

CS 130 : Computer Graphics

Lecture 12: Animation

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Types of animation

- keyframing
- rotoscoping
- stop motion
- procedural
- simulation
- motion capture

history

Gertie the Dinosaur

1914

12 minutes

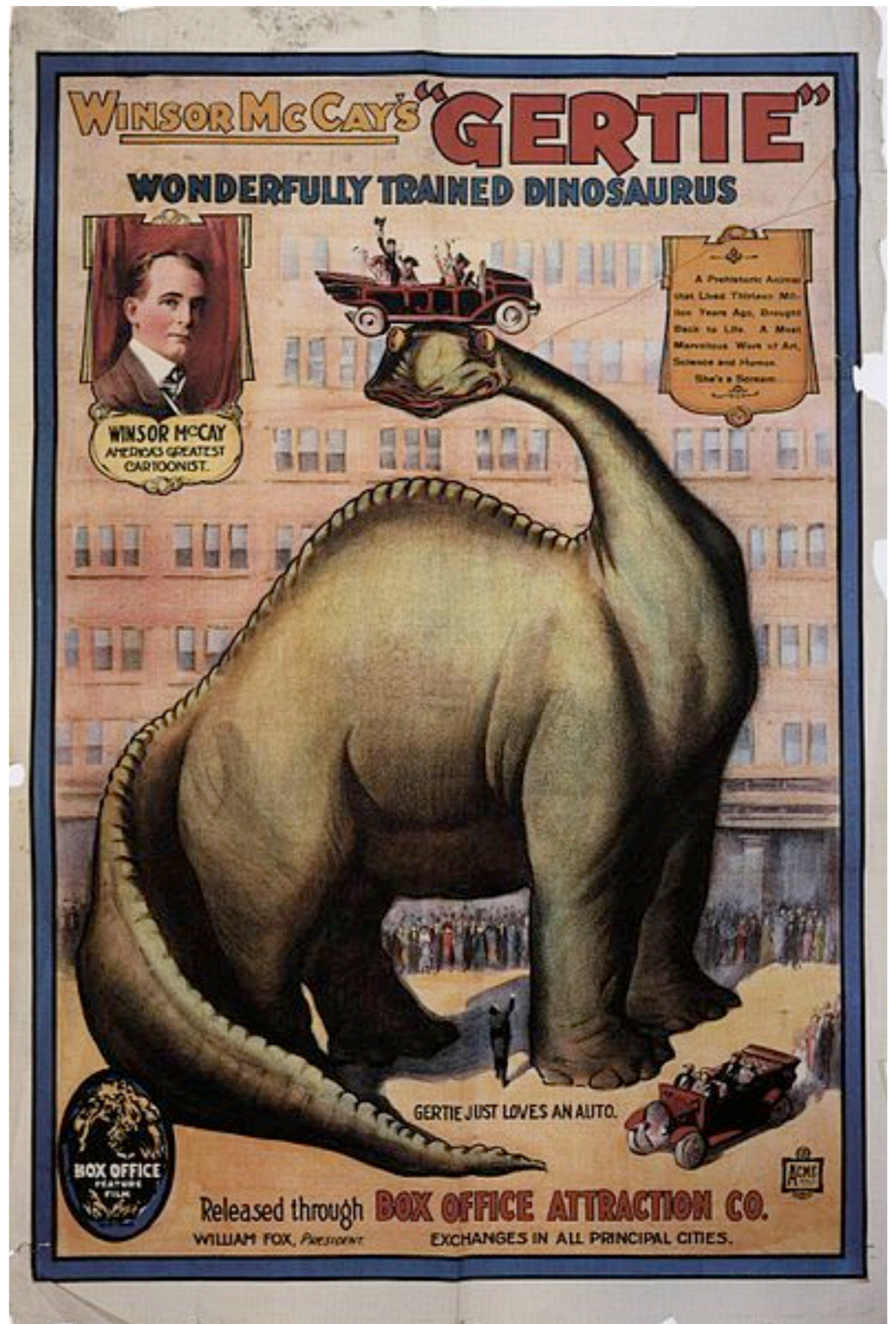
hand drawn

keyframe animation

registration

cycling

link



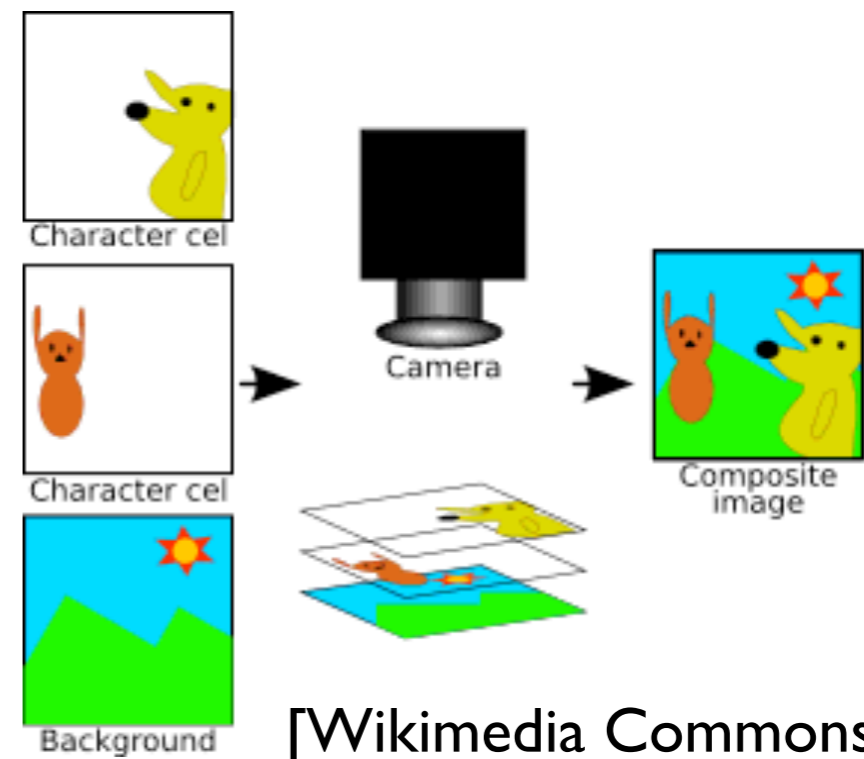
Traditional animation

Cels

Multiplane camera

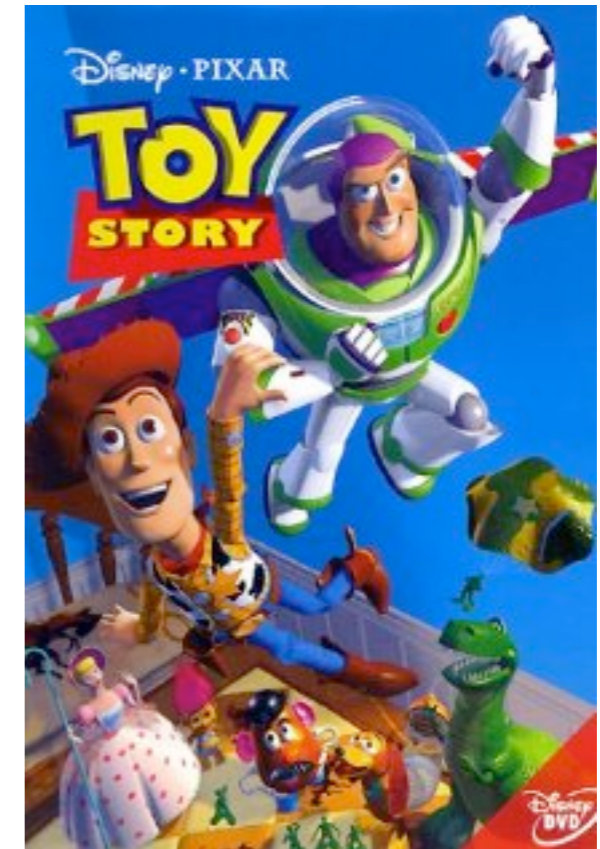
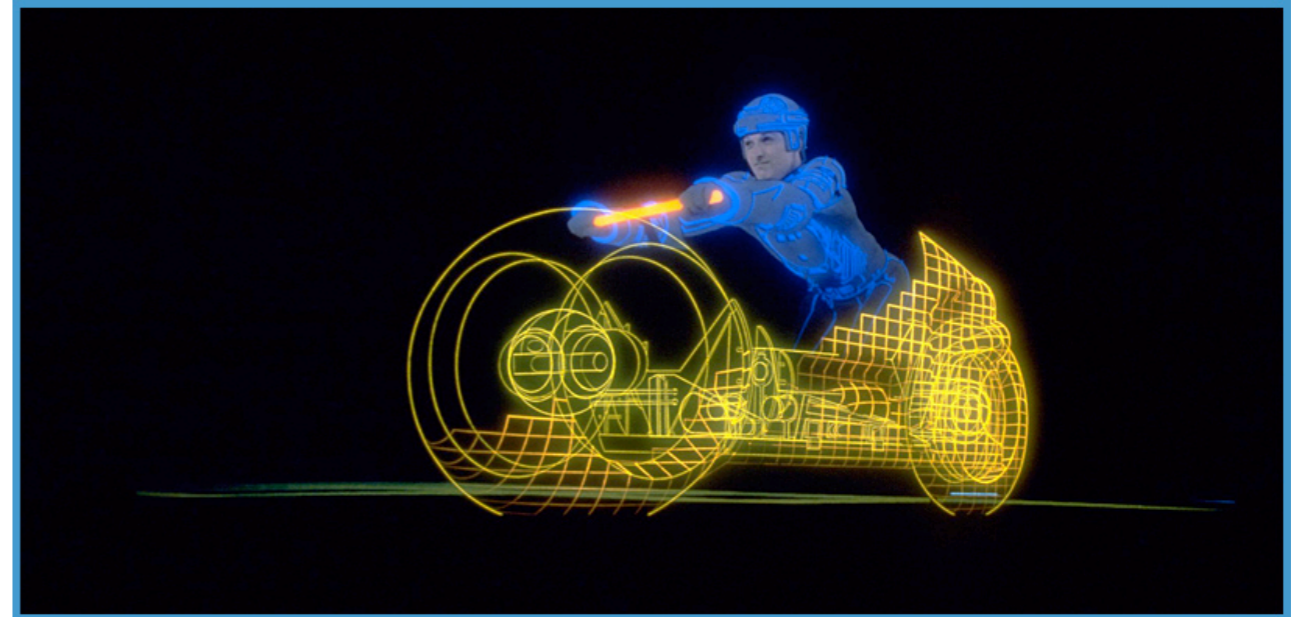


