Animation

Maneesh Agrawala

CS 294-10: Visualization
Spring 2010

Final project

Design new visualization method
- Pose problem, Implement creative solution

Deliverables
- Implementation of solution
- 8-12 page paper in format of conference paper submission
- 2 design discussion presentations

Schedule
- Project proposal: 3/29
- Initial problem presentation: 3/31 (Wed)
- Final presentation: In class 5/3 and 5/5
- Final paper: Friday 5/7

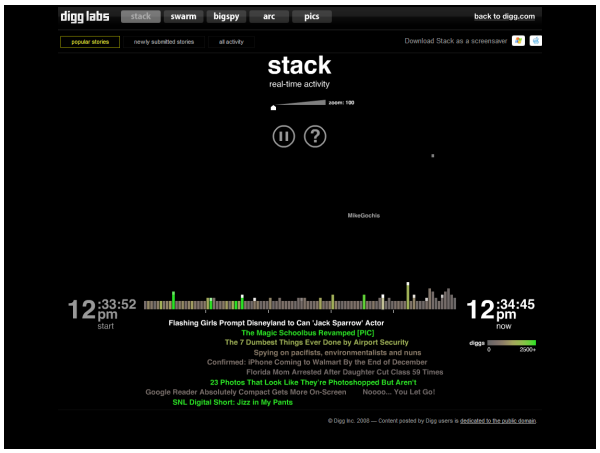
Grading
- Groups of up to 3 people, graded individually
- Clearly report responsibilities of each member

Animation

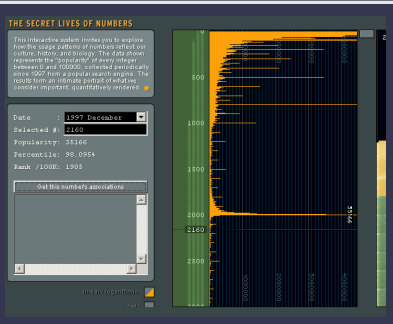
Question

The goal of visualization is to convey information

How does *animation* help convey information?

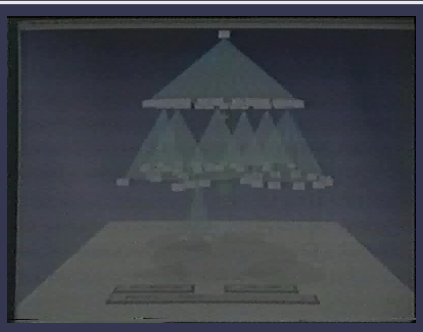


The secret lives of numbers [Levin 02]

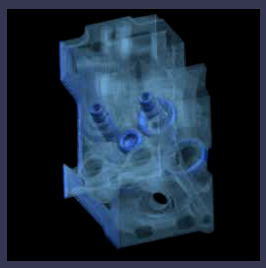


http://www.turbulence.org/Works/nums/applet.html

Cone Trees [Robertson 91]

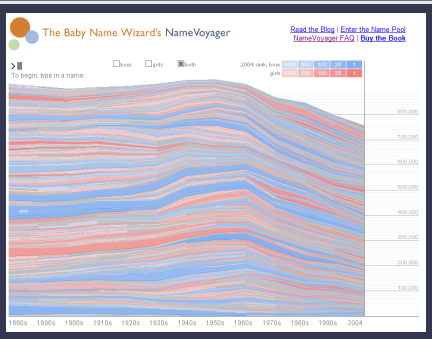


Volume rendering [Lacroute 95]



Video

NameVoyager [Wattenberg 04]



http://www.babynamewizard.com/namevoyager/lnv0105.html

Topics

Understanding motion
Interpreting animation
Design principles for animation

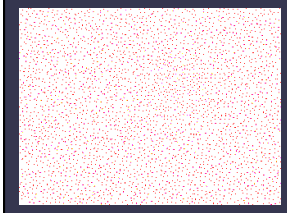
Understanding Motion

Motion as a visual cue

Pre-attentive
- Stronger than color, shape, …

More sensitive to motion at periphery
Triggers an orientation response
Motion parallax provide 3D cue (like stereopsis)

Segment by common motion (fate)



http://dragon.uml.edu/psych/commfate.html

http://www.singlecell.org/july/index.html

Tracking multiple targets

How many dots can we simultaneously track?

