  
focus on your target  
audience & eventual deployment*

- 2D vs. 3D
- Visual and/or Haptic Feedback
- Intuitive, most similar to natural (non digital/virtual) interface
- Availability/expense/learning curve, overall practicality
- Resolution/accuracy
- Robustness/noise
  - If requires reset/recalibration, is that acceptable?
  - Frames per second requirements of haptics
- Comfort/exercise/overuse injuries

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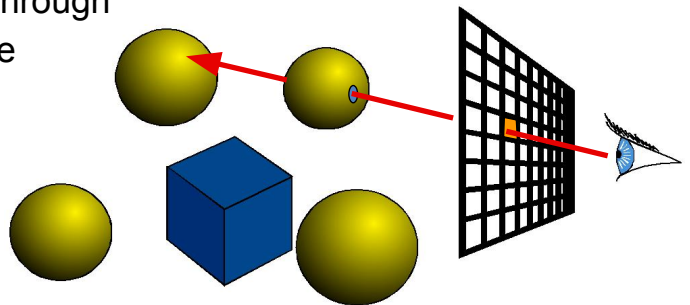
## What is “Picking”?

- Get the (3D) world coordinates of a (2D) mouse click
- Identify which object was selected and the point on the object closest to the click
- As users take this for granted
  - *How is it implemented?*
  - *What are the performance bottlenecks?*
  - *What are the usability concerns?*



## “Picking” by Ray Tracing

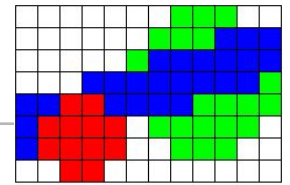
- Construct a ray from the eye through the image plane into the scene
- Loop over and intersect ray with every object in the scene
- Keep the closest intersection
- *Concerns:*
  - *Performance:  $O(n)$ , for a scene with  $n$  objects*
  - *How often are you asking?*  
*On a click? Continuously, as the mouse moves?*
  - *Positional imprecision/noise?*



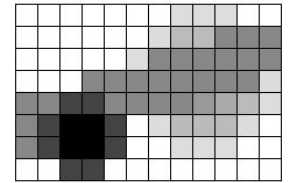
# “Picking” by the Framebuffer

- Color each object a different, unique color (no lighting/shading)
  - *Are there enough colors??*
- Grab the color of the pixel from the framebuffer (object id)
- Grab the z-value (depth) from the depth buffer

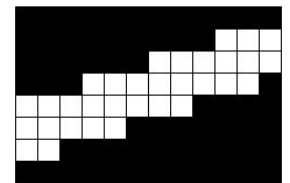
White, Crane, & Forsyth,  
"Capturing and Animating  
Occluded Cloth" SIGGRAPH 2007



frame buffer



depth buffer



stencil buffer

# Using 3D Painting

<http://www-ui.is.s.u-tokyo.ac.jp/~takeo/gallery/chameleon.png>



# Painting by Picking a Picket Fence?



## Today

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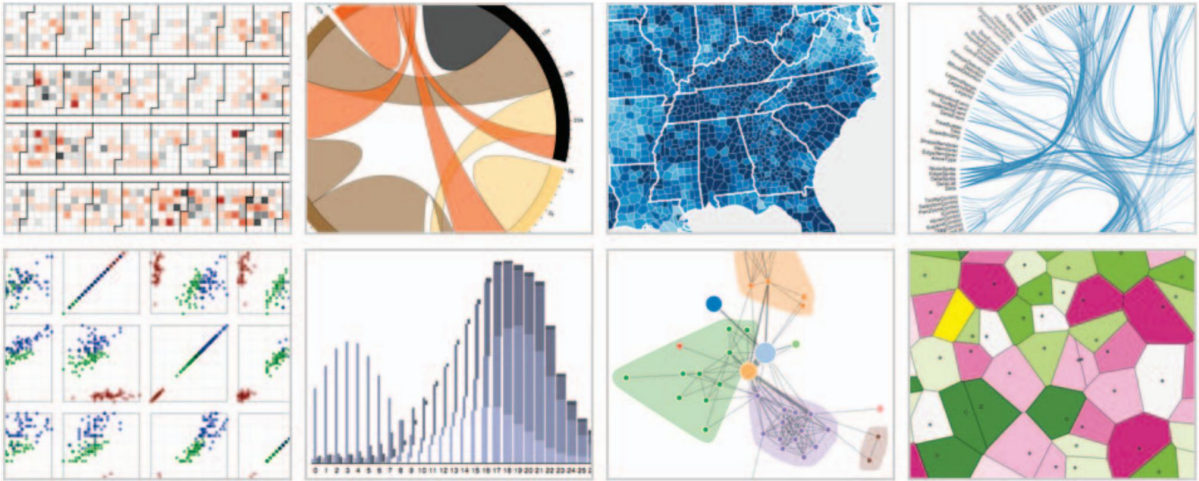
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## Reading for Friday *pick one*