Sleeping Beauty, Disney, 1959



Realistic 3D animation

- Disney's Tron, 1981
- Pixar's Toy Story, 1995, first 3D feature



Performance capture



Lord of the Rings, 2001



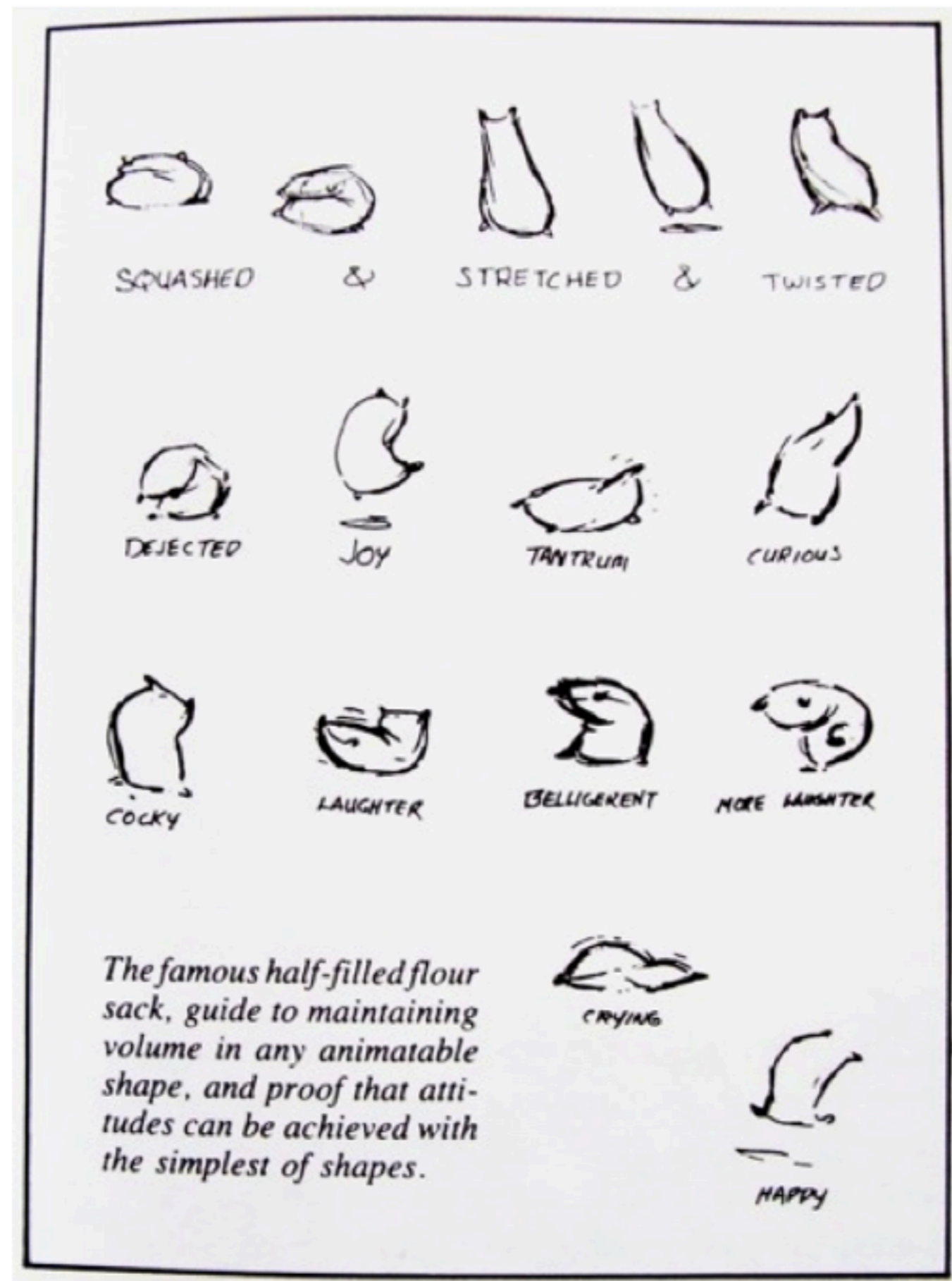
Rise of the Planet of the Apes, 2011



Avatar, 2009

Andy Serkis – Gollum, Lord of the Rings challenges – resolution, occlusion,

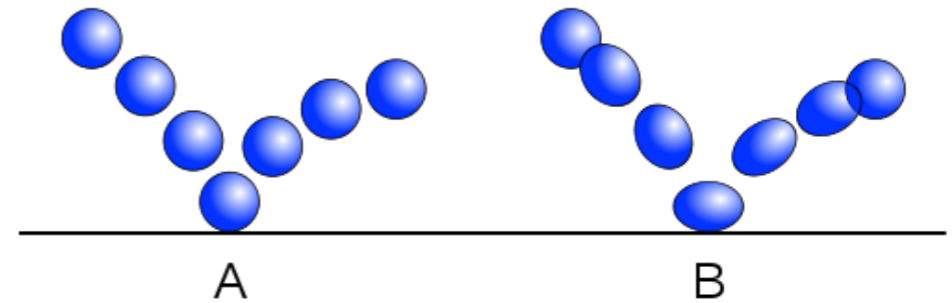
animation principles



- animation can bring even a flour sack to life
- animations principles common to any type of animation

12 principles of animation

1. Squash and stretch
2. Anticipation
3. Staging
4. Straight ahead action and pose to pose
5. Follow through and overlapping action
6. Slow in and slow out
7. Arcs
8. Secondary action
9. Timing
10. Exaggeration
11. Solid drawing
12. Appeal

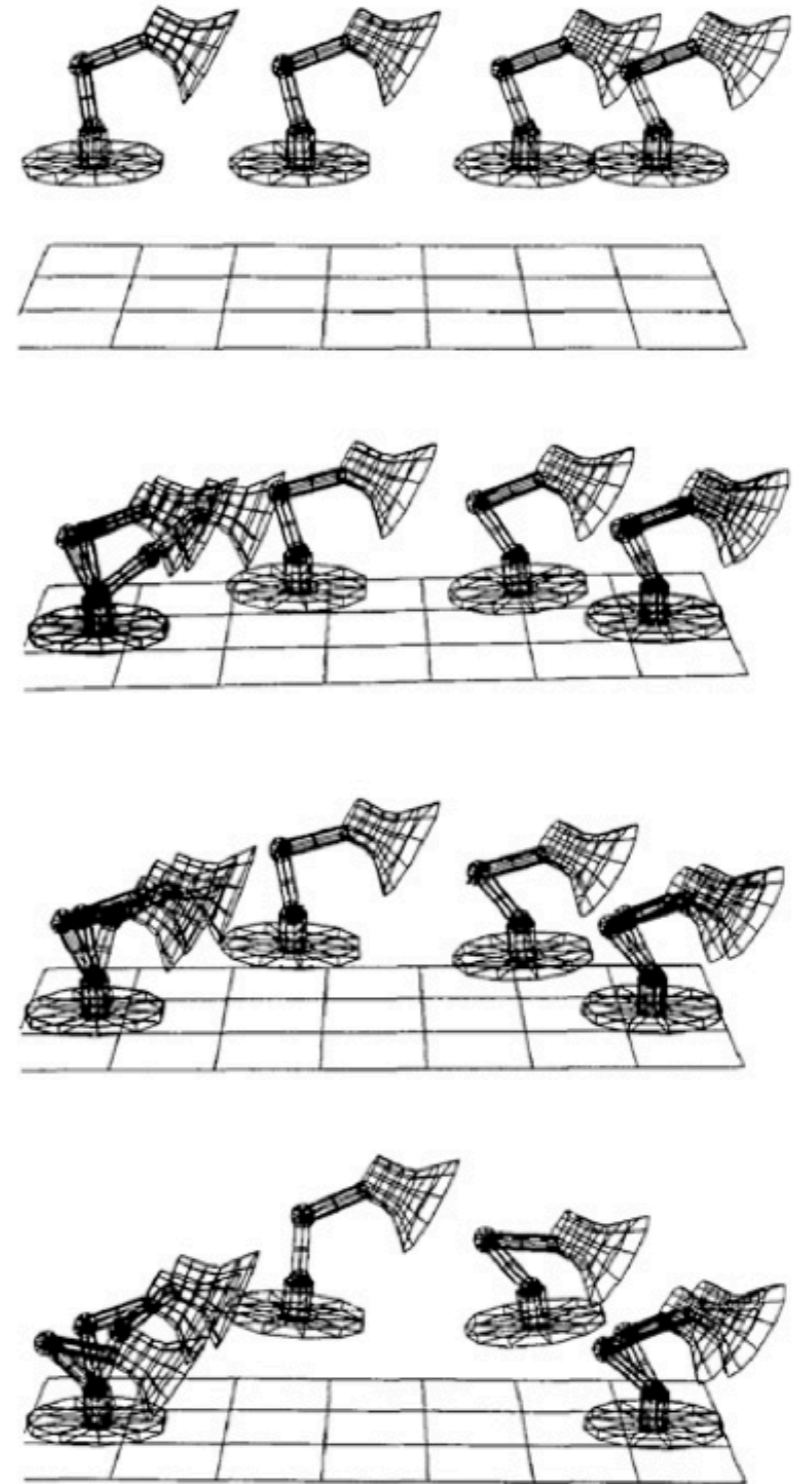


[Lasseter 87]

principles are related to the underlying physics of motion
timing: important information. ease in/ease out