[Yantis 92, Pylyshn 88, Cavanagh 05]

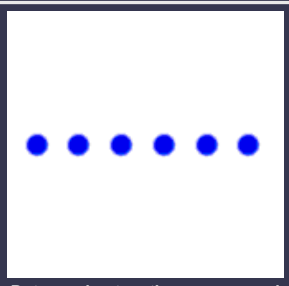
Tracking multiple targets

How many dots can we simultaneously track?

- 4 to 6 - difficulty increases significantly at 6

[Yantis 92, Pylyshn 88, Cavanagh 05]

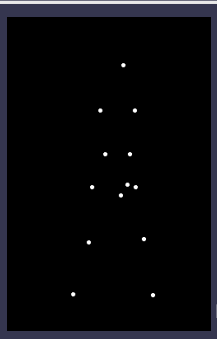
Grouped dots count as 1 object



Dots moving together are grouped

http://coe.sdsu.edu/eet/articles/visualperc1/start.htm

Grouping based on biological motion



[Johansson 73]

http://www.lifesci.sussex.ac.uk/home/George_Mather/Motion/

Motions directly show transitions

Can see change from one state to next

- States are spatial layouts
- Changes are simple transitions (mostly translations)

start

Motions directly show transitions

Can see change from one state to next

- States are spatial layouts
- Changes are simple transitions (translation, rotation, scale)

end

Motions directly show transitions

Can see change from one state to next

- States are spatial layouts
- Changes are simple transitions (translation, rotation, scale)

start end

Shows transition better, but

- Still may be too fast, or too slow
- Too many objects may move at once

Show motion path in static image

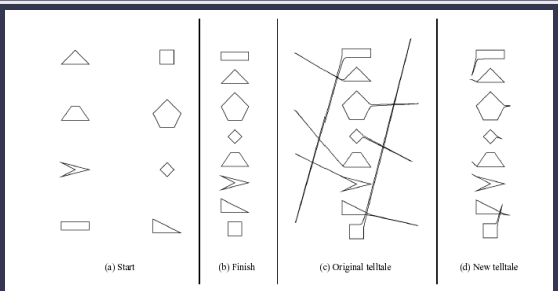
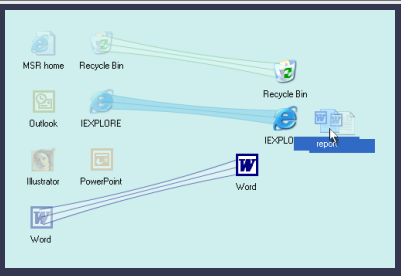


Figure 4. Example of the starting and finishing configurations for an alignment operation

Evaluation of Animation Effects to Improve Indirect Manipulation [Thomas 00]

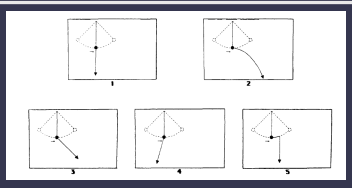
Drag-n-pop [Baudisch 03]



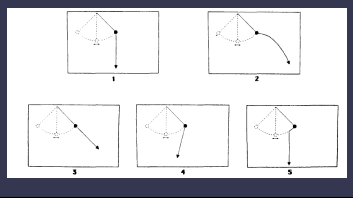
Relevant applications jump to file you are dragging with paths drawn as stretched bands (meant for large screen displays)

What about other transformations (rotation / scale)?

Intuitive physics [Kaiser 92]

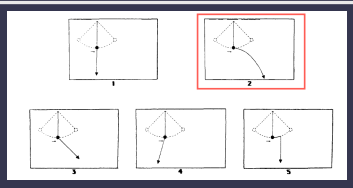


What is motion if string cut at *nadir* of motion?

