11.1 Animation Principles

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1

Example

Rango: Character Walking Tests

Computer Animation

- Models have parameters:
  - polygon positions,
  - normals,
  - spline control points,
  - joint angles,
  - camera parameters,
  - lights,
  - color, etc.

- n parameters define an n-dimensional state space

- Values of n parameters = point in state space

Computer Animation

- Animation defined by path through state space

- To produce animation:
  1. start at beginning of state space path
  2. set the parameters of your model
  3. render the image
  4. move to next point along state space path,
  5. Goto 2.

- Path usually defined by a set of motion curves (one for each parameter)

- Animation = specifying state space trajectory

Additional Reading
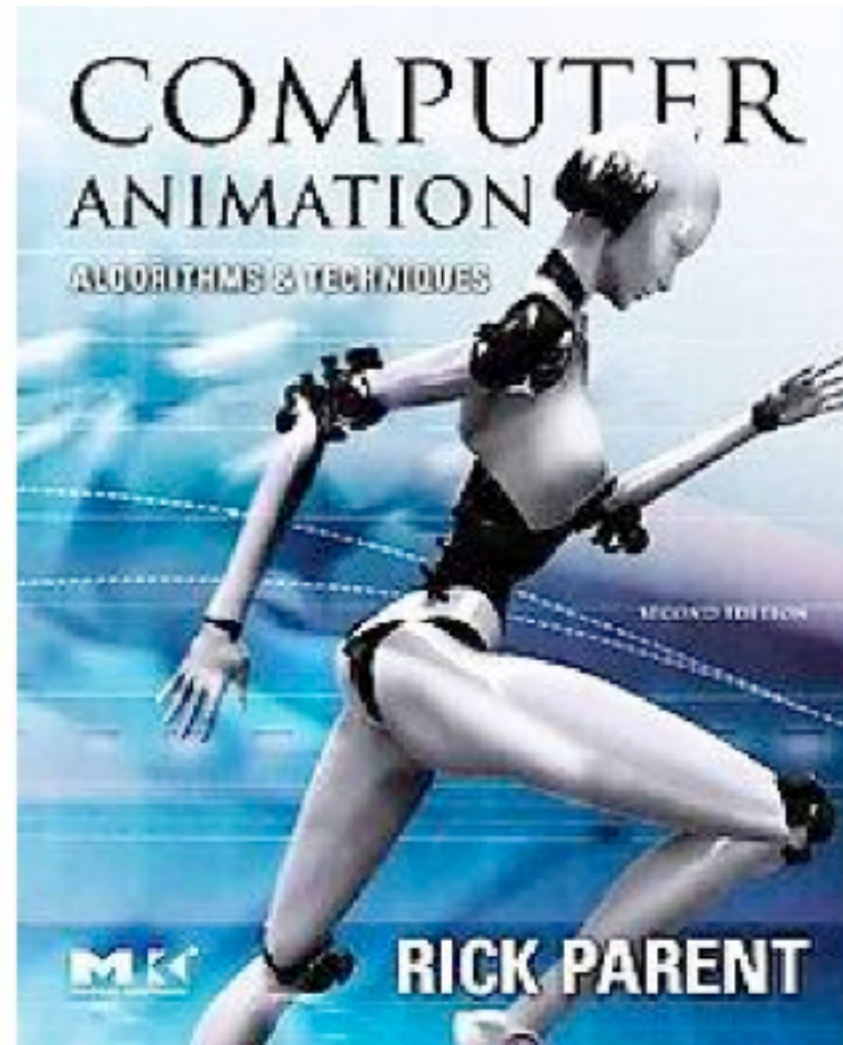
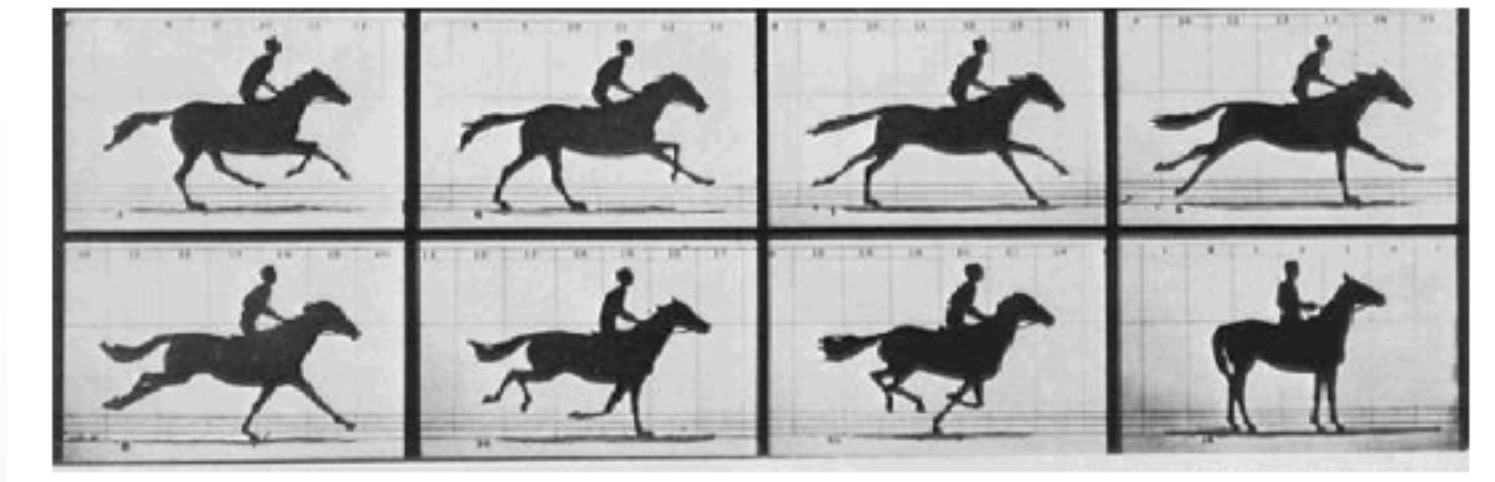R. Parent: Computer Animation, Morgan Kaufmann, 2008

Animation

"Bring things to life."

Sequence of images that give perception of movement when played in rapid succession

- Film: 24 fps, explorations in high frame-rate movies (48/60 fps)

- Video: 30 fps

~130K images for a 90 min movie

Traditional Animation

- Film runs at 24 frames per second (fps)
  - That's 1440 pictures to draw per minute
  - 1800 fpm for video (30fps)

- Productions issues:
  - Need to stay organized for efficiency and cost reasons
  - Need to render the frames systematically

