CG – T17 – Animation

L:CC, MI:ERSI

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(course designed by Verónica Orvalho, slides adapted from Steve Marschner)

U.PORTO FC

Suggested reading

- Shirley et al., “Fundamentals of Computer Graphics”, 3rd Edition, CRC Press
  - Chapter 17 – Computer Animation

What is animation?

- Modeling = specifying shape
- Animation = specifying shape as a function of time
  - Just modeling done once per frame?
  - Need smooth, concerted movement
- Controlling shape = the technical problem
- Using shape controls = the artistic problem

Adapted from Steve Marschner, Cornell University

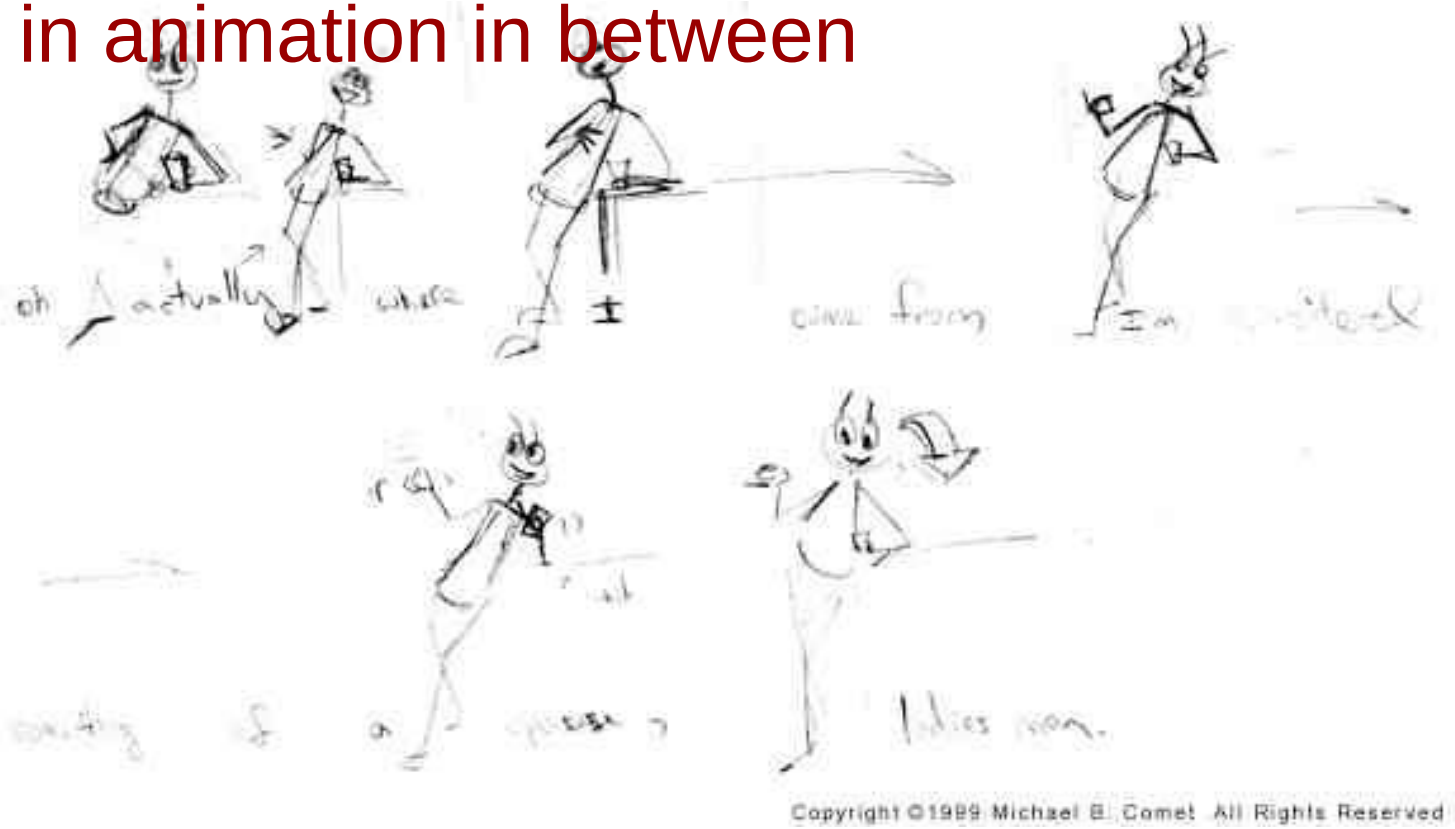
Approaches to animation

- Straight ahead
  - Draw/animate one frame at a time
  - Can lead to spontaneity, but is hard to get exactly what you want
- Pose-to-pose
  - Top-down process:
    - Plan shots using storyboards
    - Plan key poses first
    - Finally fill in the in-between frames