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"D3: Data-Driven Documents", Bostock, Ogievetsky, & Heer, TVCG 2011



## "D3: Data-Driven Documents"

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- Authors have a prior visualization system/language: Protovis
  - D3 is an iteration / improvement on the design
  - Have 2 years of experience and a variety of user visualizations with Protovis for comparison
- Motivation / Objectives: Compatibility, Debugging, & Performance
- Transformations facilitation implementation of:
  - Dynamic visualizations & Animated transitions
  - Also iterative debugging is easier
- Have you taken Programming Languages?
  - Case study design of custom / domain-specific language
- Protovis' language facilitated inheritance.  
D3 is not a language, so it does not allow this feature.

## Is this a “Systems Paper”?

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Many conferences/journals have different types/tracks for papers. E.g.:

- “Technical Research Paper”
- “Experience Paper”
- “Computing Education Paper”
- “Experience Reports and Tools”
- “Position and Curricula Initiative”
- “Survey Paper”
- “Short Paper”
- “Poster/Abstract”

Read the submission guidelines for the conference/journal and ensure your paper idea is within the scope and determine what type/track is appropriate.

## Is this a “Systems Paper”?

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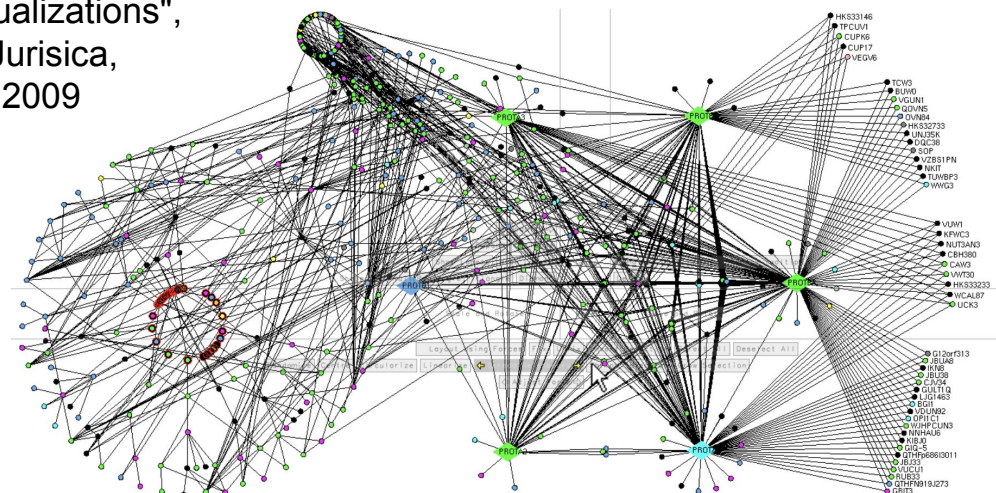
- Systems papers can be challenging to get published. “Implementation” and “Development” alone is deemed insufficient for publication in an academic Research conference/journal. Writing software is not enough, you need to evaluate the software, that’s the research angle.
- Systems papers often have a big author team.
- Systems paper can be more challenging for a new person to read
- Technical details from older systems papers may be outdated
  - Hardware / libraries (e.g., Flash) may be deprecated
  - Absolute performance (even relative / % of whole) performance stats may no longer be accurate
  - Is there any value in reading older systems papers?
- Systems paper typically requires more documentation, more examples, more supplemental material
- Often prior work is the author’s work. It can be challenging to cite prior work anonymously to satisfy a double-blind conference/journal review process.