- Artistic issues:
  - How to create the desired look and mood while conveying story?
  - Artistic vision has to be converted into a sequence of still frames
  - Not enough to get the stills right--must look right at full speed
    - Hard to "see" the motion given the stills
    - Hard to "see" the motion at the wrong frame rate
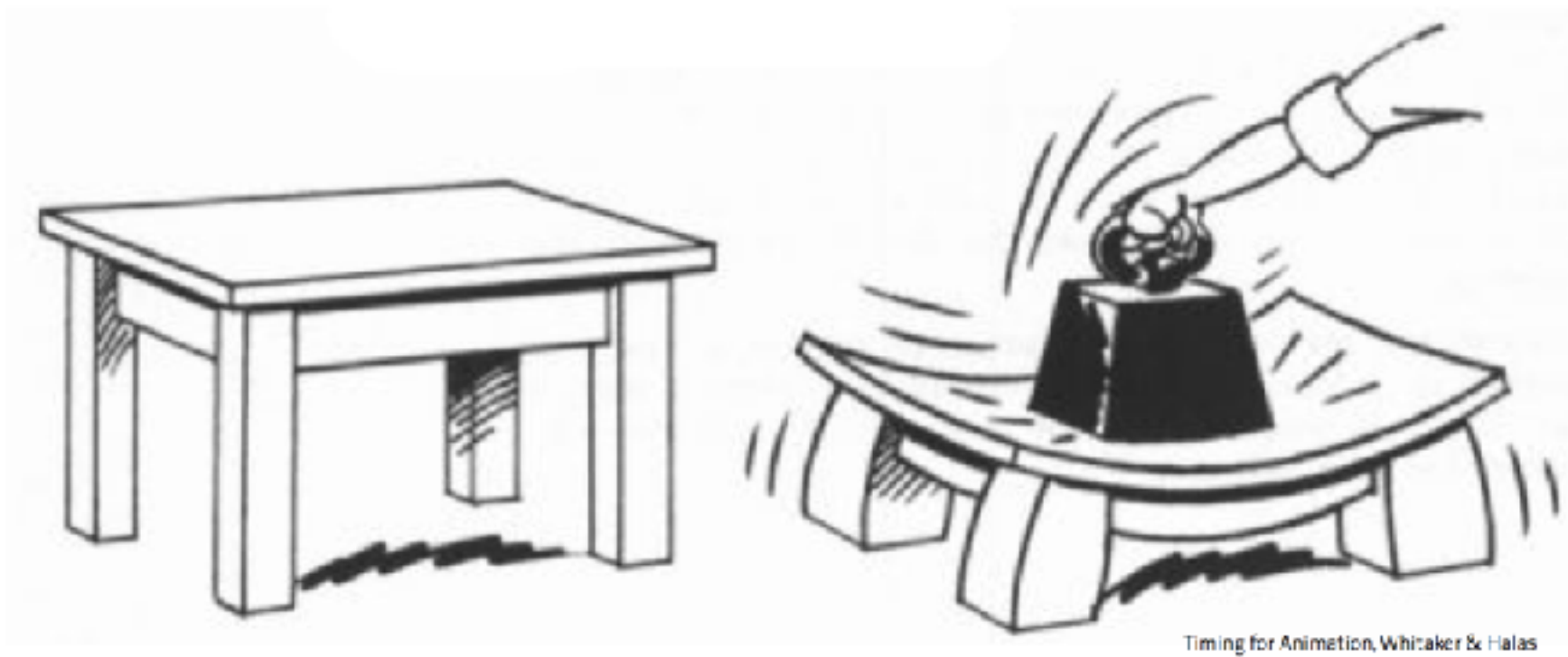
High Frame Rate Filming

Animation

"There is no particular mystery in animation... it's really very simple, and like anything that is simple, it is about the hardest thing in the world to do."
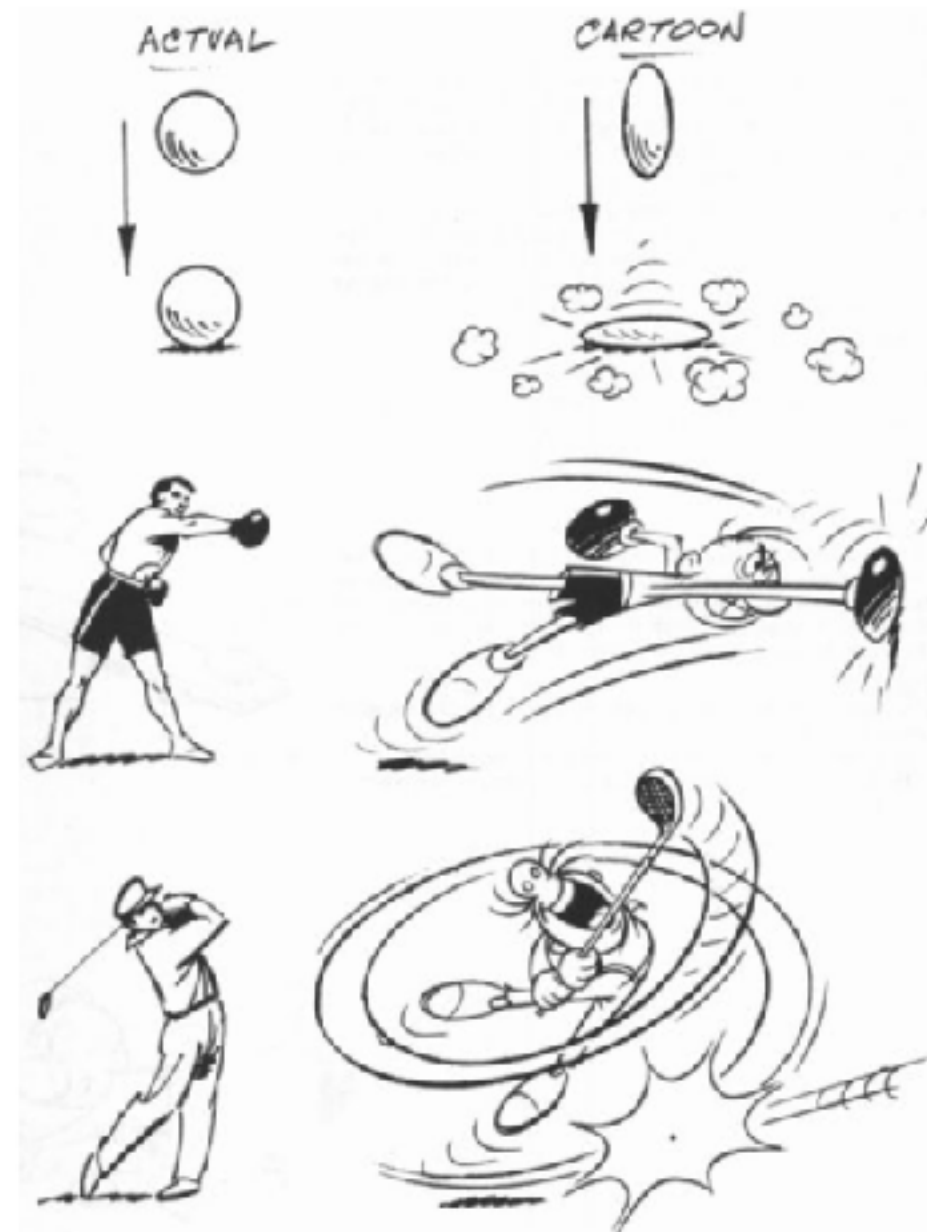
-Bill Tytla, Walt Disney Studio, 1937