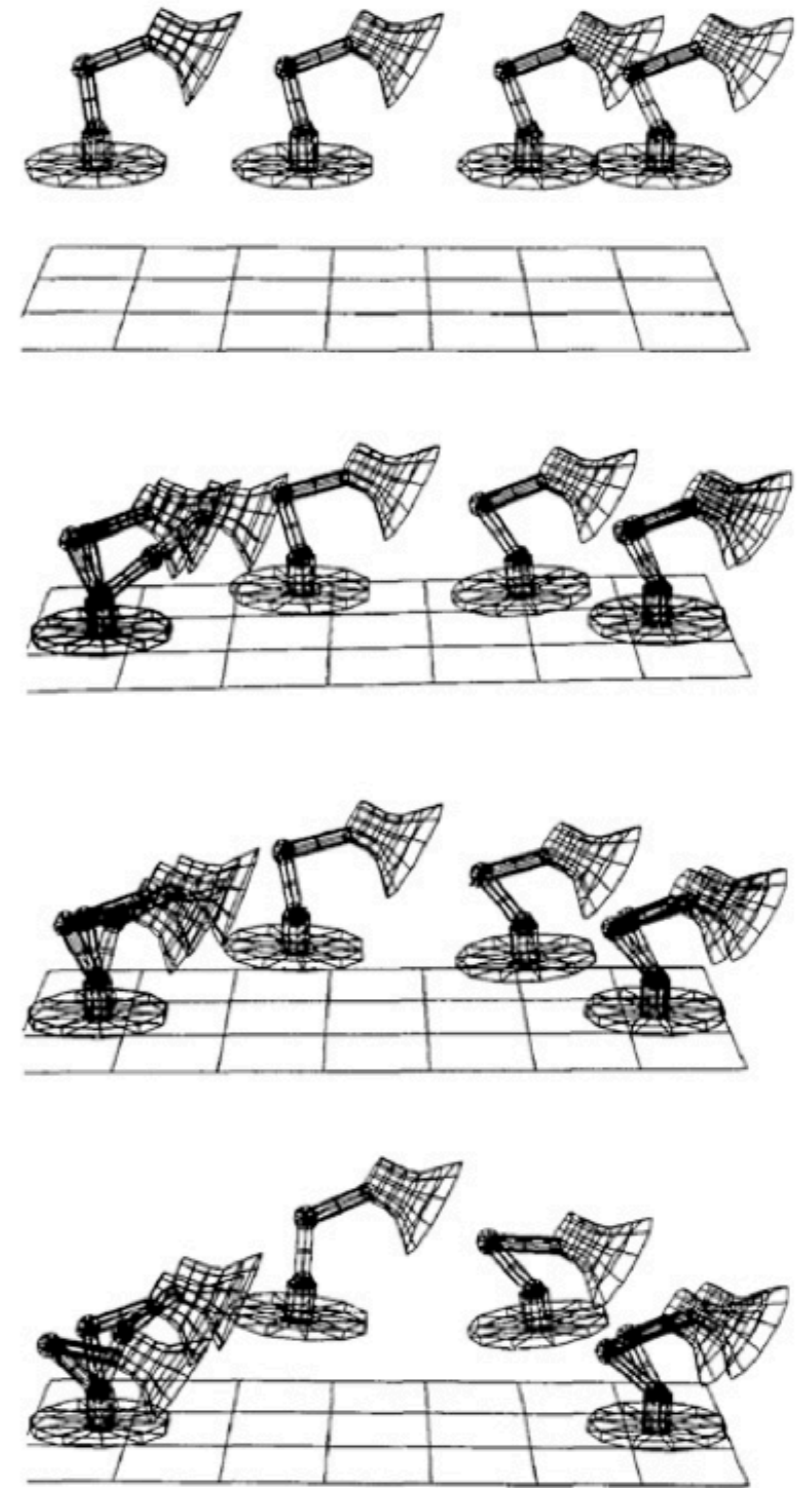
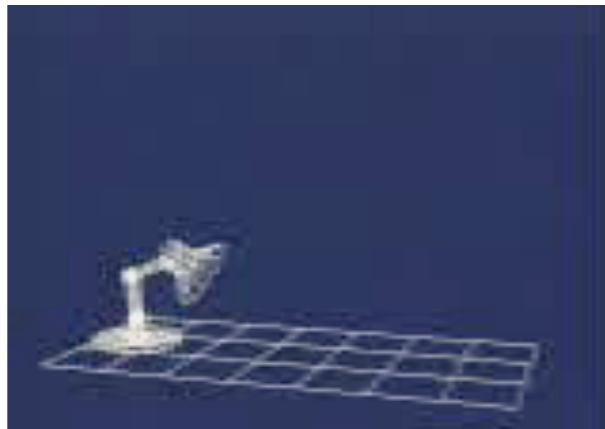
Physics-based animation

- Many animation principles follow from underlying physics
- anticipation, follow through, secondary action, squash and stretch, ...
- *Spacetime Constraints*, Witkin and Kass 1988



