Animation Principles

CSE 457, Autumn 2003

Graphics

http://www.cs.washington.edu/education/courses/457/03au/

Readings and References

- Readings
  - » Principles of traditional animation applied to 3D computer animation. John Lasseter. Proceedings of SIGGRAPH (Computer Graphics) 21(4): 35-44, July 1987.
  - » Tricks to animating characters with a computer, Siggraph 94, Course 1, Animation Tricks. John Lasseter.
- Reference
  - » Frank Thomas and Ollie Johnston, Disney animation: The Illusion of Life, Hyperion, 1981.

It's all (simulated) smoke and mirrors

"Traditional animation is basically one trick after another. Whatever it takes to get it working right on the screen is fair game. It should be the same in computer animation."

John Lasseter

Animation Objectives

- Expressiveness
  - » Artistic expression
  - » Extremely hard to automate
- Realism
  - » Hard to do by hand
  - » Easier to automate, but we lose control

Character Animation

- Make characters move in convincing way to communicate personality and mood
  - » Walt Disney developed a number of principles
  - » Computer graphics animators have adapted them to 3D animation

Animation principles

Squash and stretch
Staging
Timing
Anticipation
Follow through
Overlapping action
Secondary action
Arcs
Straight-ahead vs. pose-to-pose vs. blocking
Slow in, slow out
Exaggeration
Appeal
Weight

Squash and stretch

Squash: flatten an object or character by pressure or by its own power

Stretch: used to increase the sense of speed and emphasize the squash by contrast

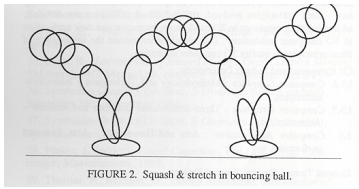


FIGURE 2. Squash & stretch in bouncing ball.

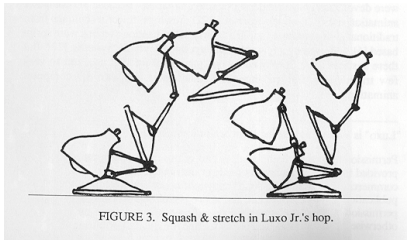
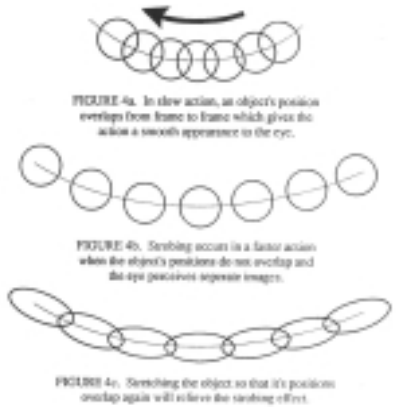


FIGURE 3. Squash & stretch in Luxo Jr.'s hop.

Note: keep volume constant

Squash and stretch (cont'd)



Squash and stretch (cont'd)

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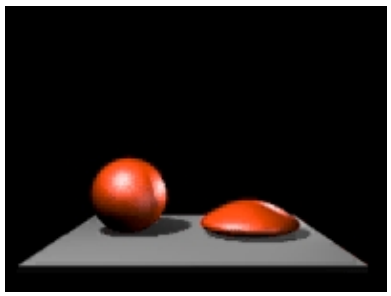
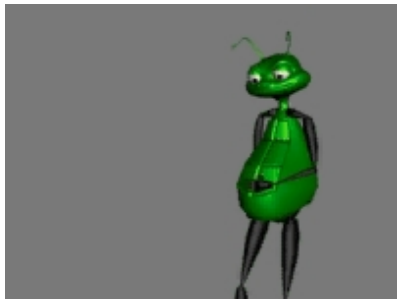
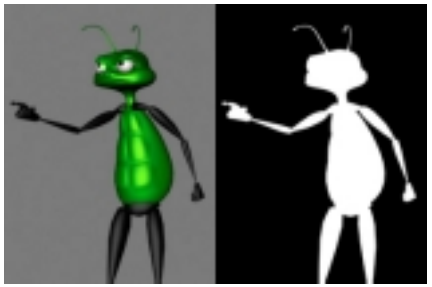
Squash & stretch