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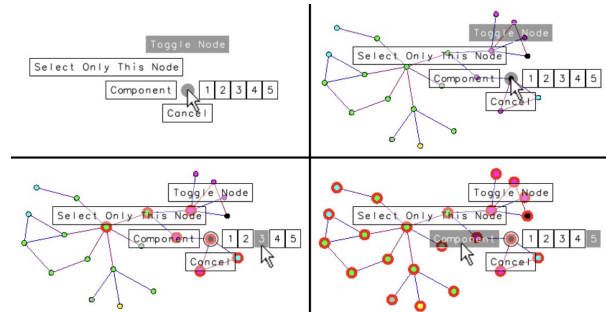
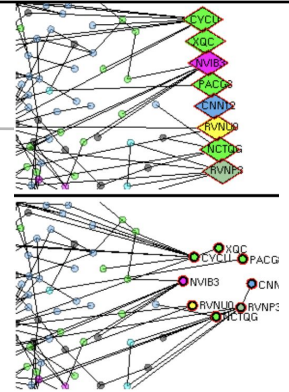
## Reading for Friday *pick one*

"Interaction Techniques for Selecting and Manipulating Subgraphs in Network Visualizations",  
McGuffin & Jurisica,  
IEEE TVCG 2009



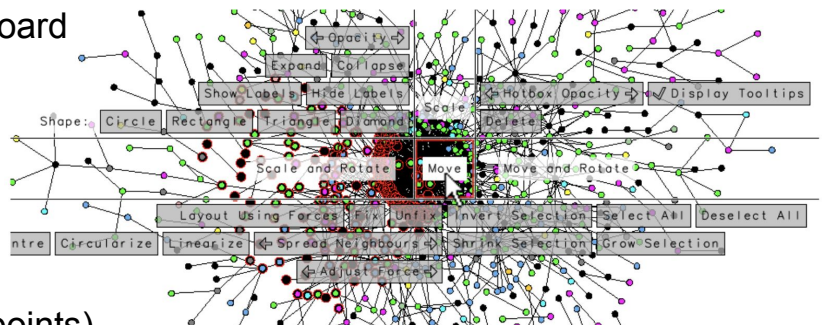
## "Interaction Techniques for Selecting and Manipulating Subgraphs in Network Visualizations",

- Customization & selection is necessary to effectively visualize bigger datasets
- Advanced interaction techniques: lasso, gestural, radial menu, hotbox, keyboard shortcuts, etc.
- Force directed initial layout
- Ability to select subgraph
- Option to fix position and other properties, such as: color, size, shape, label, etc
- Option to optimize layout of selected subgraph in a line (PCA based) or circle



## "Interaction Techniques for Selecting and Manipulating Subgraphs in Network Visualizations",

- Aim to minimize keyboard & mouse clicks
- Auto-detect rectangular lasso vs circular lasso (length of pen stroke relative to distance between start & end points)
- User Testing / Interface Evaluation
- *“However, the interface took a non-negligible amount of time to learn, and we suspect the users did not have time within a 2-hour session to converge to expert-level performance.”*



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## HW 4: Make Something Interactive

- Explore and learn D3.js: Data Driven Documents
- Make something new & interactive
- (open-ended)