Physics-based animation

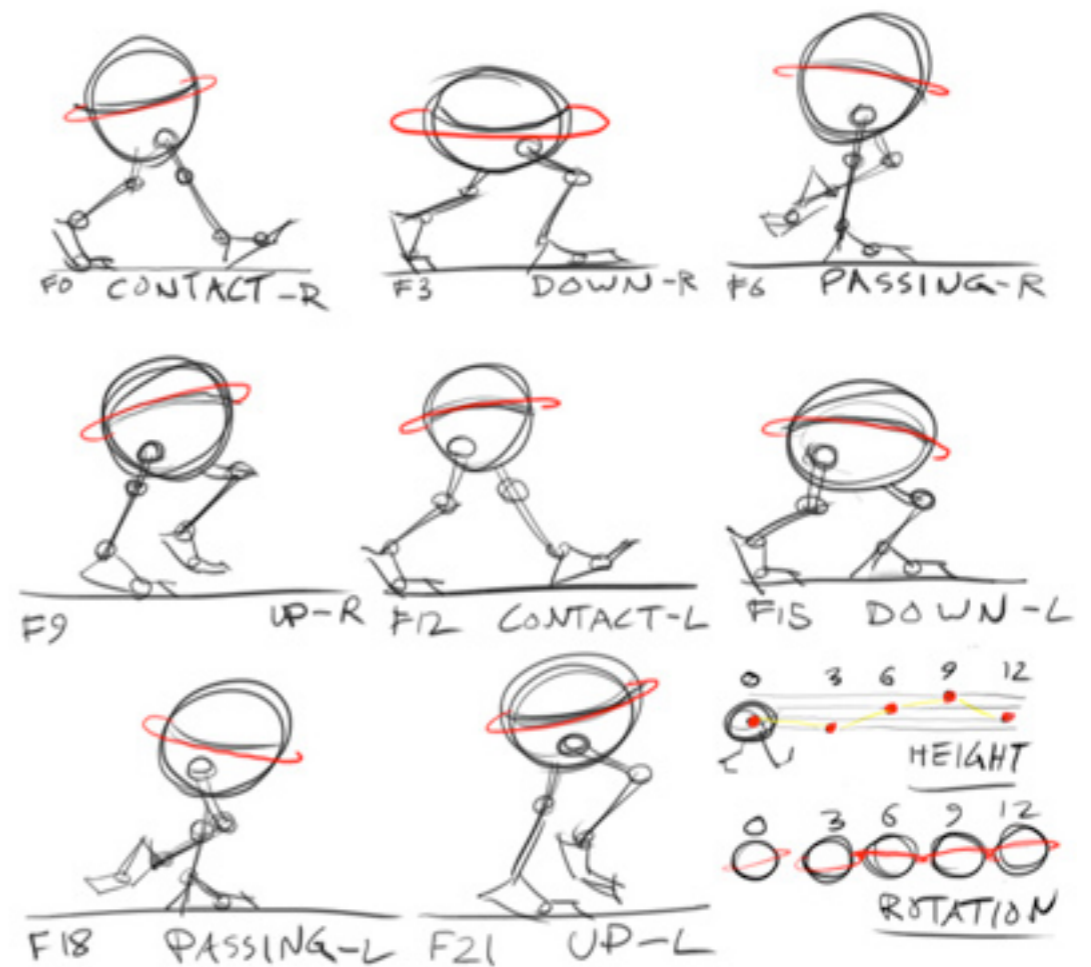
- Many animation principles follow from underlying physics