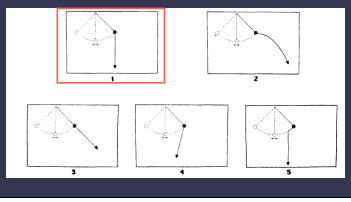


What is motion if string cut at *apex* of motion?

Intuitive physics [Kaiser 92]

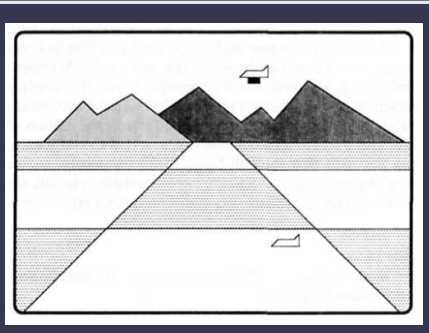


What is motion if string cut at *nadir* of motion?



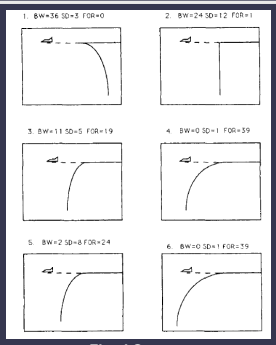
What is motion if string cut at *apex* of motion?

Intuitive physics [Kaiser 92]

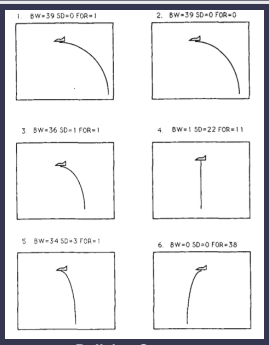


Airplane animations with 2 conditions, 1) fixed camera and 2) dollying camera

Intuitive physics [Kaiser 92]



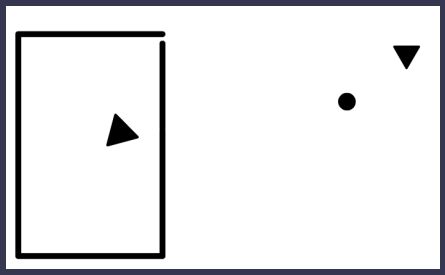
Fixed Camera



Dollying Camera

Interpreting Animation

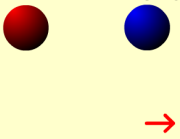
Constructing narratives



http://anthropomorphism.org/img/Heider_Flash.swf

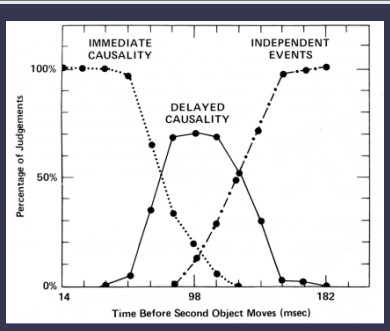
Attribution of causality [Michotte 46]

Michotte demonstration 1. What do you see? Most observers report that "the red ball **hit** the blue ball." The blue ball moved "**because** the red ball hit it." Thus, the red ball is perceived to **"cause"** the blue ball to move, even though the balls are nothing more than color disks on your screen that move according to a programme.



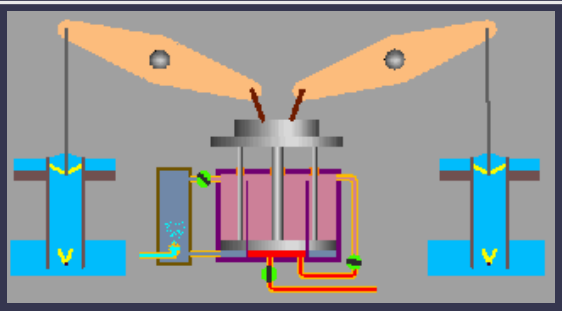
http://cogweb.ucla.edu/Discourse/Narrative/Heider_45.html

Attribution of causality [Michotte 46]

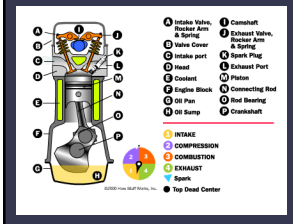


[Reprint from Ware 04]

How does it work?