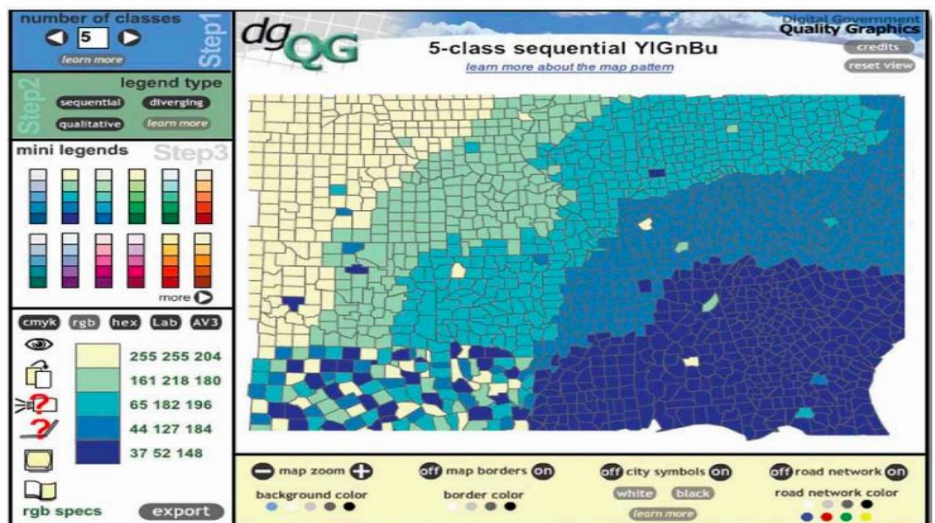


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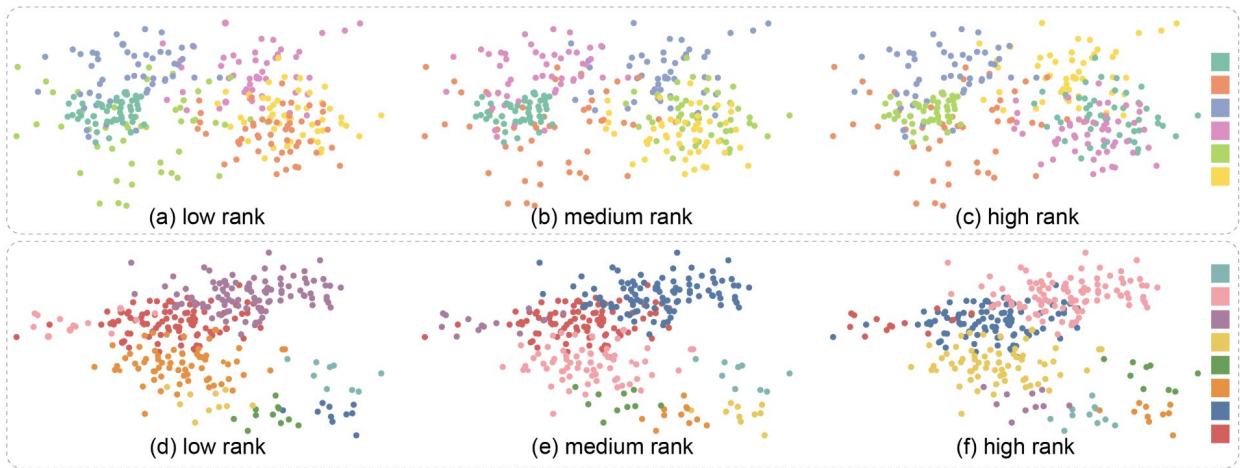
## Reading for Tuesday *pick one*

“ColorBrewer.org:  
An Online Tool  
for Selecting  
Colour Schemes  
for Maps”,  
Harrower &  
Brewer,  
The Cartographic  
Journal, 2003.



## Reading for Tuesday *pick one*

“Optimizing Color Assignment for Perception of Class Separability in Multiclass Scatterplots”, Wang, Chen, Ge, Bao, Sedlmair, Fu, Deussen, and Chen, IEEE InfoVis 2018.