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keyframe animation

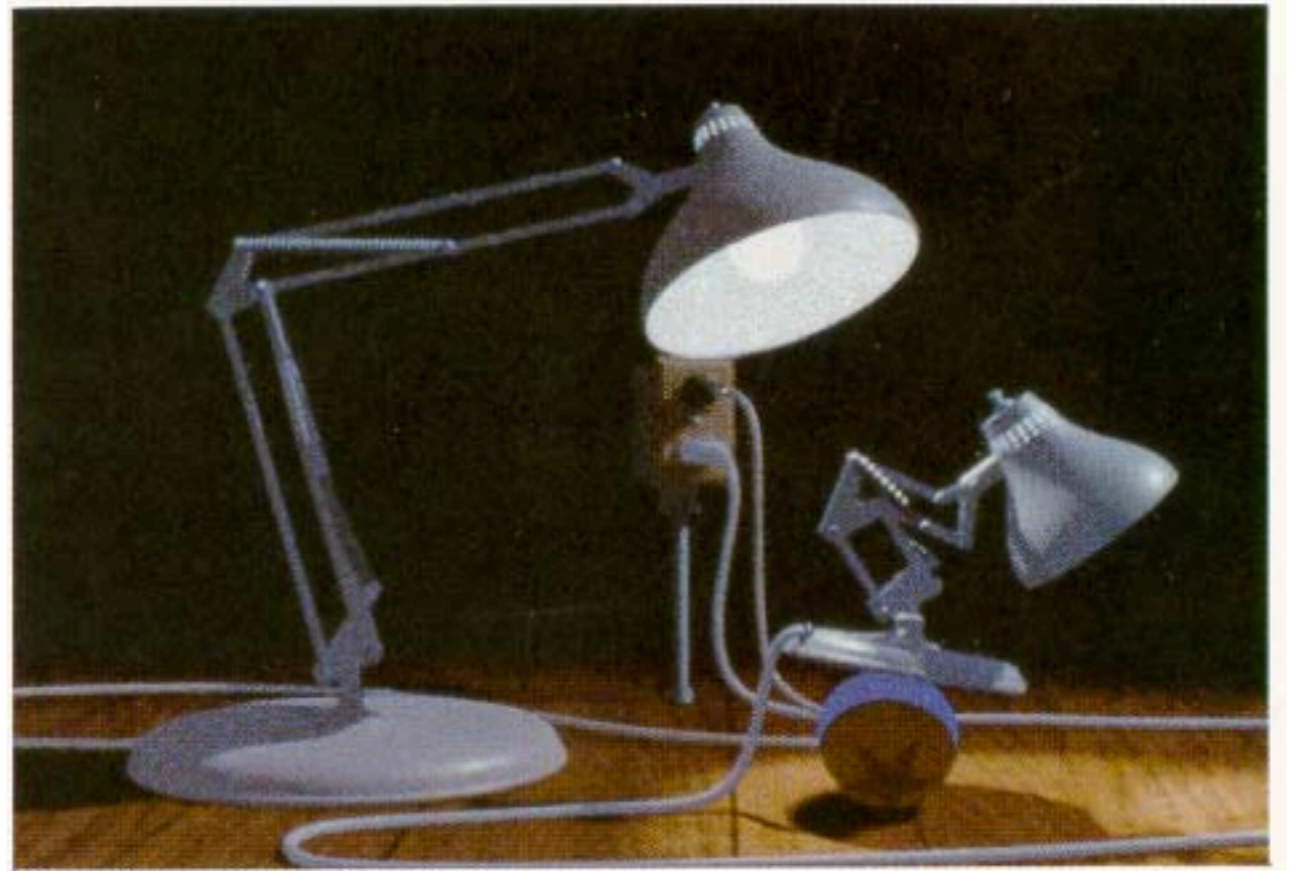
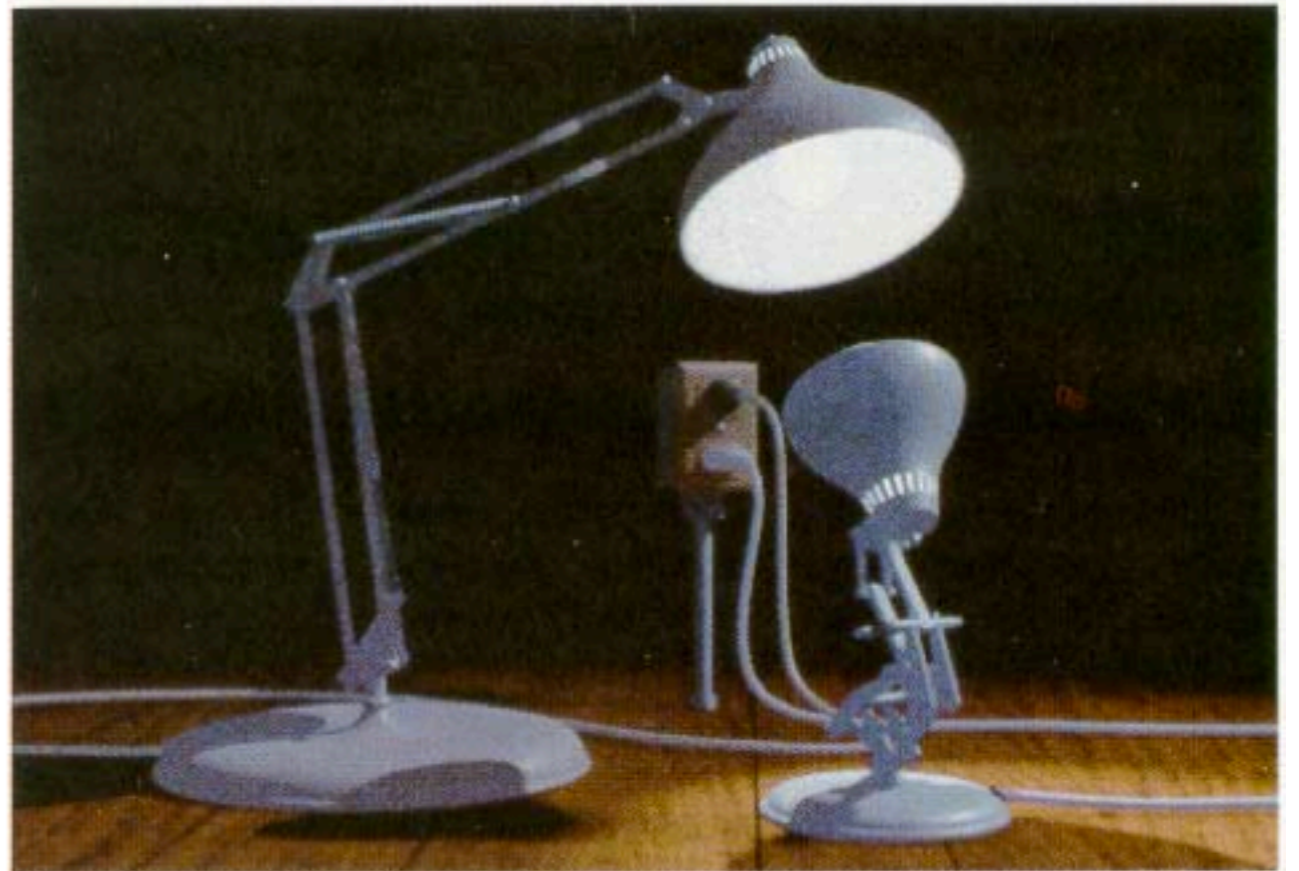
Keyframe animation