Four-stroke combustion cycle



Q1: How many times does the piston go up and down per spark-plug firing?

Q2: What side does the fuel come in? What side does it exit?

Q2: How is the timing of the two valves coordinated?

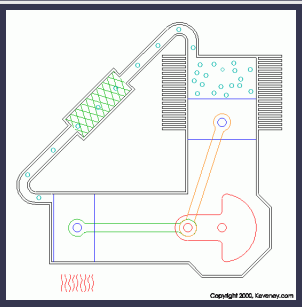
http://auto.howstuffworks.com/engine1.htm

Problems [Tversky 02]

Difficulties in understanding animation

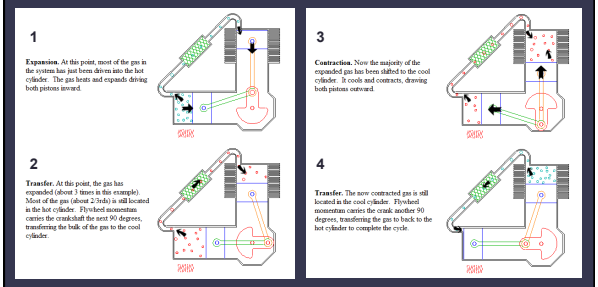
- Difficult to estimate paths and trajectories
- Motion is fleeting and transient
- Cannot simultaneously attend to multiple motions
- Trying to parse motion into events, actions and behaviors
- Misunderstanding and wrongly inferring causality
- Anthropomorphizing physical motion may cause confusion or lead to incorrect conclusions

Solution I: Break into static steps



Two-cylinder Stirling engine
http://www.keveney.com/Vstirling.html

Solution I: Break into static steps



Two-cylinder Stirling engine
http://www.keveney.com/Vstirling.html

Challenges

Choosing the set of steps

- How to segment process into steps?
- Note: Steps often shown sequentially for clarity, rather than showing everything simultaneously

Tversky suggests

- Coarse level – segment based on objects
- Finer level – segment based on actions
  - Static depictions often do not show finer level segmentation

Design Principles for Animation

Disney's traditional principles [Lasseter 87]

1. Squash and stretch
2. Anticipation
3. Staging
4. Straight-ahead vs. Post-to-pose
5. Follow through and overlapping action
6. Slow-in and slow-out
7. Arcs
8. Secondary action
9. Timing
10. Exaggeration
11. Solid drawing
12. Appeal

Squash and stretch

Defines rigidity of material

Should maintain constant volume

Smoothes fast motion – similar to motion blur

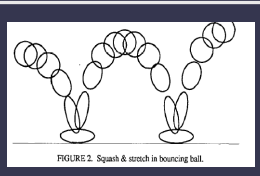
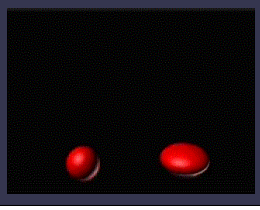


FIGURE 2. Squash & stretch in bouncing ball.



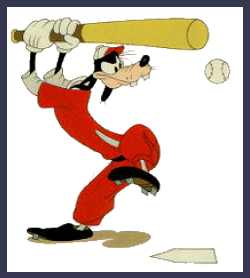
Staging

Clear presentation of one idea at a time

- Highlight important actions
  - Lead viewers' eyes to the action
  - Motion in still scene, stillness in busy scene
  - Motion clearest at silhouette

