Animation Principles

CSE 457, Autumn 2003
Graphics

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

• Readings
  » Tricks to animating characters with a computer, Siggraph 94, Course 1, Animation Tricks. John Lasseter.

• Reference
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
Arches
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

Note: keep volume constant
Squash and stretch (cont’d)

FIGURE 4a. In slow action, an object's position overlaps from frame to frame which gives the action a smooth appearance to the eye.

FIGURE 4b. Strobing occurs in a faster action when the object's positions do not overlap and the eye perceives separate images.

FIGURE 4c. Stretching the object so that its positions overlap again will relieve the strobing effect.
Squash and stretch (cont’d)

The famous half-filled flour sack guide to maintaining volume in any animatable shape, and proof that attitudes can be achieved with the simplest of shapes.
Squash and stretch (cont’d)

1928 — Oswald shows determination by lifting his chest with one hand in front and one in back. While the gesture is easily recognizable, it is little more than a diagram of the action.

ANIMATOR: Norm Ferguson
—Shanghaied

1934 — Peg Leg Pete does the same gesture, only now there is more belly than chest involved. This broader action gave the impression of a round solid character with a combination of life and spirit— and fat.

ANIMATOR: Jack Campbell
—The Riveter.

1940 — The gesture has been done so often by this time that it is almost a gag in itself. An action this broad loses realism, but gains a type of comedy.
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 $\frac{3}{4}$ towards the camera, not right at each other
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
**Ares**

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!!
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

Geometric modeling and instrumentation
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