Animation

- Animator must use movement to convey weight, size, scale, motion, humor…

Timing for Animation, Whitaker & Halas

Animation

Synthesize real movement of objects and add just the right amount of creative exaggeration.
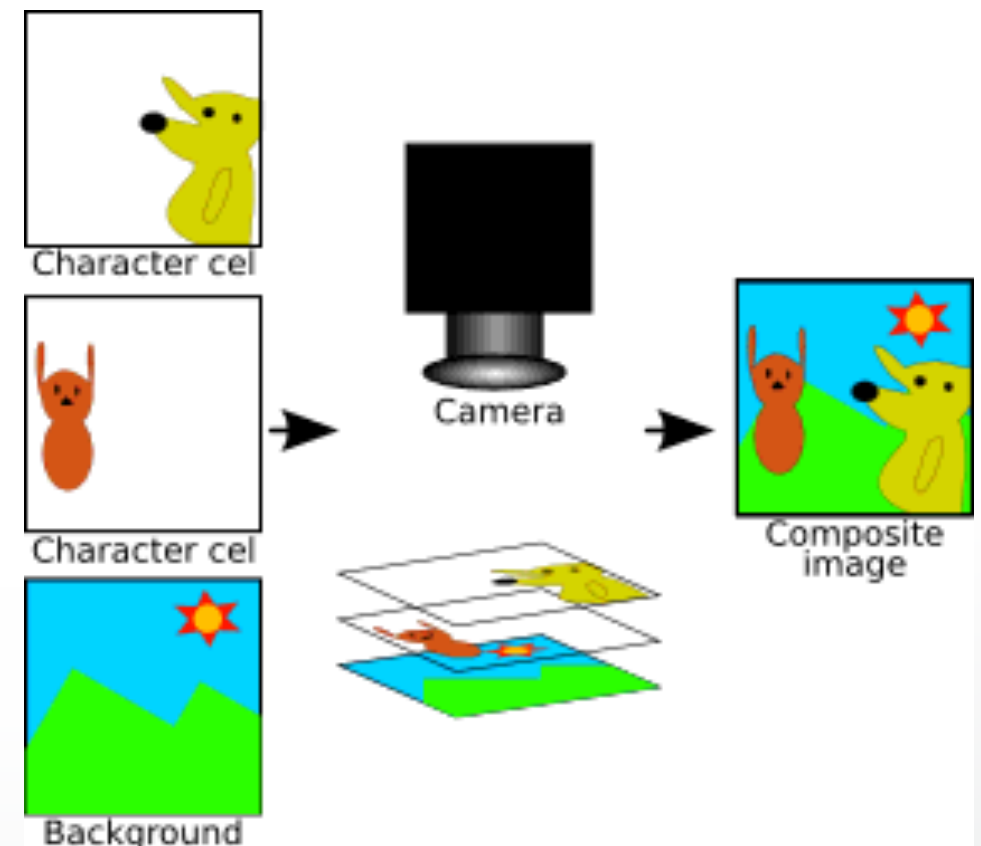
Animation

- Key frames
  - Important frames
  - Motion-based description
  - Example: beginning of stride, end of stride

- Inbetweens: draw remaining frames
  - Traditionally done by (low-paid) human animators

Layered Motion

- It's often useful to have multiple layers of animation
  - How to make an object move in front of a background?
  - Use one layer for background, one for object
  - Can have multiple animators working simultaneously on different layers, avoid re-drawing and flickering

- Transparent acetate allows multiple layers
  - Draw each separately
  - Stack them on a copy stand
  - Transfer onto film by taking a photograph of the stack

Character cel

Character cel

Background

Camera

Composite image

Geri's Game

Character Animation

- Bring characters to life!
- Make them act with personality and style to tell a story.

Character Animation
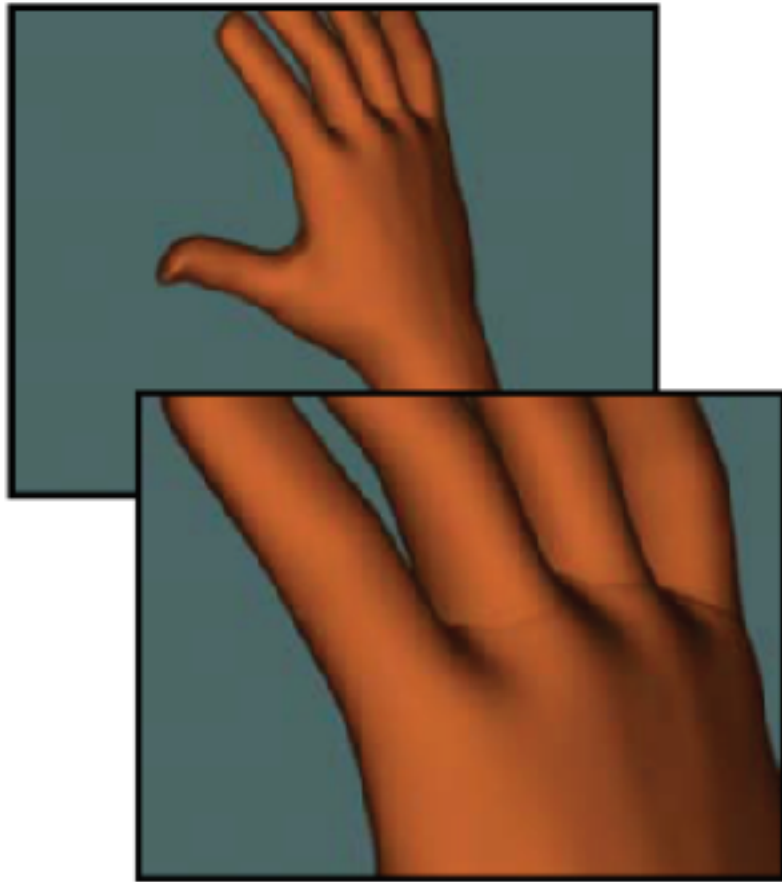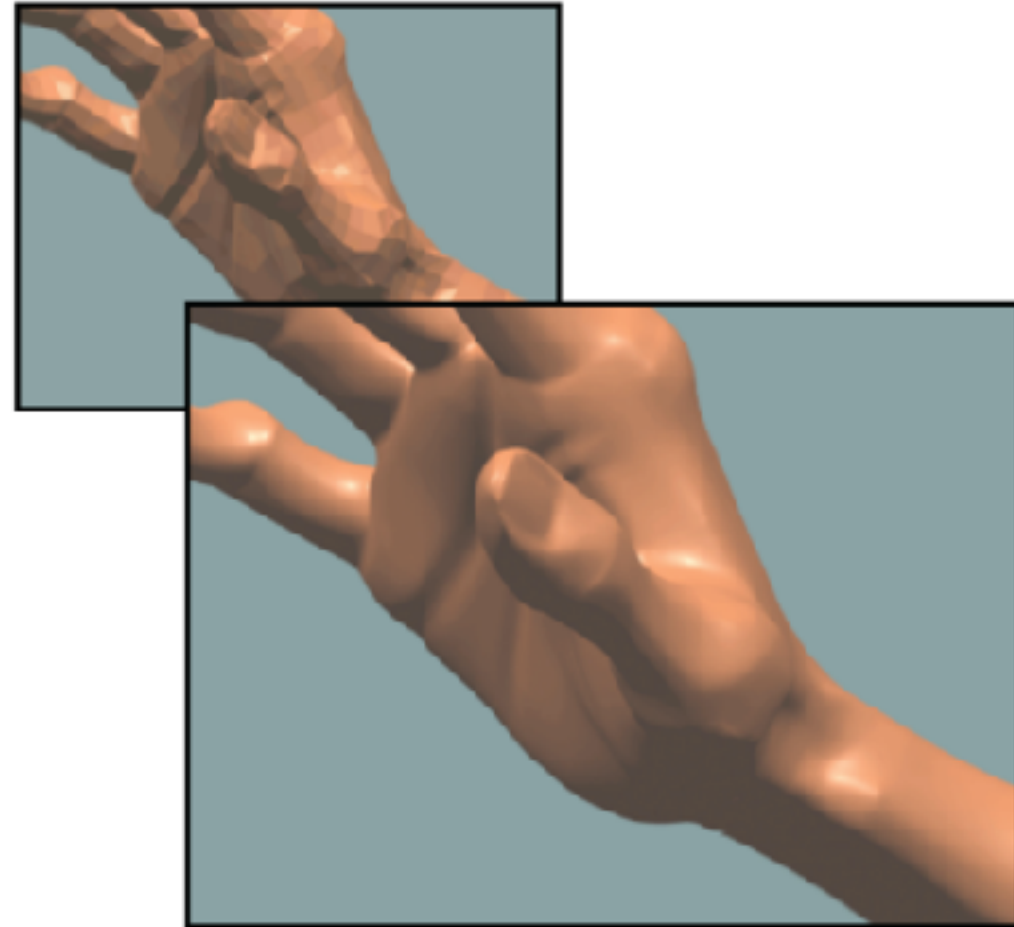
- Thinking character: all movement of a character result of its own cognition.
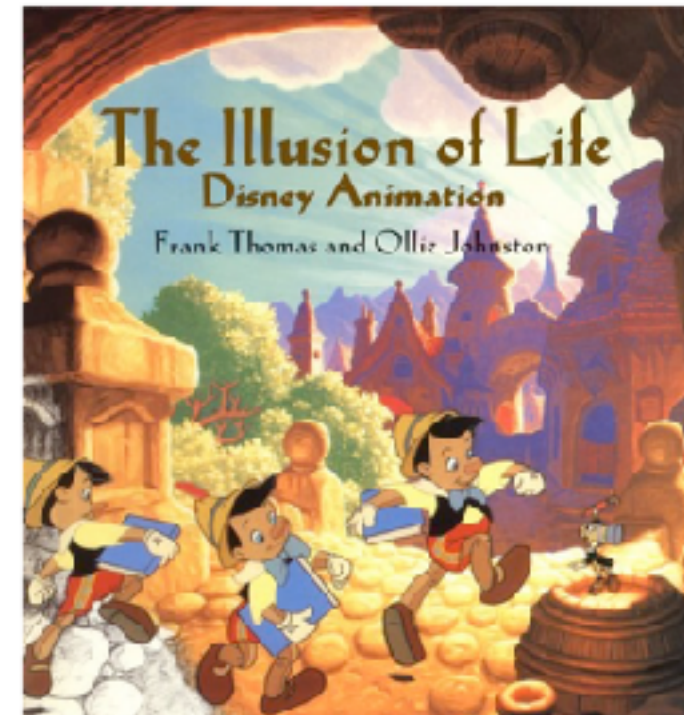
Woody's hand
Spline Surfaces