Adapted from Steve Marschner, Cornell University

Pose-to-pose animation planning

- First work our poses that are key to the story
- Next fill in animation in between



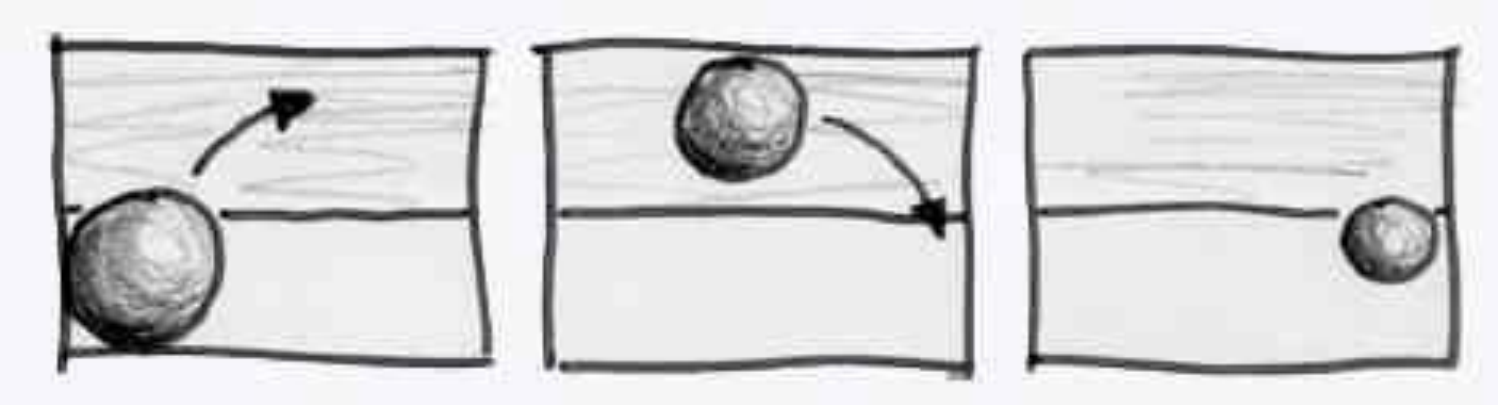
Adapted from Steve Marschner, Cornell University

Keyframe animation

- Keyframing is the technique used for pose-to-pose animation
  - Head animator draws key poses—just enough to indicate what the motion is supposed to be
  - Assistants do “in-betweening” and draws the rest of the frames
- In computer animation substitute “user” and “animation software”
  - *Interpolation* is the principal operation

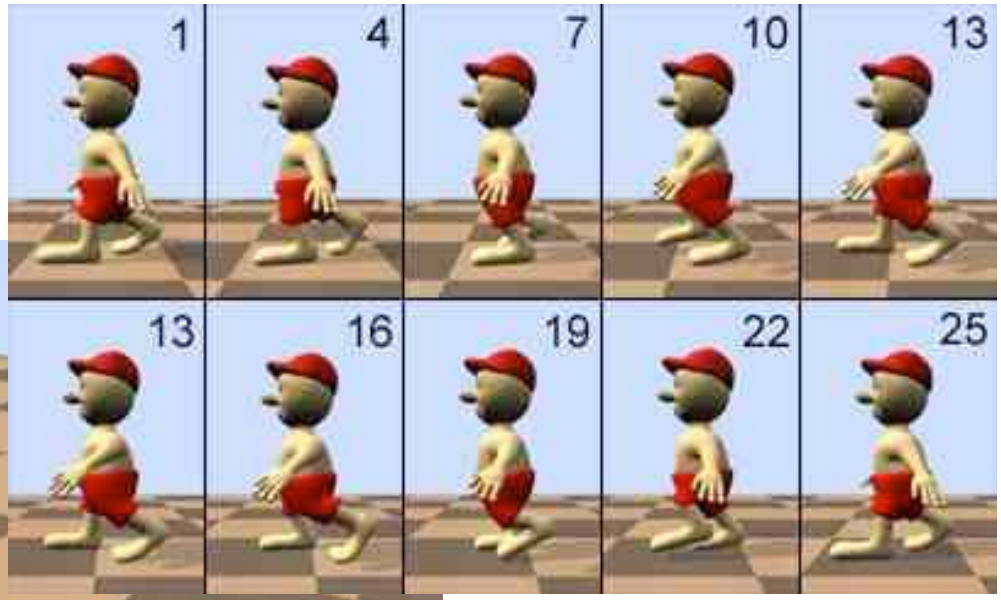
Adapted from Steve Marschner, Cornell University