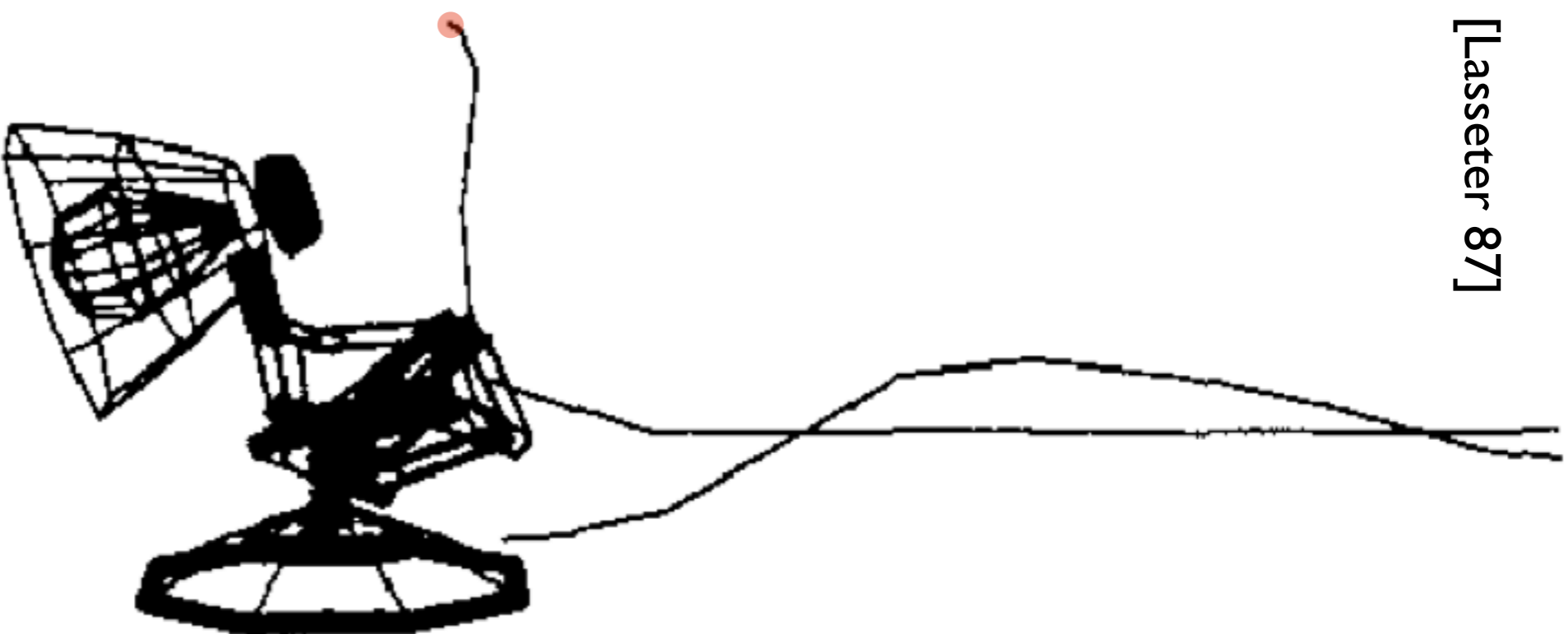
- draw a series of poses
- fill in the frames in between (“inbetweening”)
- computer animation uses interpolation