Geri's hand
Subdivision Surfaces

Animation Principles

- From
  - "Principles of Traditional Animation Applied to 3D Computer Animation" - John Lasseter, ACM Computer Graphics, 21(4), 1987

- In turn from
  - "The Illusion of Life"

- Same for 2D and 3D

Luxo Jr.

Squash and Stretch

- Refers to defining the rigidity and mass of an object by distorting its shape during an action.

- Shape of object changes during movement, but not its volume.
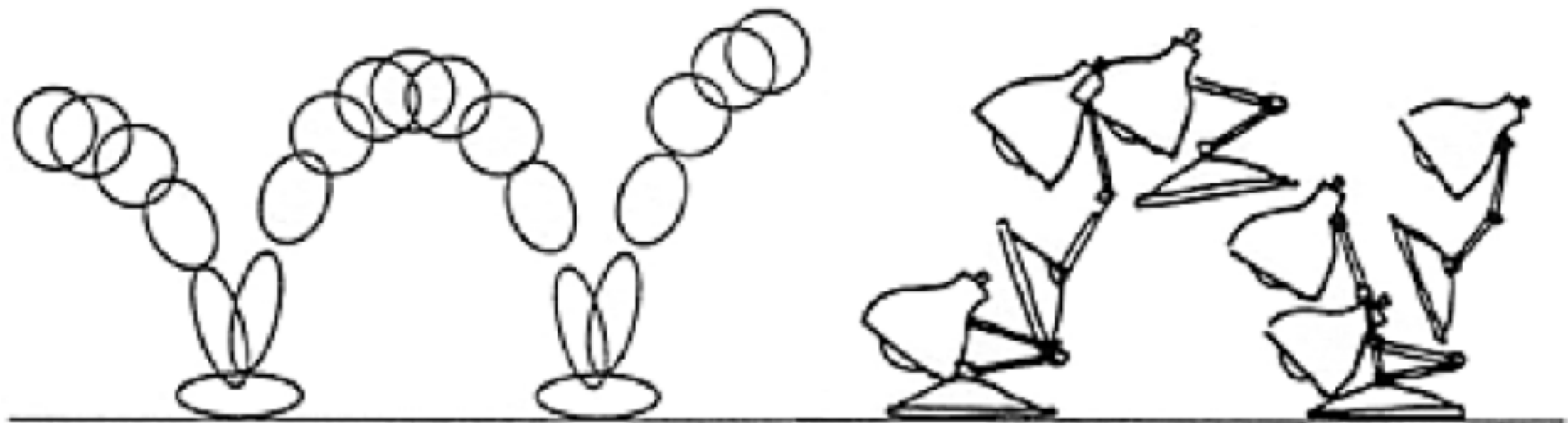
Squash and Stretch

• Used to alleviate strobing effect – in fast action, object's positions do not overlap, which is perceived by the eye.
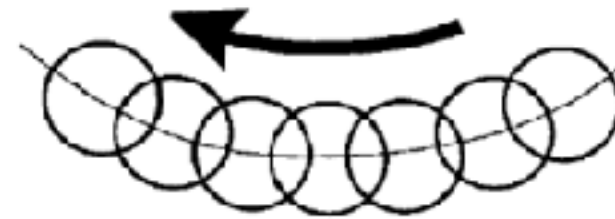

FIGURE 4a. In slow action, an object's position overlaps from frame to frame which gives the action a smooth appearance to the eye.