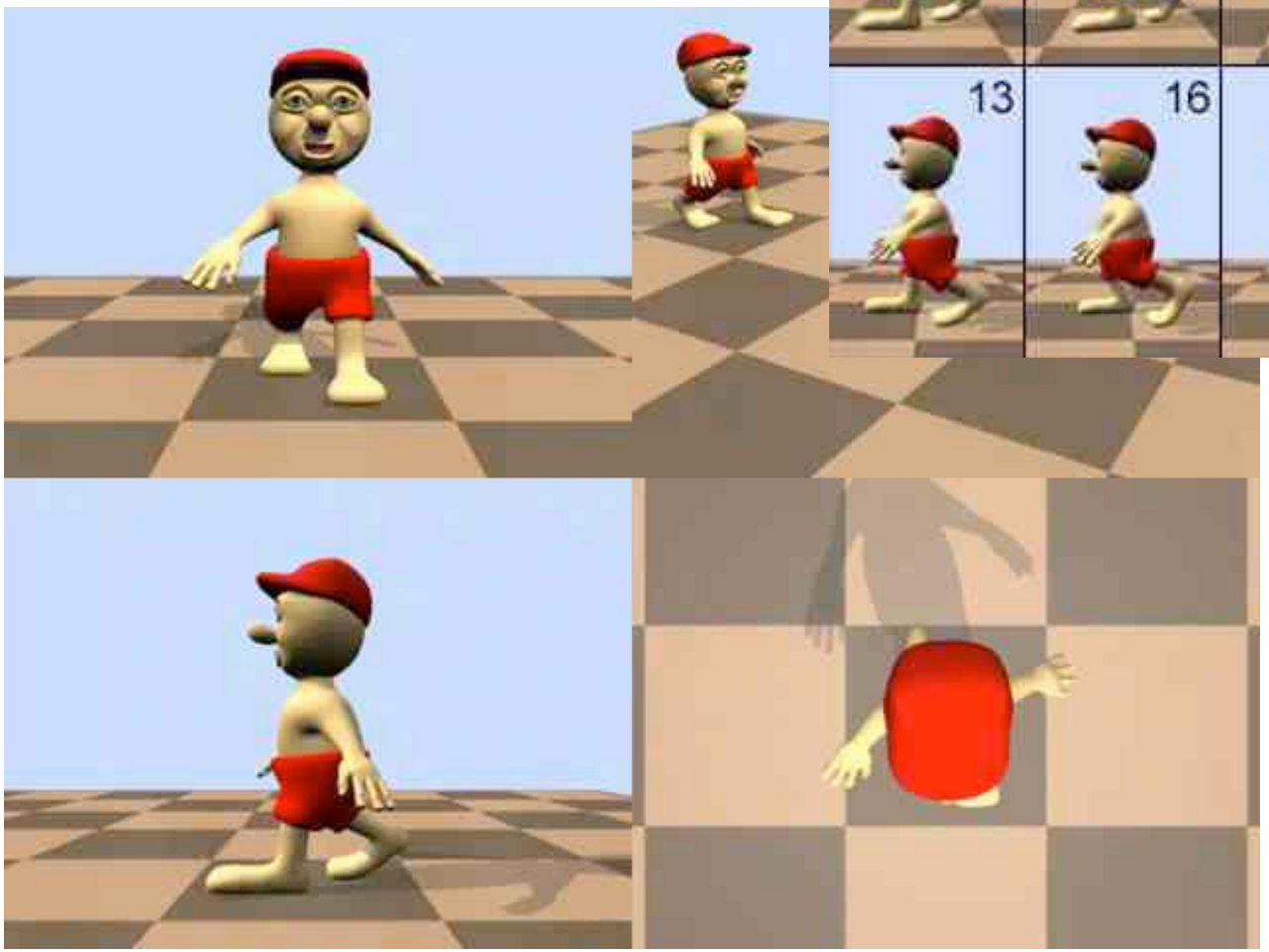
Keyframe animation



[Bryce Tutorial
http://www.cadtutor.net/dd/bryce/anim/anim.html]

