Interpreting and Designing Animation

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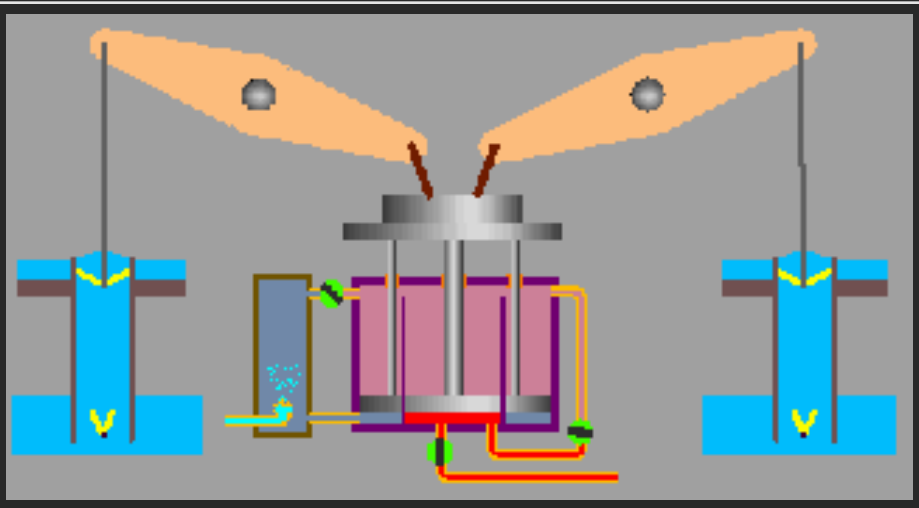
Goals for animation use

The goal of visualization is to convey information

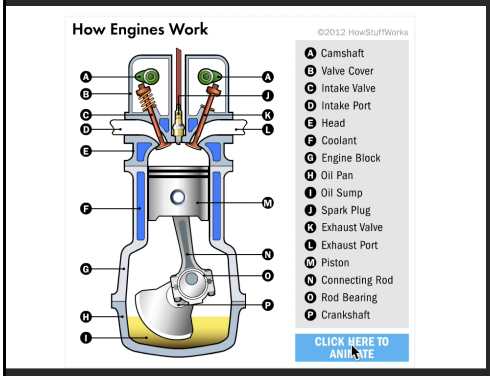
How does *animation* help convey information?

- Explain a process
- Smooth a transition between states

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?

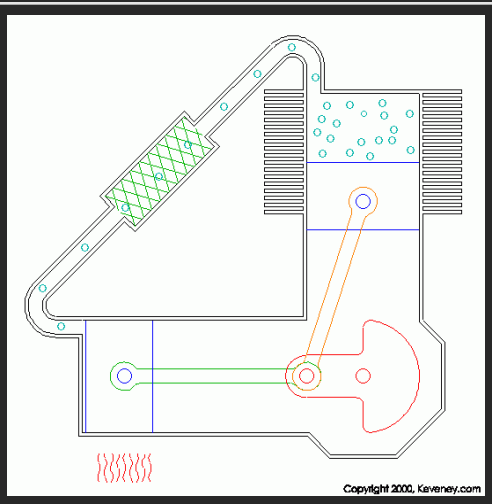
http://auto.howstuffworks.com/engine1.htm