FIGURE 4b. Strobing occurs in a faster action when the object's positions do not overlap and the eye perceives seperate images.
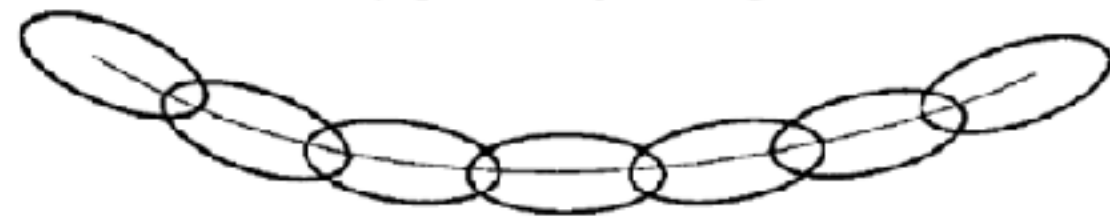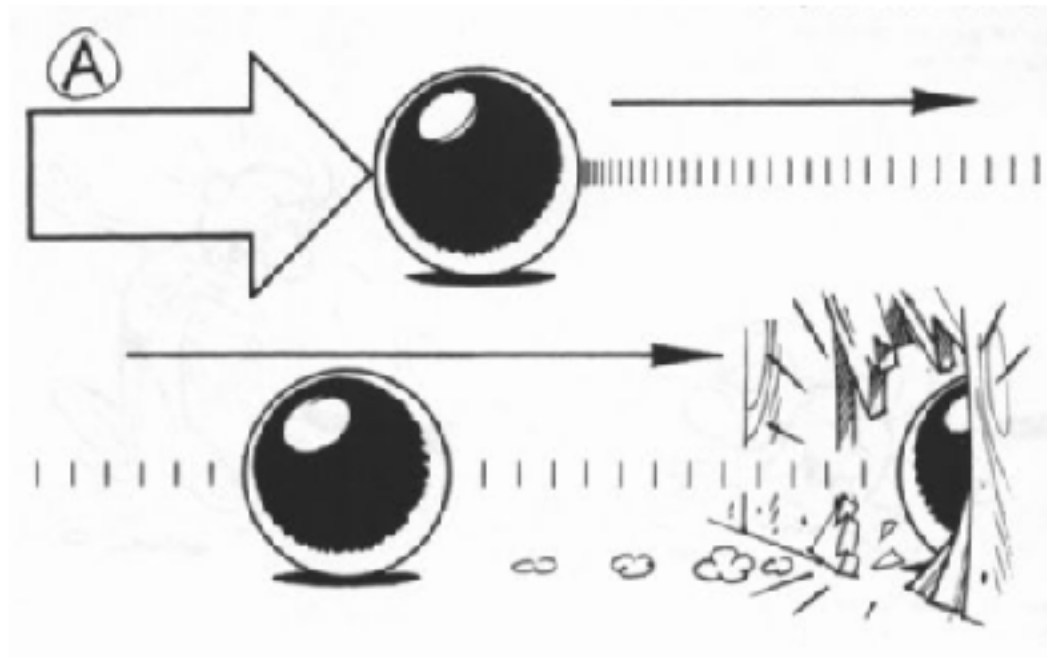
FIGURE 4c. Stretching the object so that it's positions overlap again will relieve the strobing effect.
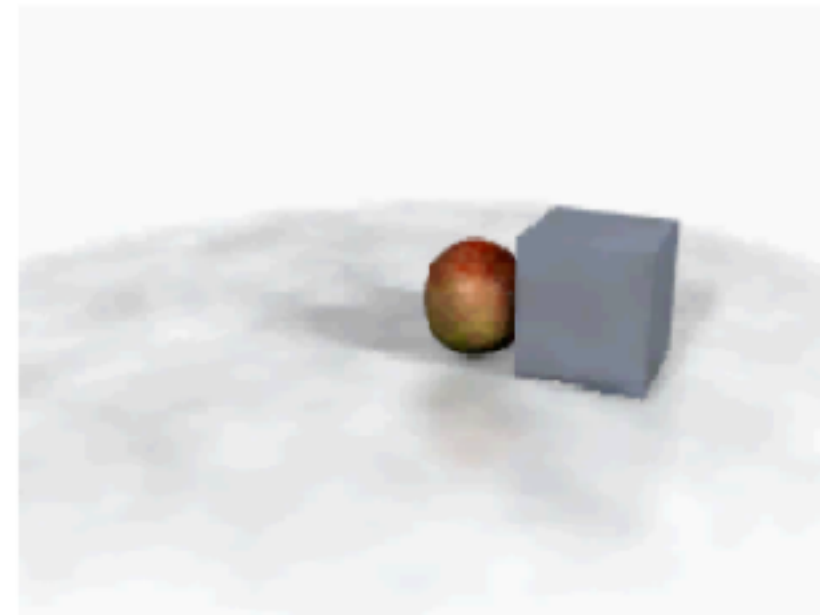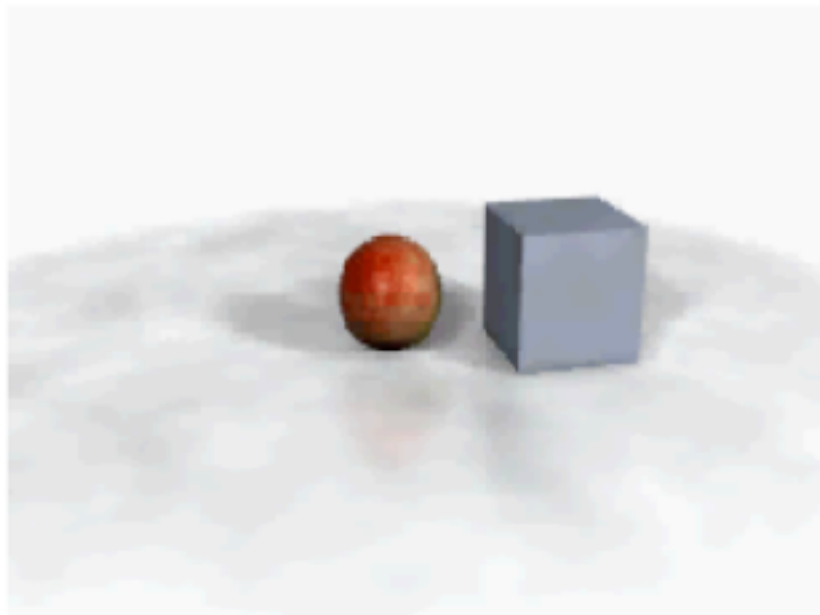
Timing

- Rate of acceleration conveys weight
- Speed and acceleration of character's movements convey emotion