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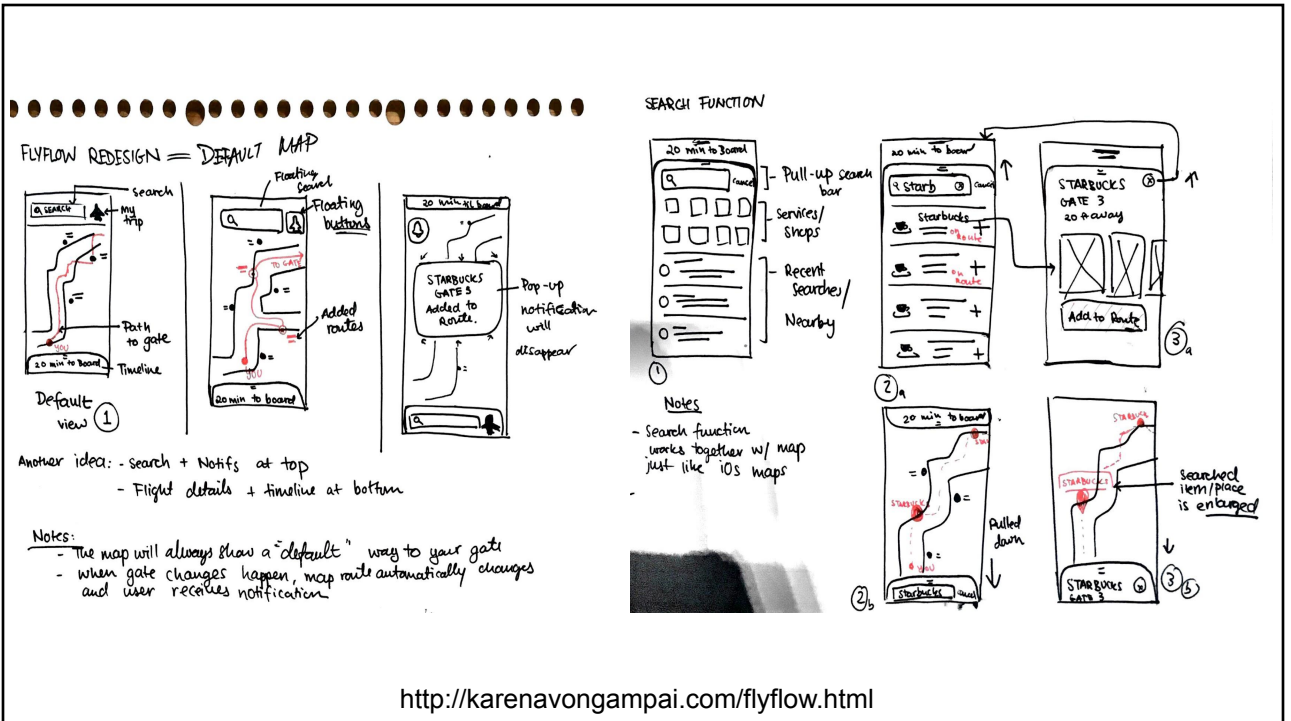
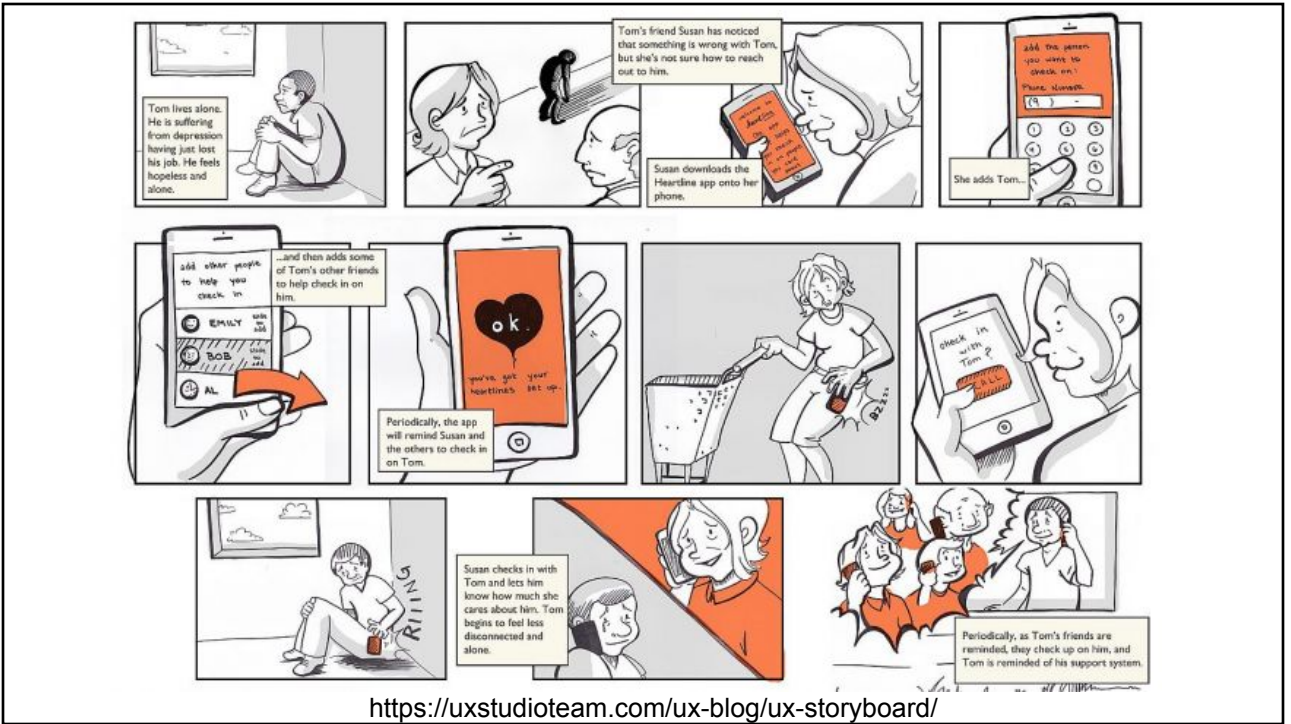
# Animated Movie “Storyboarding”