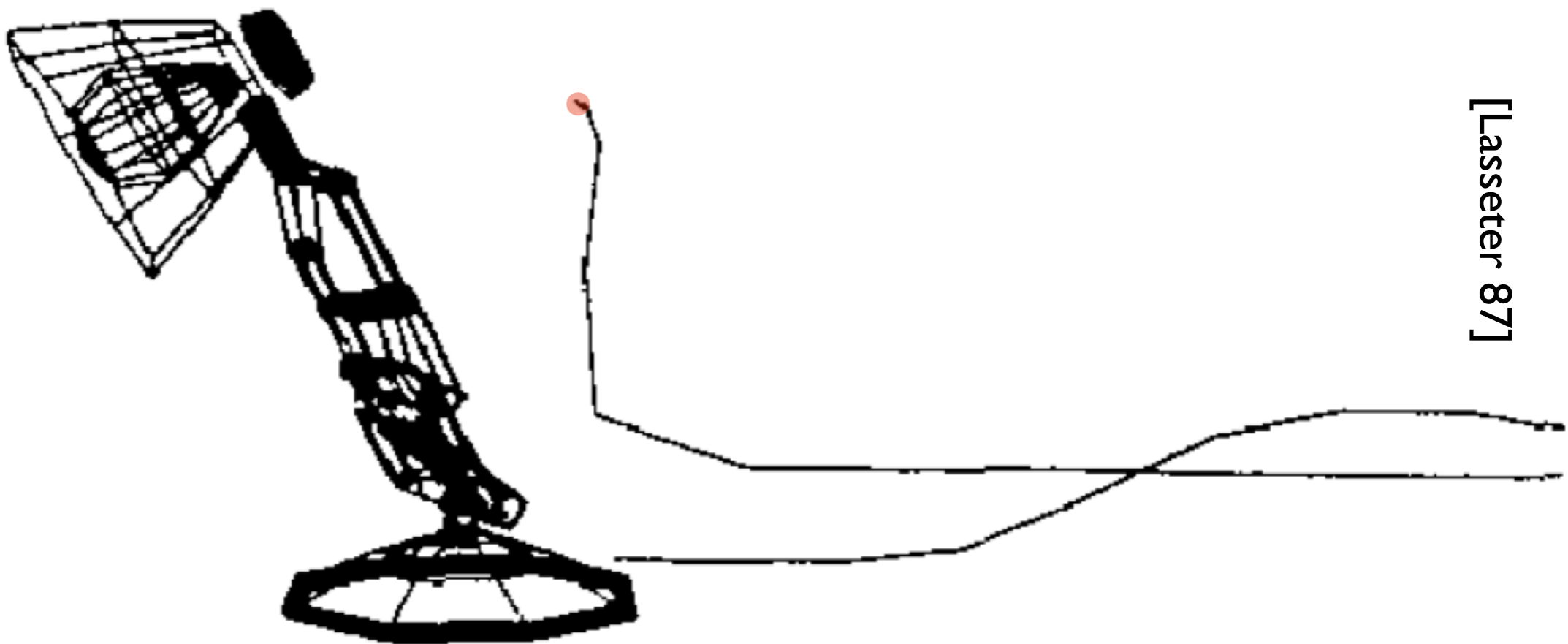
<http://anim.tmog.net>

Luxo Jr.