Timing for Animation, Whitaker & Halas

Timing

- Rate of acceleration conveys weight

- Speed and acceleration of character's movements convey emotion

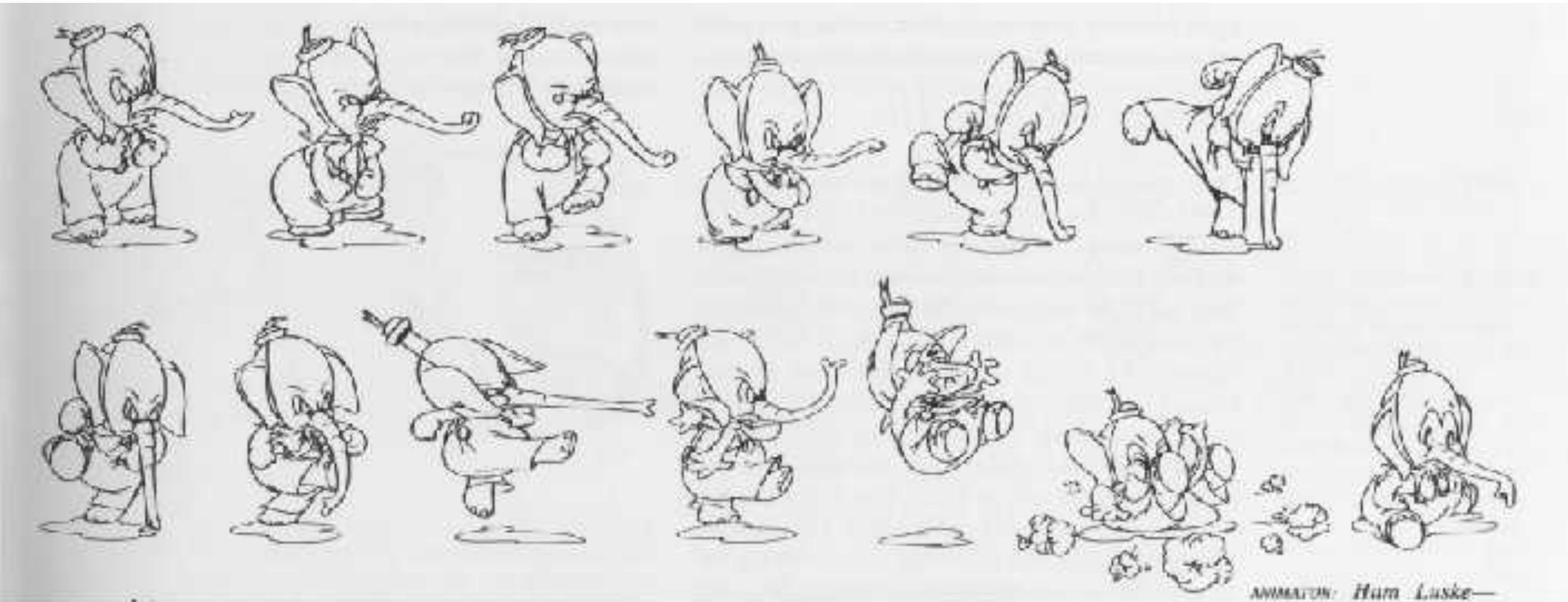Timing for Animation, Whitaker & Halas

Anticipation

- Prepare for each movement

- For physical realism

- To direct audience's attention

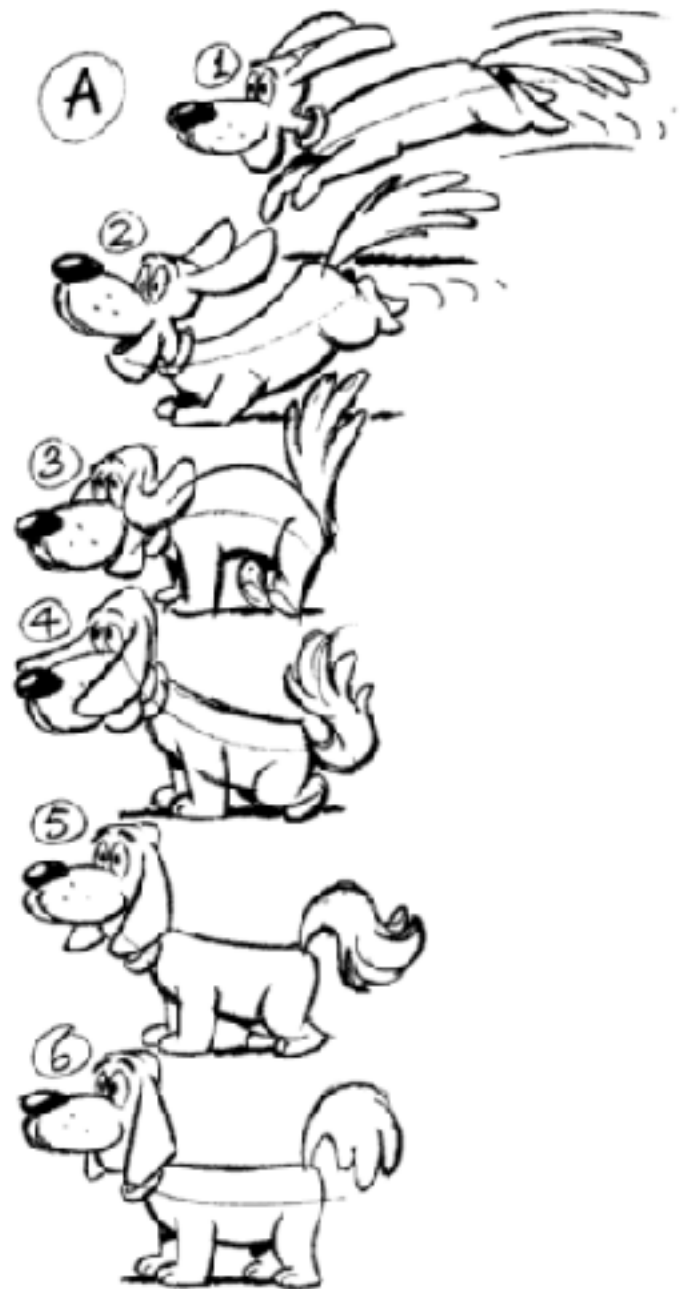Timing for Animation, Whitaker & Halas

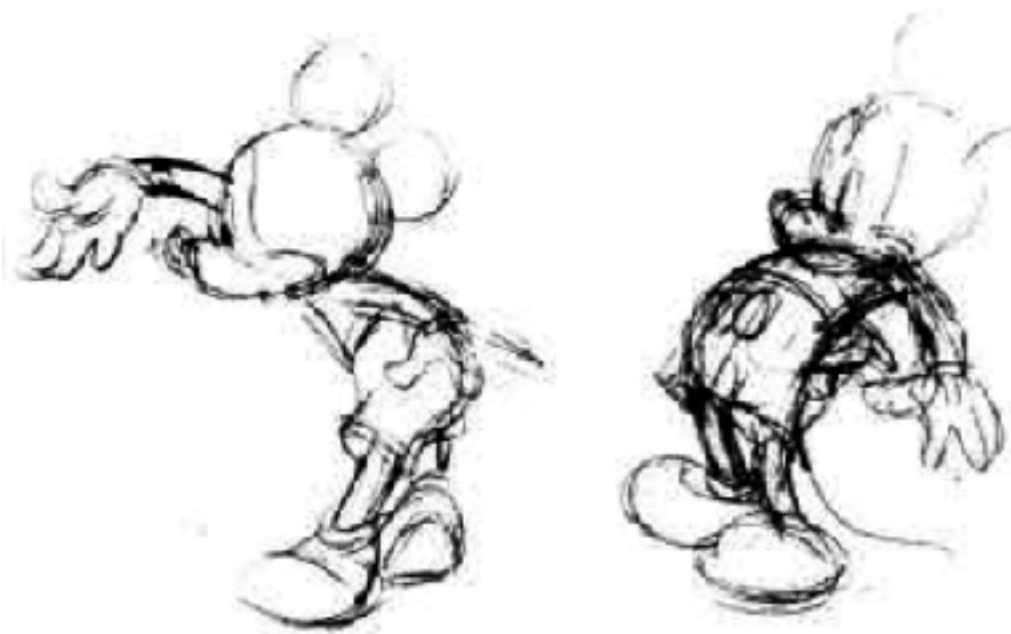# Follow Through

ANIMATION: Ham Luske—

Follow Through

- Overlapping motion
- Motion doesn't stop suddenly
- Pieces continue at different rates
- One motion starts while previous is finishing, keeps animation smooth

Staging

- Picture is 2D

- Make situation clear

- Audience looking in right place
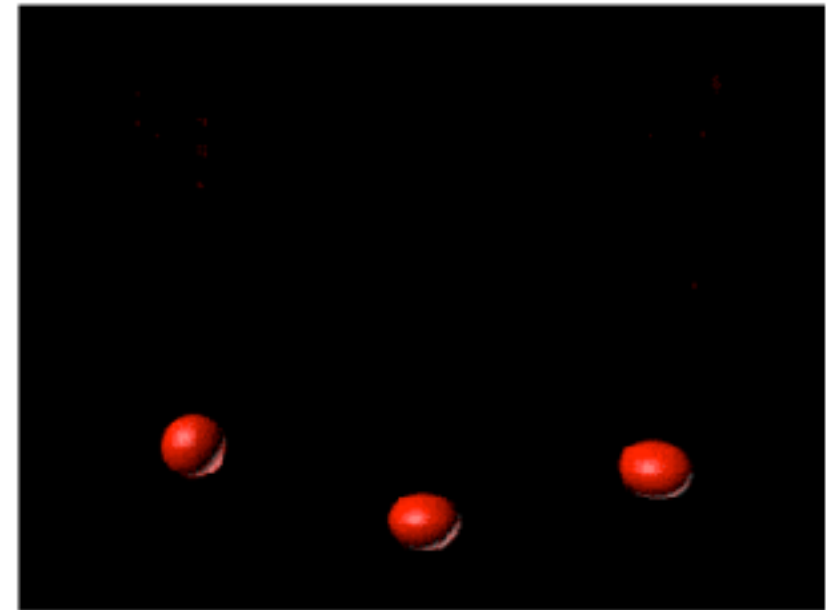
- Action clear in silhouette