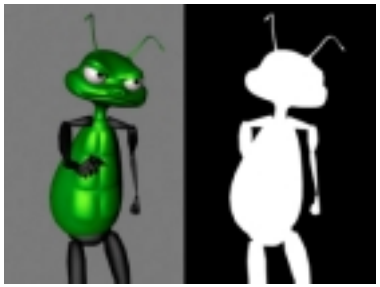




Staging

- Present the idea so it is unmistakably clear
- Audience can only see one thing at a time
- Useful guide: stage actions in silhouette
- In dialogue, character faces ¾ towards the camera, not right at each other





Timing

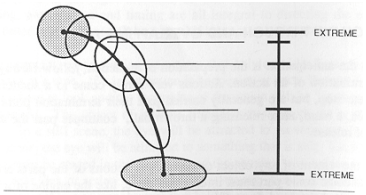


FIGURE 9. Timing chart for ball bounce.

Timing affects weight:

- Light objects move quickly
- Heavier objects move more slowly

Timing can completely change the meaning of an action

Timing (cont'd)

The many meanings of a simple head turn:

NO inbetweens	hit by a tremendous force.
ONE inbetween	hit by a brick, frying pan.
TWO inbetweens	nervous tic, muscle spasm.
THREE inbetweens	dodging a thrown brick.
FOUR inbetweens	giving a crisp order (move it!)
FIVE inbetweens	a more friendly order (c`mon!)
SIX inbetweens	sees a sportscar he always wanted
SEVEN inbetweens	trying to get a better look...
EIGHT inbetweens	searching for something on shelf
NINE inbetweens	considering thoughtfully
TEN inbetweens	stretching a sore muscle

Timing examples



Anticipation

An action has three parts:

- Anticipation
- Action
- Reaction

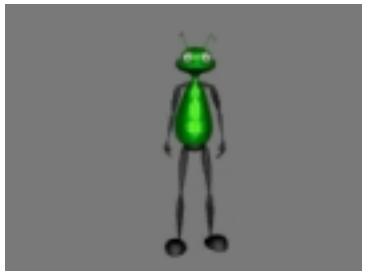
Anatomical motivation: a muscle must extend before it can contract

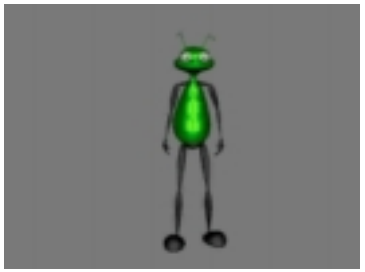
Prepares audience for action so they know what to expect