Anticipation

Show preparation for an action



Follow-through

Emphasize termination of action

Overlapping action

Start 2nd action before 1st has completed

Luxo Jr's hop and cord moves at the same time

Slow-in and slow-out

Space in-betweens to provide slow-in and out

Linear interpolation is less pleasing

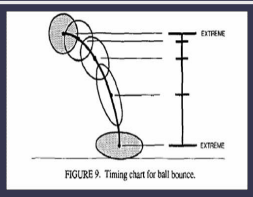
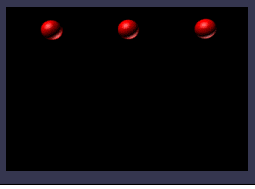
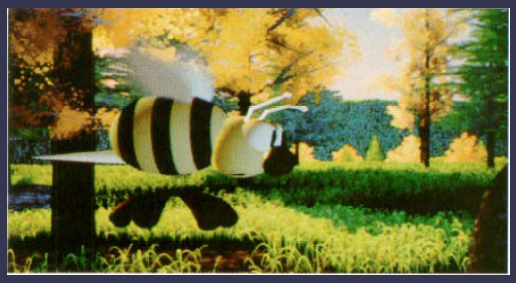


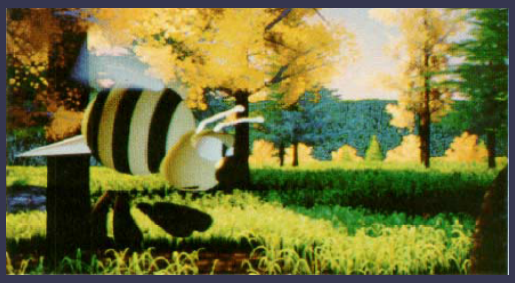
FIGURE 9. Timing chart for ball bounce.



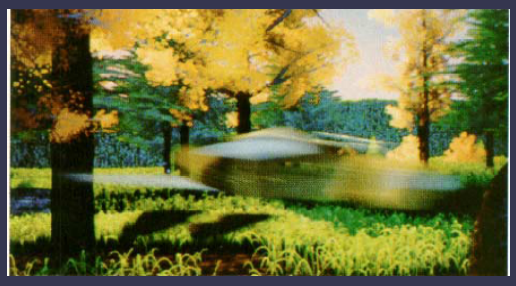
Example: Andre and Wally B.



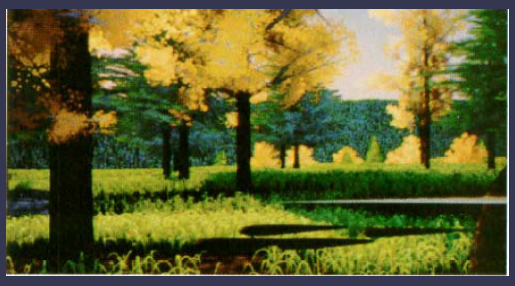
Example: Andre and Wally B.



Example: Andre and Wally B.



Example: Andre and Wally B.



Principles for conveying information

Congruence:

The structure and content of the external representation should correspond to the desired structure and content of the internal representation.

Apprehension:

The structure and content of the external representation should be readily and accurately perceived and comprehended.

[from Tversky 02]

Principles for animated presentations

Slithy – system for creating animated presentations [Zongker 03]

Make all movement meaningful (??)
- Avoid cartoony squash and stretch, exaggeration, etc.
- Highlight important things in simple ways

Avoid instantaneous changes
- Allow users to see tranformations from one state to another

Reinforce hierarchical structure with transitions
- Subtler transition for small change of ideas, less subtle for big changes

Create a large virtual canvas (??)

Smoothly expand and compress detail
- Provide a zooming, focus+context view

Manage complexity through overlays (??)
- Bring in detail as required (think of detail as being layered in)

Do one thing at a time

Reinforce animation with narration (present same idea visually and orally)

Distinguish dynamics (content) from transitions (connections)

On Creating Animated Presentations

Doug Zongker
David Salesin

University of Washington
Microsoft Research

Summary

Animations convey motion, action, story, process

Problems
- Divided attention
- Transient
- Character animation different than explanatory animation

Techniques
- Aid segmentation into events, actions, sequences, story
- Relies on our ability to fill in temporal gaps (closure)
- More research required on principles for creating effective animated visualizations