Disney Animation: The Illusion of Life
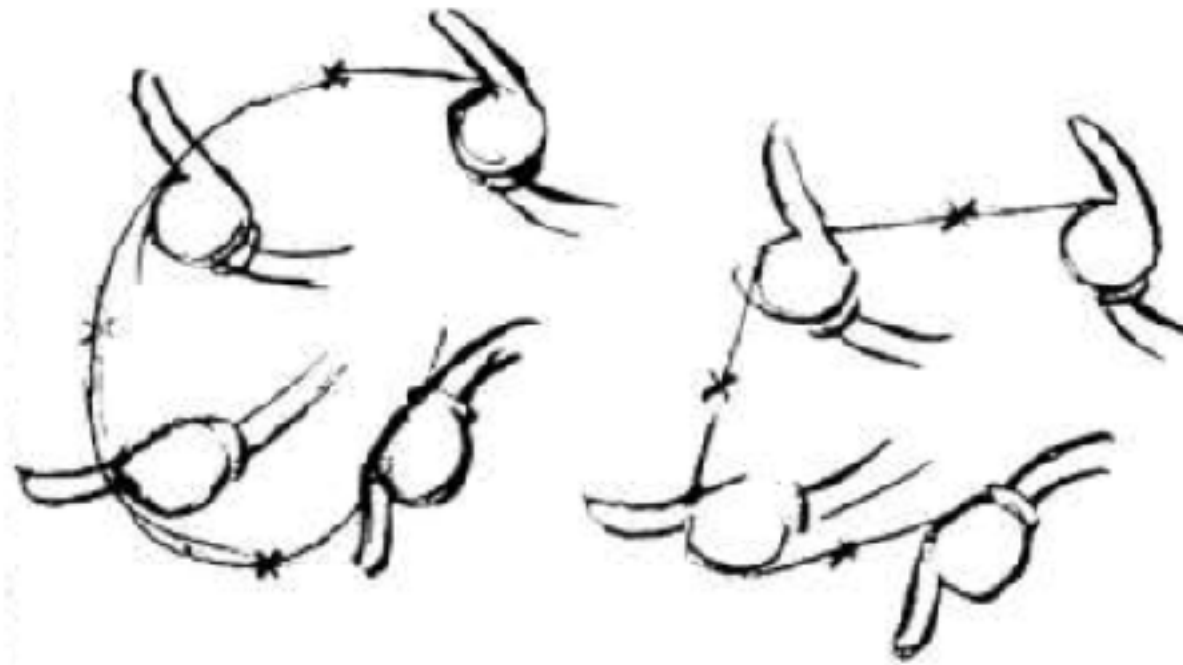
Ease-In and Ease-Out

- Movement doesn't start & stop abruptly.
- Also contributes to weight and emotion

Arcs

- Move in curves, not in straight lines

- This is how living creatures move

Disney Animation: The Illusion of Life

Exaggeration

- Helps make actions clear
- Helps emphasize story points and emotion
- Must balance with non-exaggerated parts

Timing for Animation, Whitaker & Halas

Secondary Action

- Motion that results from some other action

- Needed for interest and realism

- Shouldn't distract from primary motion

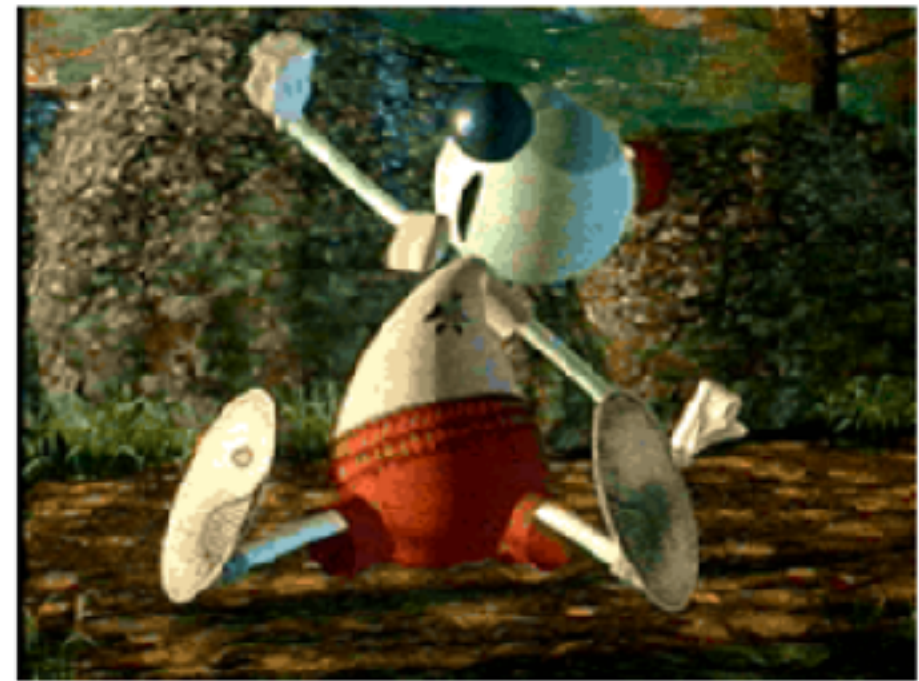Today: often use simulation to compute secondary motion of hair, clothing, etc

Appeal

- Attractive to the eye, strong design,

- Avoid symmetries

Disney Animation: The Illusion of Life

Personality

- Action of character is result of its thoughts

- Must know purpose and mood before animating each action.

- No two characters move the same way.

Principles of Traditional Animation

- Stylistic conventions followed by Disney's animators and others (but this is not the only interesting style, of course)