Walk cycle



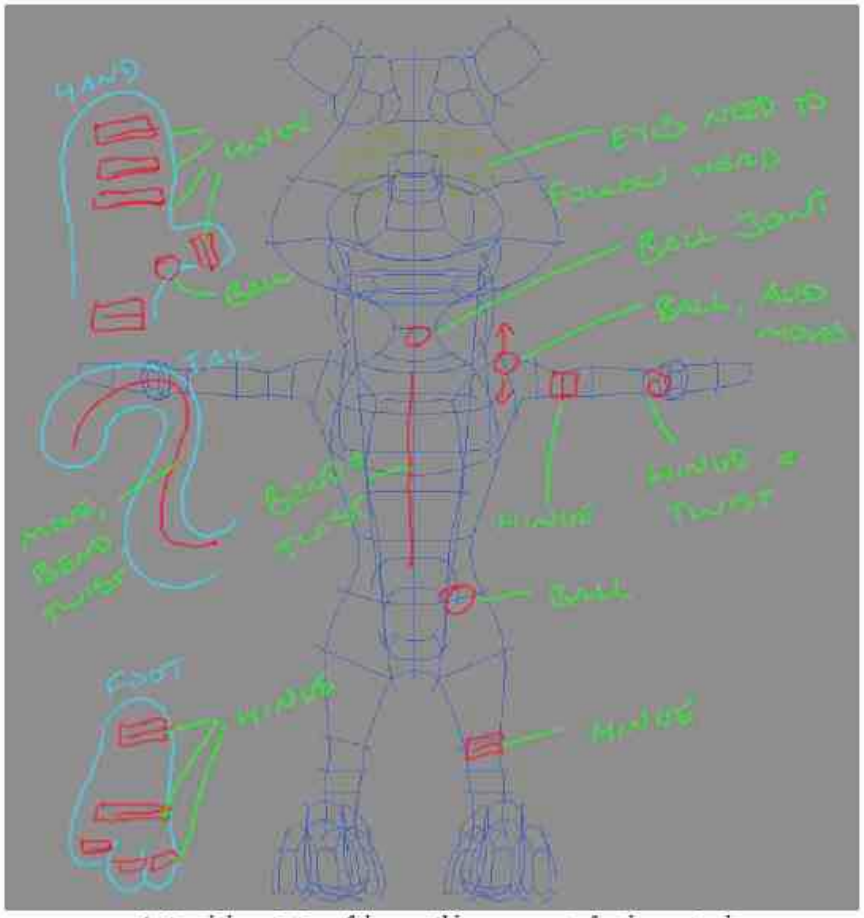


[Christopher Lutz http://www.animationsnippets.com]

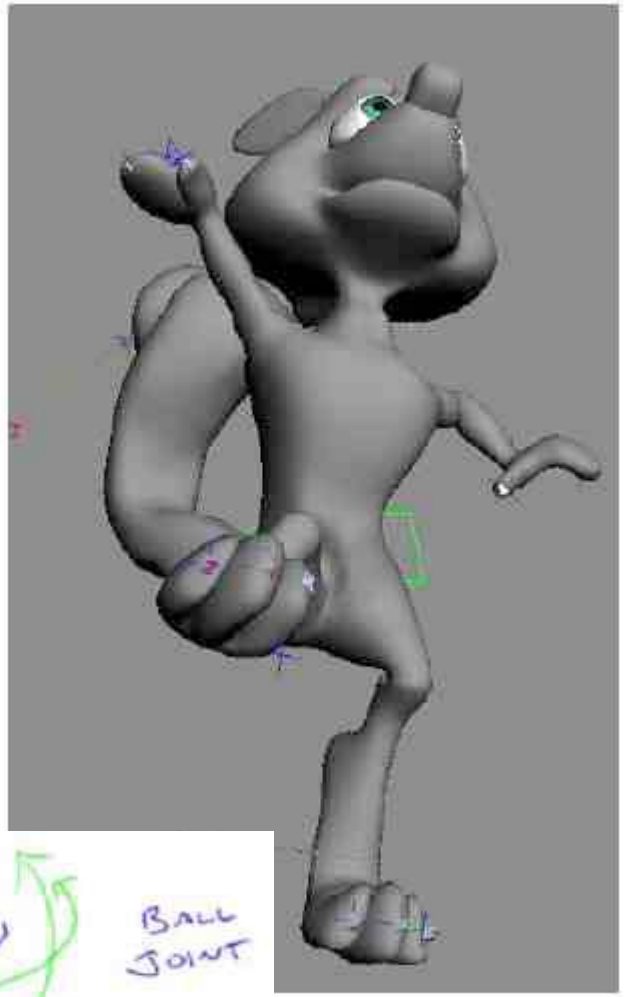
Controlling geometry conveniently

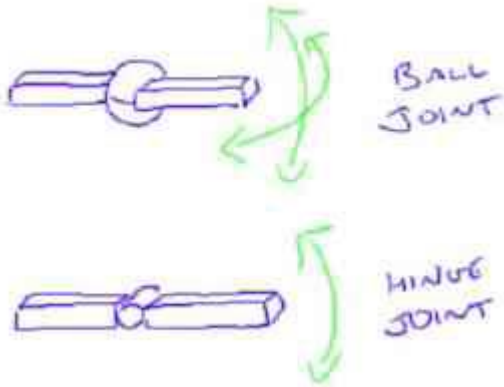
- Could animate by moving every control point at every keyframe
  - This would be labor intensive
  - It would also be hard to get smooth, consistent motion
- Better way: animate using smaller set of meaningful *degrees of freedom* (DOFs)
  - Modeling DOFs are inappropriate for animation
    - E.g. “move one square inch of left forearm”
  - Animation DOFs need to be higher level
    - E.g. “bend the elbow”