Directs audience's attention

Amount of anticipation can affect perception of speed and weight

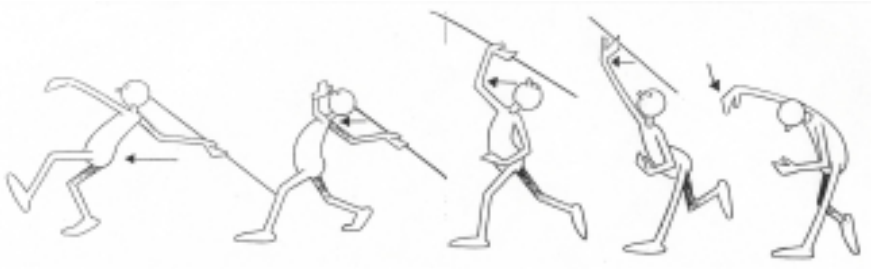
Anticipation



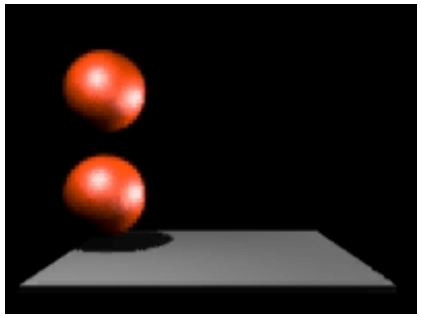


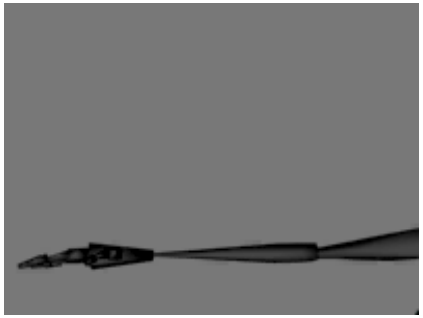
Follow through

- Action seldom come to an abrupt stop
- Physical motivation: inertia



Follow through





Overlapping and secondary action

Overlapping Action

One part initiates (leads) the move. Others follow in turn.

- » Hip leads legs, but eyes often lead the head.
- » Loose parts move slower and drag behind.

Overlaps apply to intentions. Example: settling into the house at night

- » Close the door
- » Lock the door
- » Take off the coat

Each action doesn't come to a complete finish before the next starts

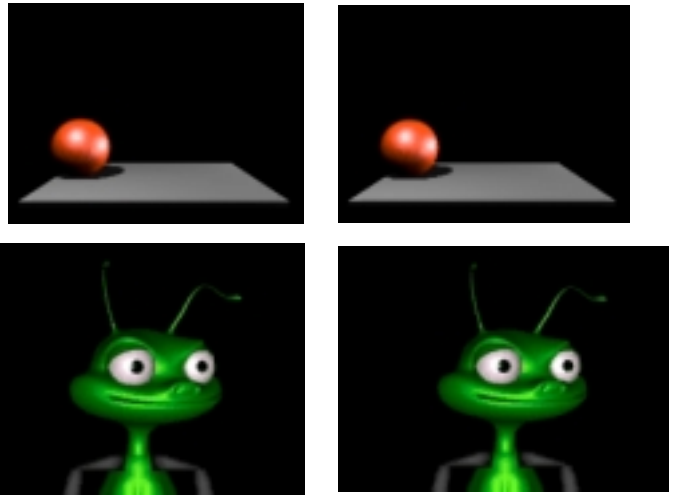
Secondary action

An action that emphasizes the main point, but is secondary to it.

Overlapping and secondary action

Arcs

Avoid straight lines since most things in nature move along curves



Action planning

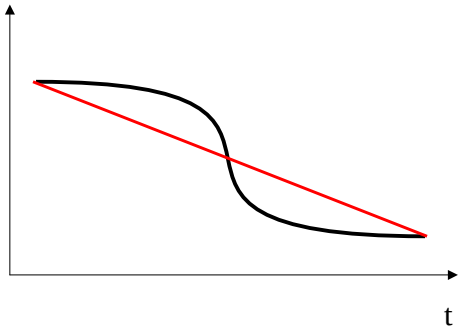
- Straight ahead: proceed from frame to frame without planning where you want to be in ten frames. Can be wild, spontaneous.
- Pose-to-pose: Define key frames and “inbetweens”.
- Blocking: computer graphics animators adaptation:
  - » Start key–framing at the top of the hierarchy
  - » Refine level by level
  - » Key frames for different parts need not happen at the same time.

The plan

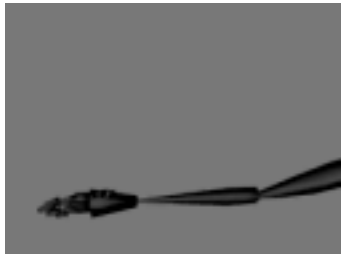
The result

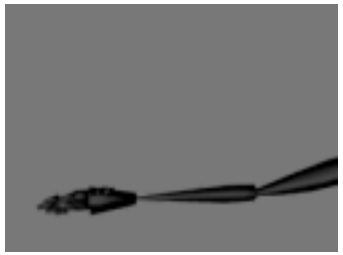
Slow in, slow out

- An extreme pose can be emphasized by slowing down as you get to it (and as you leave it)