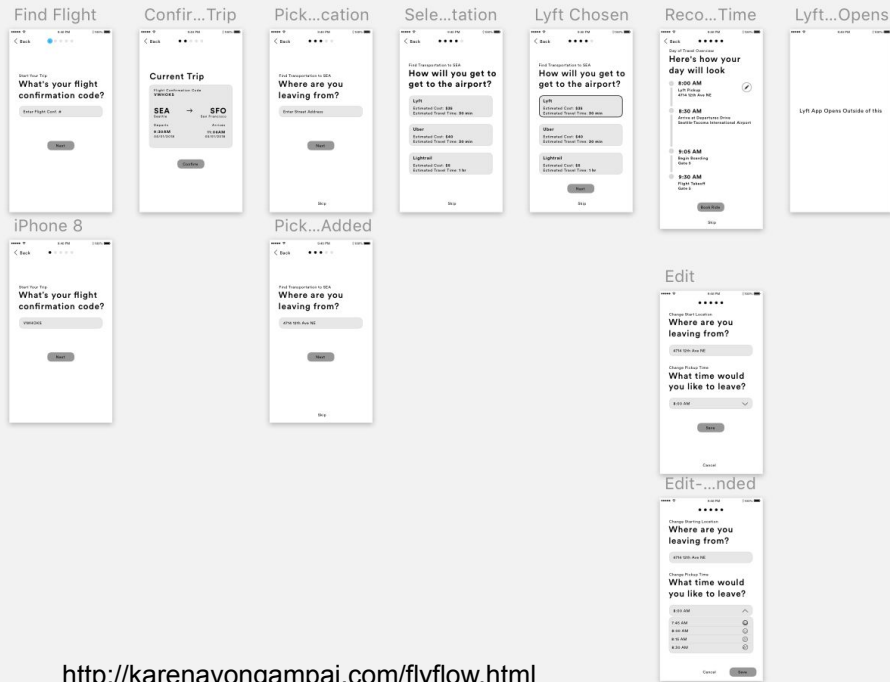


<http://pixar-animation.weebly.com/storyboard.html>



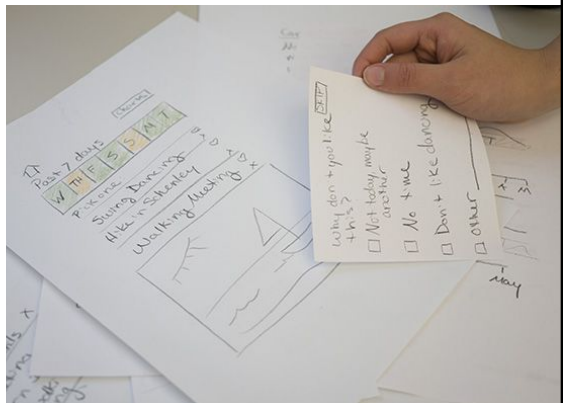
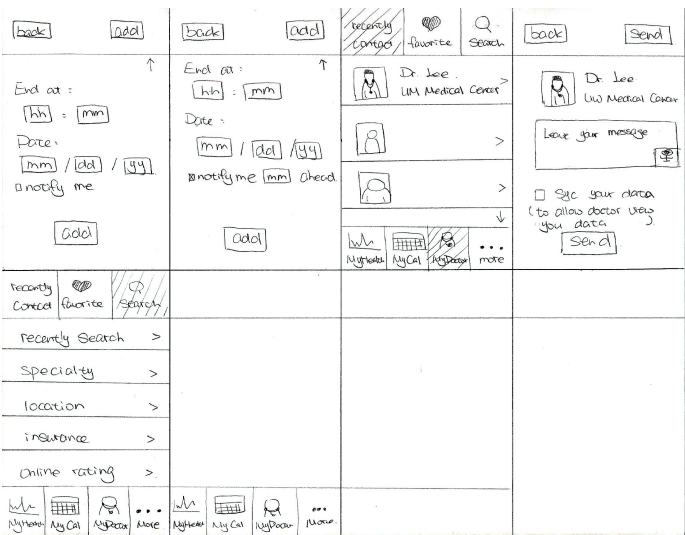






<http://karenavongampai.com/flyflow.html>

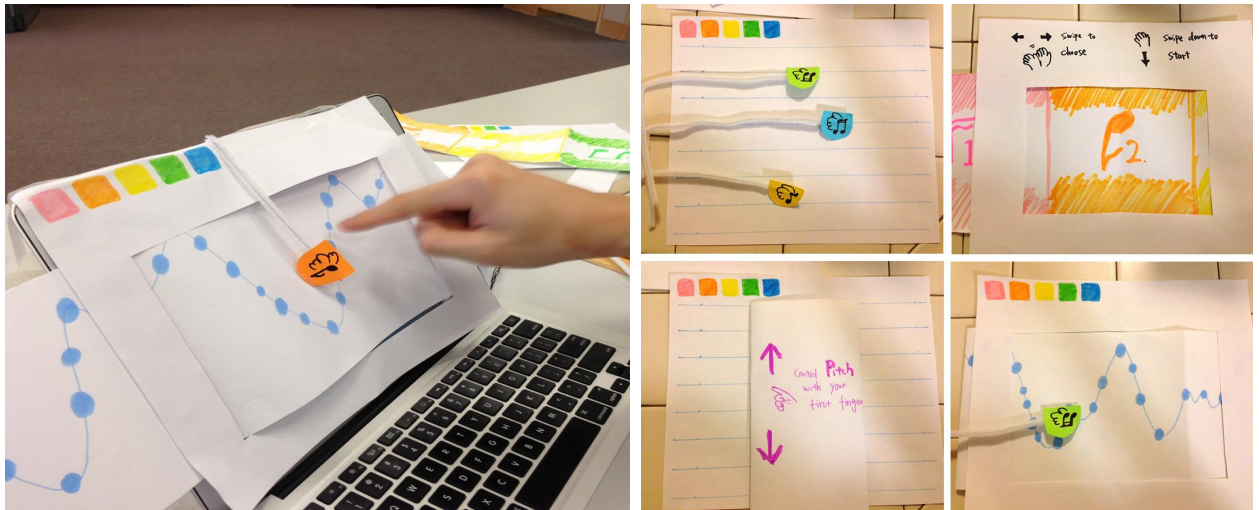
## “Wizard-of-Oz” for Interface Testing



<http://kate-vogt.com/bond.html>

<http://courses.cs.washington.edu/courses/cse440/12wi/projects/pocketdoctor/medfi.html>

# “Wizard-of-Oz” for Interface Testing



<https://bwang29.github.io/offshore/gesture/wizard.html>

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