Character with DOFs



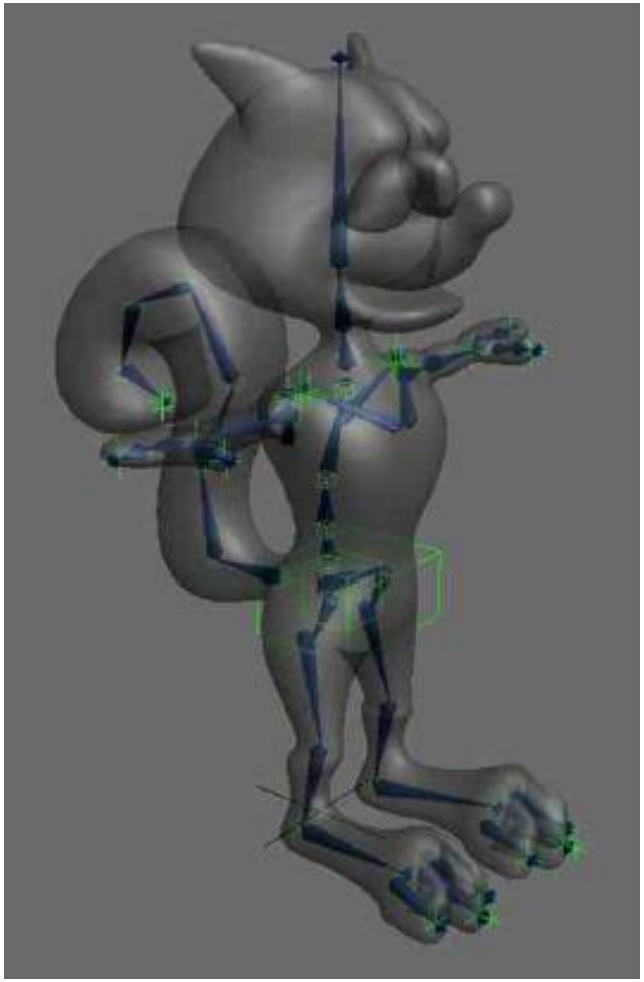
A visual description of the possible movements for the squirrel





[Greenberg/Pellacini | CIS 565]

Rigged character



- Surface is deformed by a set of *bones*
- Bones are in turn controlled by a smaller set of *controls*
- The controls are useful, intuitive DOFs for an animator to use

[CIS 565 staff]

The artistic process of animation

- What are animators trying to do?
  - Important to understand in thinking about what tools they need
- Basic principles are universal across media
  - 2D hand-drawn animation
  - 2D computer animation
  - 3D computer animation
- (The following slides follow the examples from Michael Comet's very nice discussion on the page: " http://www.comet-cartoons.com/toons/3ddocs/charanim/)

Adapted from Steve Marschner, Cornell University

Animation principles: timing

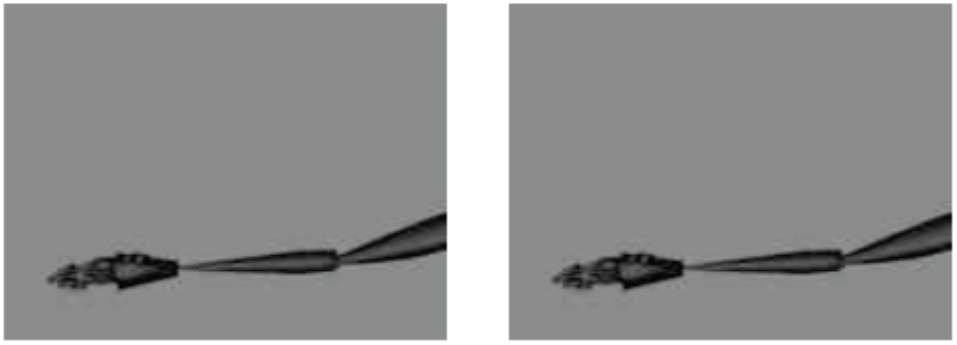
- Speed of an action is crucial to the impression it makes
  - examples with same keyframes, different times:

See annexed files: timing*.avi

[Michael B. Comet]

Animation principles: ease in/out

- Real objects do not start and stop suddently
  - Animation parameters shouldn't either
  - A little goes a long way (just a few frames acceleration or deceleration for "snappy" motions)



See annexed files: ease*.avi

[Michael B. Comet]

