Assembly and Cutaway Illustration & Interaction

Erik Johansson, Cut & Fold
http://erikjohanssonphoto.com/work/cut-fold/
Today’s Class

• What is Interaction?
  – Camera Manipulation
  – Data Manipulation

• Interaction Devices

• Picking & 3D Painting

• Visual Response to Interaction

• Readings for Today
  – “Designing Effective Step-by-step Assembly Instructions” Agrawala et al., SIGGRAPH 2003
  – “Interactive Cutaway Illustrations of Complex 3D Models”

• Readings for Tuesday
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?
- Scale of object
- Is this the natural viewpoint?

Are you selling an immersive experience?
- 1st person video game navigation?
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Interaction Devices

• 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) or Touch
• 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)

Sensible’s Phantom
http://www.sensable.com/
More Interaction Devices

- Wii

- Kinect

- 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)
Choosing the Right Device

- 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, 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  

• *Do we as users take this for granted??*  
  – *How?*  
  – *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
• Intersect with all objects in the scene
• Keep the closest

• Concerns:
  – Expense of Intersection?
  • How often are you asking? On click? Continuously?
  – 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
Using 3D Painting

http://www-ui.is.s.u-tokyo.ac.jp/~takeo/gallery/chameleon.png
Painting by Picking a Picket Fence?
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Visual Response to Interaction

• Hide/Unhide elements
  – Increase/Decrease level of detail
  – Change camera/magnification
  – Add text labels

• Highlight element(s)
  – Change color
  – Change transparency

• Motion
  – Showing time simulation
  – User can rearrange for clarity/exploration
Animation Explaining Mechanical Parts

http://imgur.com/gallery/FvCTr
Animation to explain an algorithm

http://tholman.com/bezier-curve-simulation/
Quite interesting for “Just” a Slider

How Birth Year Influences Political Views

By AMANDA COX JULY 7, 2014

How whites born in 1962 have leaned politically over their lives

At age 10
1972

20
1982

30
1992

40
2002

50
2012

60
2022

70
2032

55%
Republican*

45%

Age 50 in 2012
55% Republican

http://www.nytimes.com/interactive/2014/07/08/upshot/how-the-year-you-were-born-influences-your-politics.html?partner=rss&emc=rss&_r=2&abt=0002&abg=1
A Really Small Slice of Americans Get to Decide Who Will Rule the Senate

Put another way: The number of people who'll decide this election will likely be smaller than the population of Florida.

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“Designing Effective Step-by-step Assembly Instructions”
Agrawala et al.,
SIGGRAPH 2003

• Inspired by robotics planning research
• Need to solve planning & presentation simultaneously for best result
Design Principles for Illustrations

• hierarchy/grouping of parts
• hierarchy of operations
• step by step instructions vs. single diagram
• only 1 significant piece at a time
• structural vs. action diagrams
• present as much information as possible
  – don't repeat, don't be tedious
• orientation, natural & preferred views
  – maximize # of important features visible
  – minimize accidental alignments
• visibility
  – occlusion ok when symmetry is clear
  – earlier parts visible for context
Input/Output/Automated/User-Driven

• Input:
  – geometry, orientation, grouping, ordering constraints
• Automatic:
  – location translational blocking, visibility
  – at each step, “planner” chooses to attach a part or reorient diagram
  – optimization for visibility
  – direction (maximally separate, interference free) & separation distance
  – diagrammatic elements, guidelines (based on bounding box or contact)
• Semi-automated user-driven/interactive editing
  – add grouping
  – add constraints
• Not automatic (yet):
  – structure
  – zoom in/use insets to show small details, e.g., subassemblies
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“Interactive Cutaway Illustrations of Complex 3D Models”, Wilmot Li, Lincoln Ritter, Maneesh Agrawala, Brian Curless, David Salesin, SIGGRAPH 2007
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Reading for Tuesday (*pick one*)

- "Interactive Visualization on Large and Small Displays: The Interrelation of Display Size, Information Space, and Scale", Jakobsen and Hornbaek, IEEE Visualization 2013
“Immersive Collaborative Analysis of Network Connectivity: CAVE-style or Head-Mounted Display?”, Cordeil, Dwyer, Klein, Laha, Marriott, Thomas, IEEE InfoVis 2016
Reading for Tuesday *(pick one)*