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

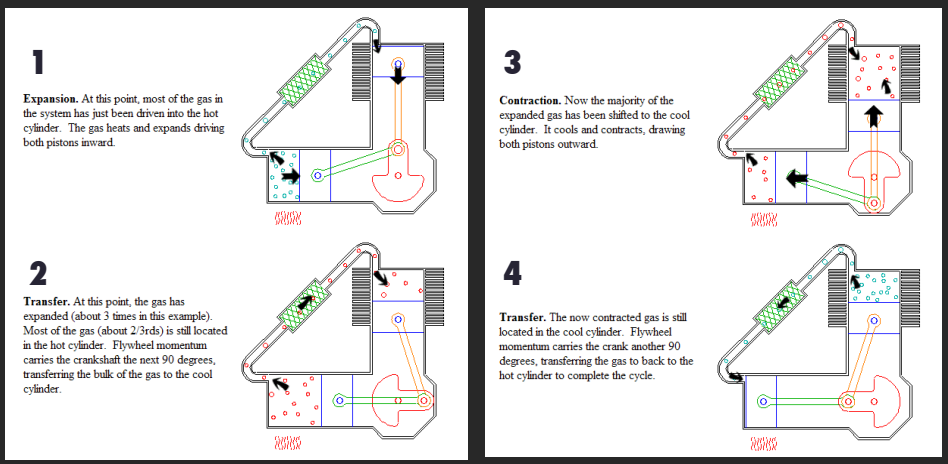
Solution I: Break into static steps



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

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

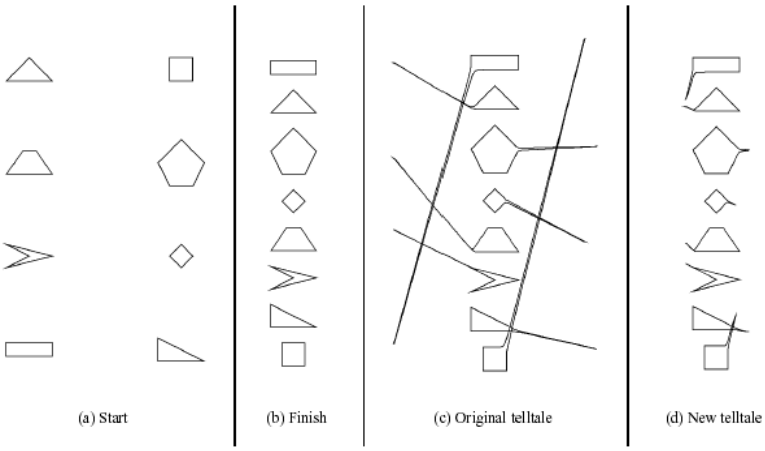


Figure 4. Example of the starting and finishing configurations for an alignment operation

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

Design Principles for Animation

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 Animation

Congruence

- Maintain valid data graphics during transitions
- Use consistent syntactic/semantic mappings
- Respect semantic correspondence
- Avoid ambiguity

Apprehension

- Group similar transitions
- Minimize occlusion
- Maximize predictability
- Use simple transitions
- Use staging for complex transitions
- Make transitions as long as needed, but no longer
- Introduce interactivity to help user avoid difficulties

Animated Transitions in Statistical Data Graphics

Jeffrey Heer
George G. Robertson

Microsoft Research

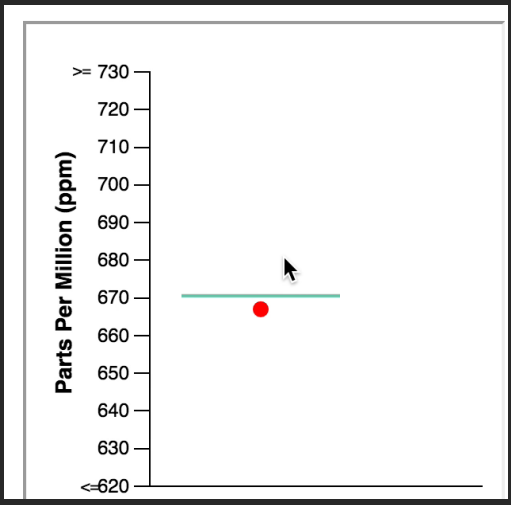
Animated Graph Transition

Animated Exploration of Graphs with Radial Layout
IEEE InfoVis 2001

Ka-Ping Yee
Rachna Dhamija
Danyel Fisher
Marti Hearst

University of California, Berkeley

Animation of Uncertainty



Summary

Animations convey motion, action, story, process

- Can be useful for helping user maintain mental model across changing states of display
- 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

Problems

- Divided attention
- Transient