Animation principles: moving in arcs

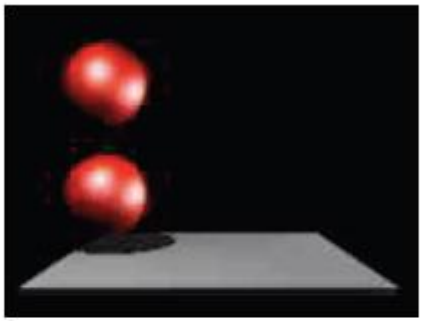
- Real objects also don't move in straight lines
  - Generally curves are more graceful and realistic

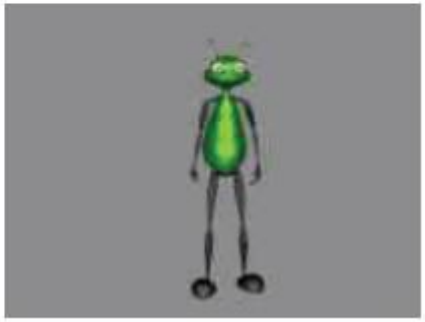
See annexed files: arc*.avi

[Michael B. Comet]

Animation principles: anticipation

- Most actions are preceded by some kind of “wind up”



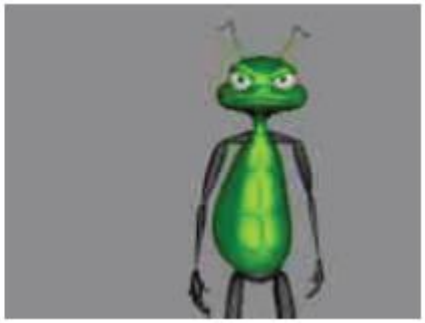


See annexed files: anticip*.avi

[Michael B. Comet]

Animation principles: exaggeration

- Animation is not exactly modeling reality
- Exaggeration is very often used for emphasis

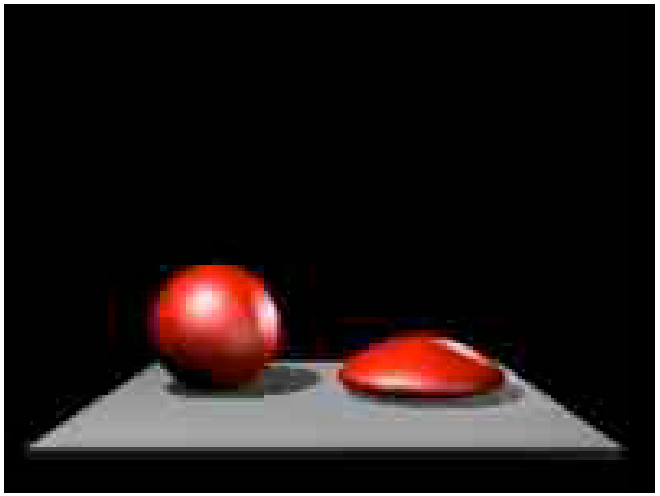


See annexed files: exagg*.avi

[Michael B. Comet]

Animation principles: squash & stretch

- Objects do not remain perfectly rigid as they move
- Adding stretch with motion and squash with impact:
  - models deformation of soft objects
  - indicates motion by simulating exaggerated “motion blur”

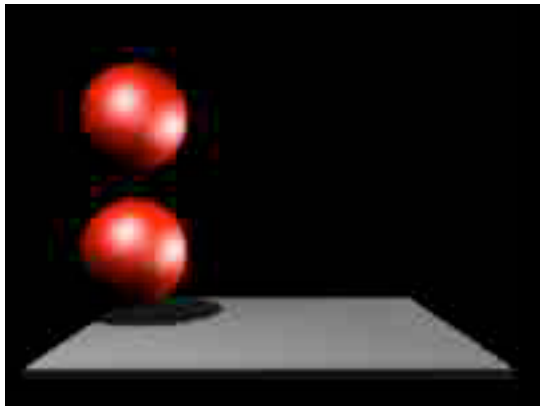


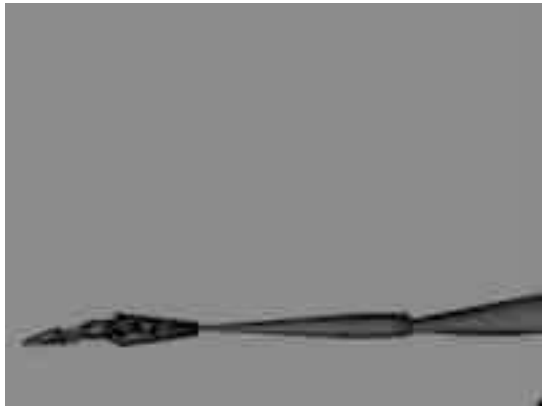
See annexed files: squash*.avi

[Michael B. Comet]