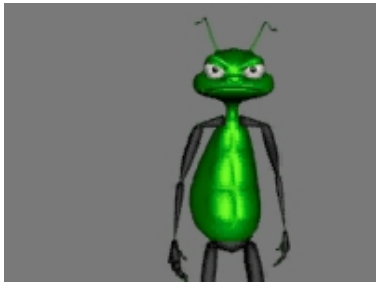
Slow in, slow out examples

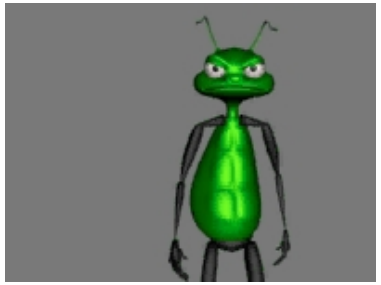




Exaggeration

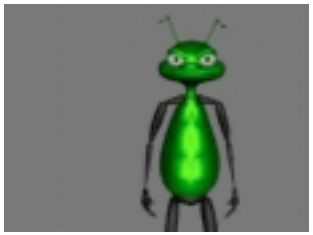
Get to the heart of the idea and emphasize it so the audience can see it.





Appeal

The character must interest the viewer.
It doesn't have to be cute and cuddly
Design, simplicity, behavior all affect appeal.
Note: avoid perfect symmetries



Appeal

Design, simplicity, behavior all affect appeal.
Example: Luxo, Jr. is made to appear childlike.

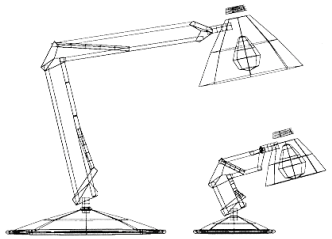


FIGURE 11. Varying the scale of different parts of Dad created the child-like proportions of Luxo Jr.

Weight

Combination of Timing, Slow in/out, Arcs, Anticipation, Exaggeration, Squash&Stretch, Secondary motion, FollowThru/Overlap,and Staging

Frontiers: faces

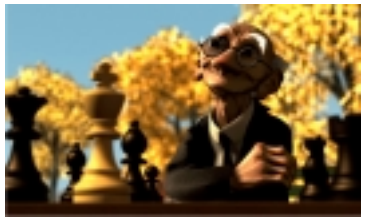
- Making realistic human facial animations is really hard
- Modeling the shape of a face
  - » free form CAD design
  - » photographs, laser scanner (0.5mm resolution)
- Designing the right set of controls
  - » Muscle groups
  - » Blending example expressions
  - » spline control points
- Future input device: performance driven facial animation
  - » animator makes faces
  - » video camera watches
  - » computer processes in real time
  - » character's face comes to life
  - » animators are actors!!

Geometric modeling and instrumentation

Building characters with the right shape and control points is time consuming..

Want the "right" set of controls

- » Control points
- » Muscle groups
- » Blending example expressions
- » "Instrumentation" controls

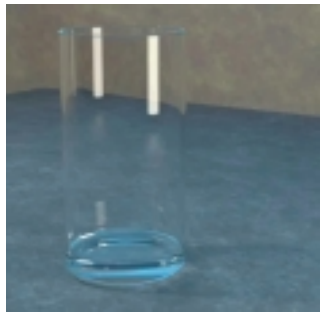


Physical simulation

Some effects are too difficult to model by hand (fire, snow, steam, rustling trees, hair, cloth, etc.)

Can do simulation (both physical and non-physical)

- » Particle systems
- » Fluid flow and turbulence modeling
- » Rigid body dynamics
- » …



Physical simulation (cont'd)

Frontiers: controllable simulation

- The main problem: animator and director want to have some interactive control.
- Example: I want this object to land here …
  - » How do you merge this with the physical simulation?

Controllable simulation

Frontiers: motion capture

- Making a realistic human body motion is hard
- Approaches
  - » Computer vision using raw video footage
    - not accurate enough
  - » Special sensors that give joint angles and/or positions
    - wires get in the way

- Cover person with white or retroreflective targets like ping pong balls
  - » Have to handle occlusions