- From experience built up over many years
  - Squash and stretch -- use distortions to convey flexibility
  - Timing -- speed conveys mass, personality
  - Anticipation -- prepare the audience for an action
  - Followthrough and overlapping action -- continuity with next action
  - Slow in and out -- speed of transitions conveys subtleties
  - Arcs -- motion is usually curved
  - Exaggeration -- emphasize emotional content
  - Secondary Action -- motion occurring as a consequence
  - Appeal -- audience must enjoy watching it
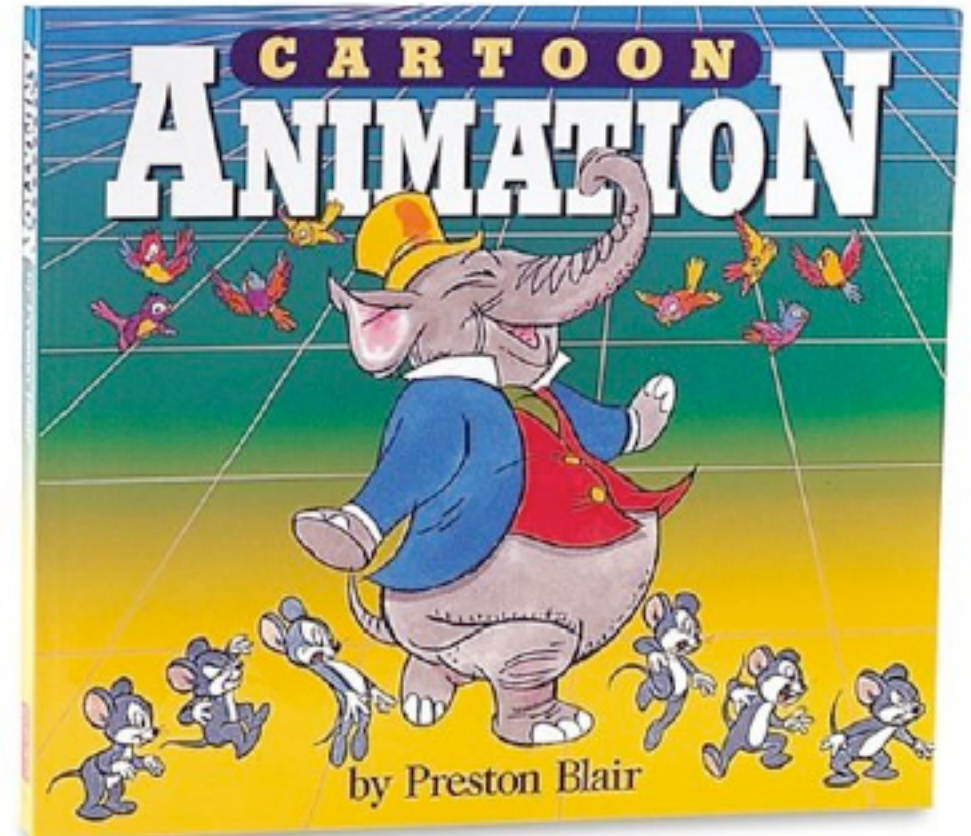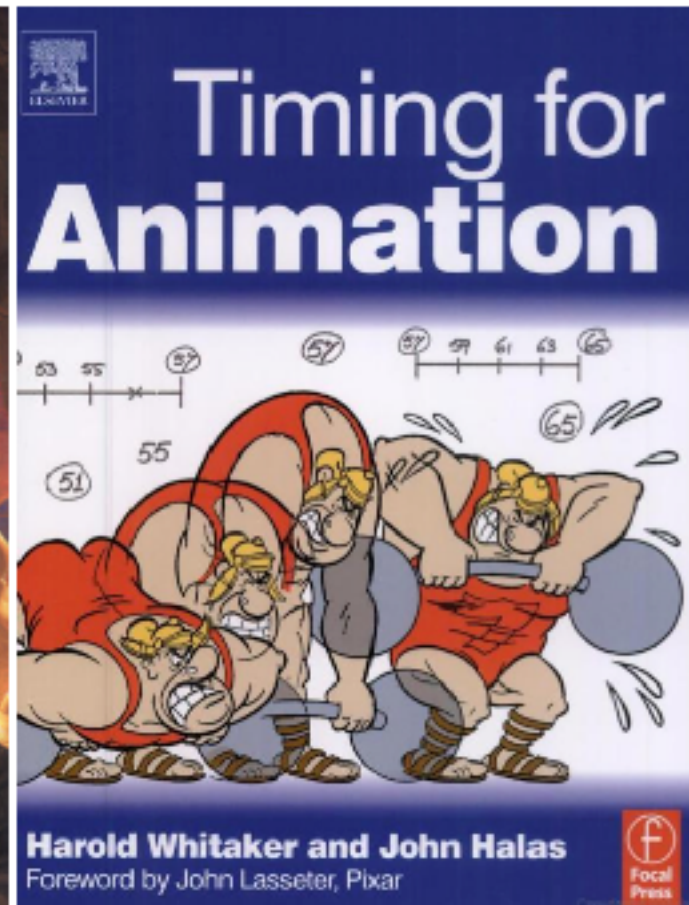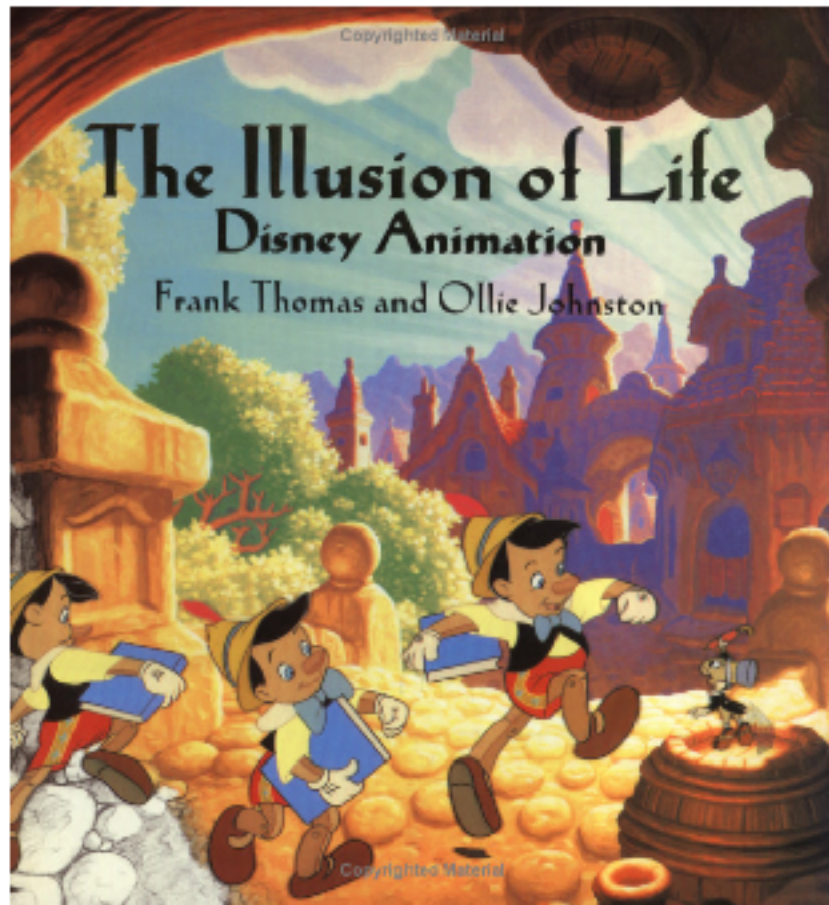
Computer-Assisted Animations

- Computerized Cel painting
  - Digitize the line drawing, color it using seed fill
  - Eliminates cel painters
  - Widely used in production (little hand painting any more)
  - e.g. *Lion King*

- Cartoon Inbetweening
  - Automatically interpolate between two drawings to produce inbetweens (similar to morphing)
  - Hard to get right
    - inbetweens often don't look natural
    - what are the parameters to interpolate? Not clear...
    - not used very often

Computer Animation

- Generate images by rendering a 3D model

- Vary parameters to produce animation

- Brute force
  - Manually set the parameters for every frame
  - 1440n values per minute for n parameters
  - Maintenance problem

- Computer keyframing
  - Lead animators create important frames
  - Computers draw inbetweens from 3D(!)
  - Dominant production method

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Thanks!