Animation principles: follow through

- We've seen that objects don't start suddenly
- They also don't stop on a dime





See annexed files: follow*.avi

[Michael B. Comet]

Animation principles: overlapping action

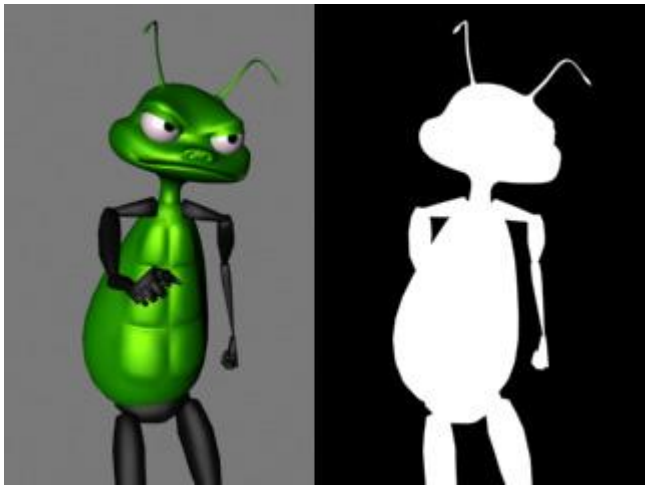
- Usually many actions are happening at once

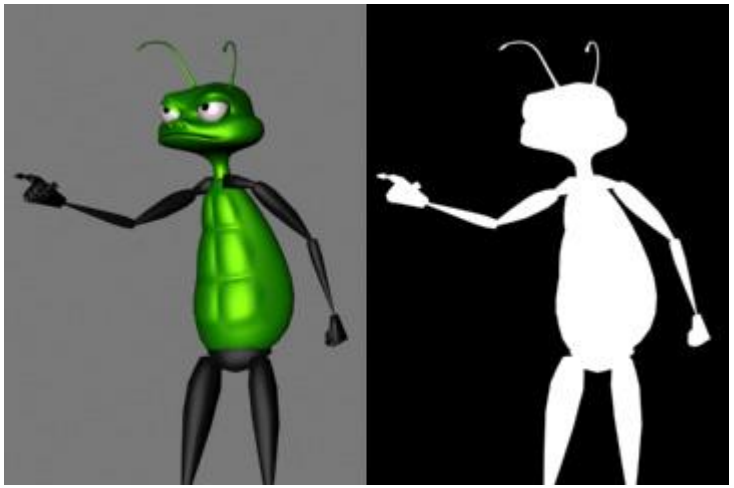
See annexed files: sec*.avi

[Michael B. Comet]

Animation principles: staging

- Want to produce cler, good-looking 2D images
  - Need good camera angles, set design, and character positions

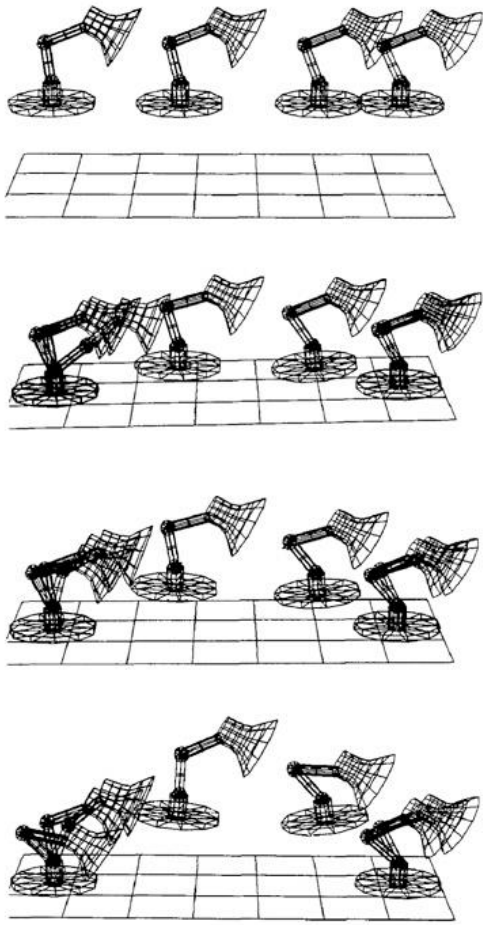




[Michael B. Comet]

Computer-generated motion

- Interesting aside: many principles of character animation follow indirectly from physics
- Anticipation, follow-through, and many other effects can be produced by simply minimizing physical energy
- Seminal paper: “Spacetime Constraints” by Witkin and Kass in SIGGRAPH 1988



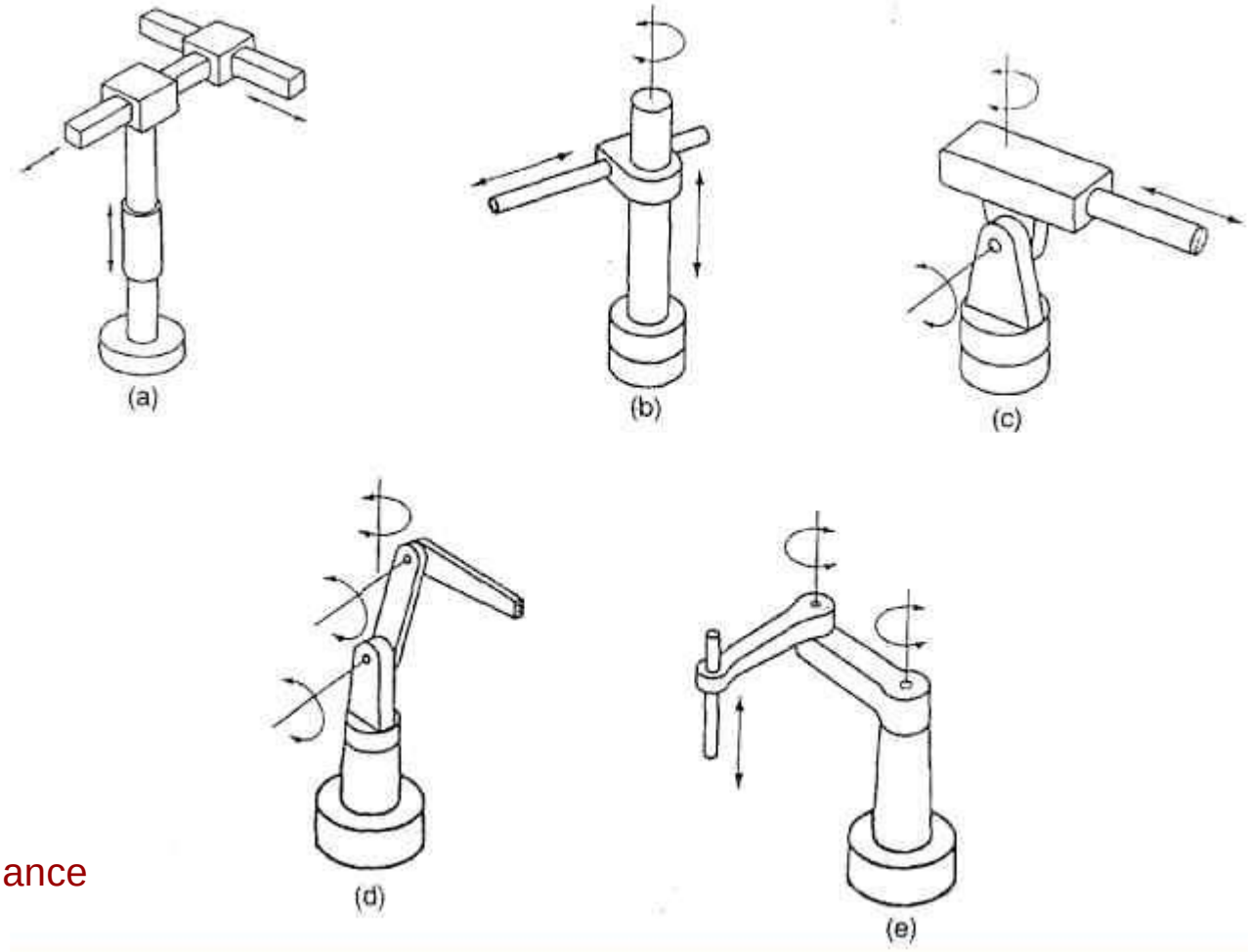
Adapted from Steve Marschner, Cornell University

Controlling shape for animation

- Start with modeling DOFs (control points)
- Deformations control those DOFs at a higher level
  - Example: move first joint of second finger on left hand
- Animation controls control those DOFs at a higher level
  - Example: open/close left hand
- Both cases can be handled by the same kinds of deformers

Adapted from Steve Marschner, Cornell University

Example: Articulation in robotics



a. rectangular or cartesian
b. cylindrical or post-type
c. spherical or polar
d. joint-arm or articulated
e. SCARA (selective compliance assembly robot arm)

Adapted from Steve Marschner, Cornell University

Motion capture

- A method for creating complex motion quickly: measure it from the real world

Adapted from Steve Marschner, Cornell University

Summary

- Keyframe animation
  - User creates key poses; computer interpolates the rest
- Controlling geometry
  - Use a small set of *degrees of freedom* (DOFs)
- Animation principles for more interesting animations
- Motion capture as a way to model complex animations