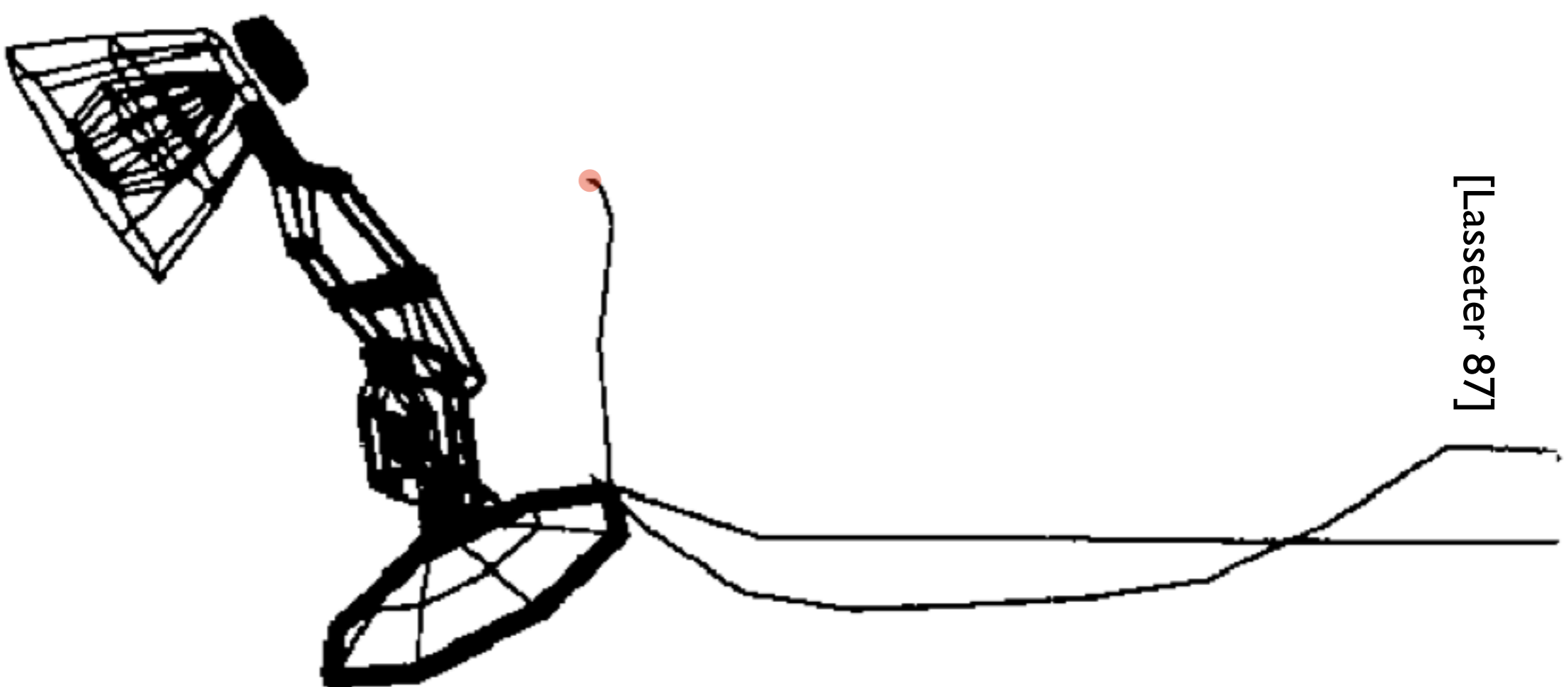




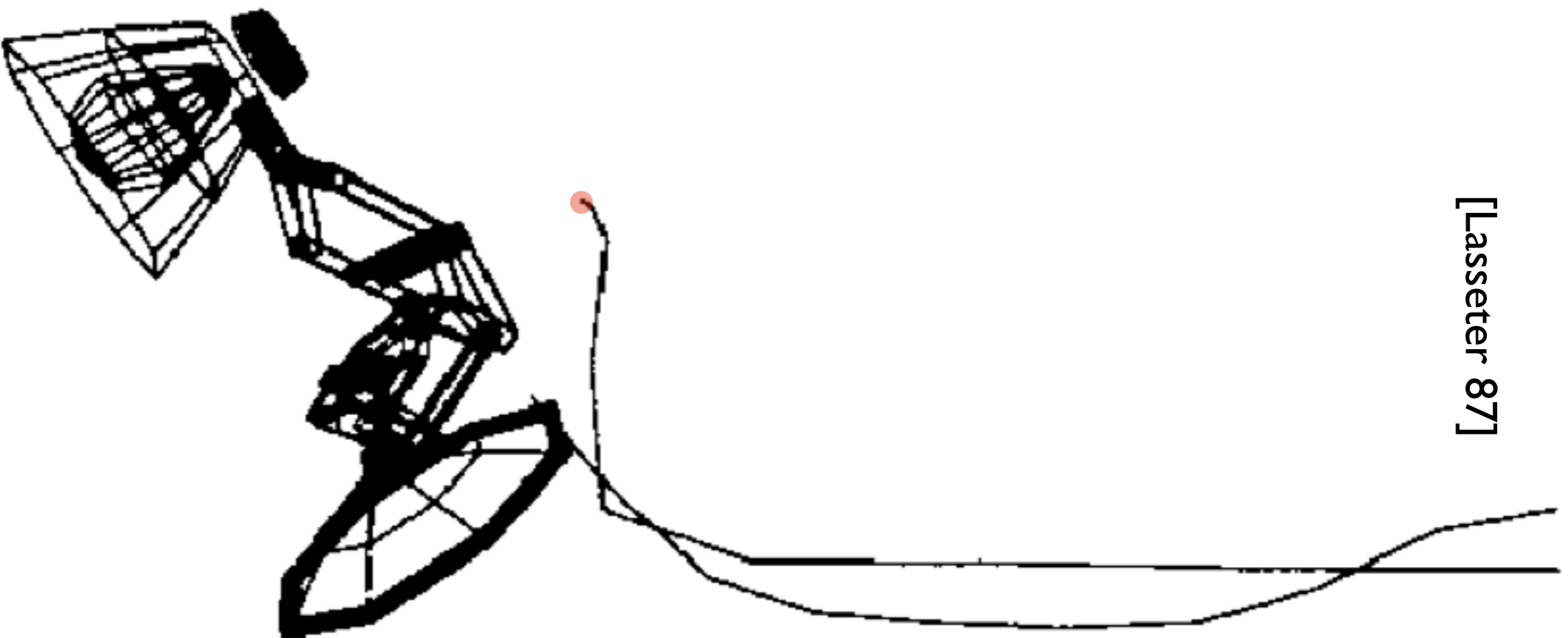
[Lasseter 87]



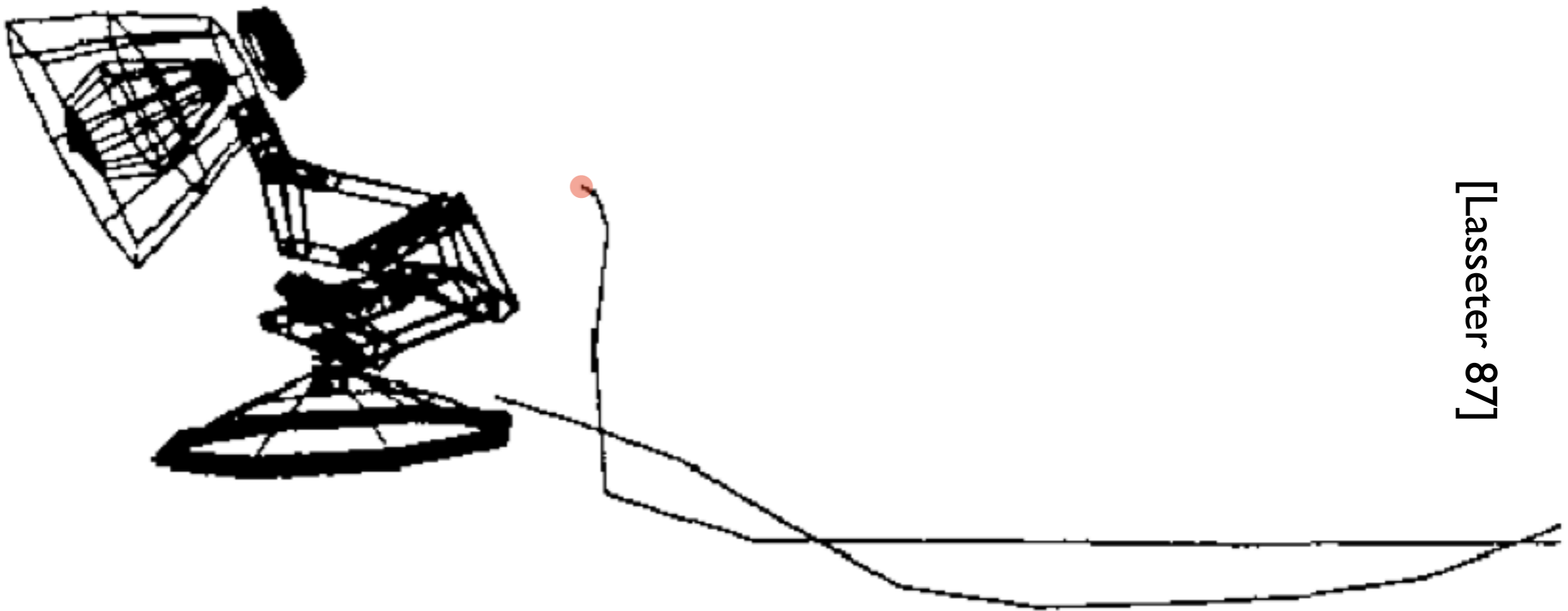
[Lasseter 87]



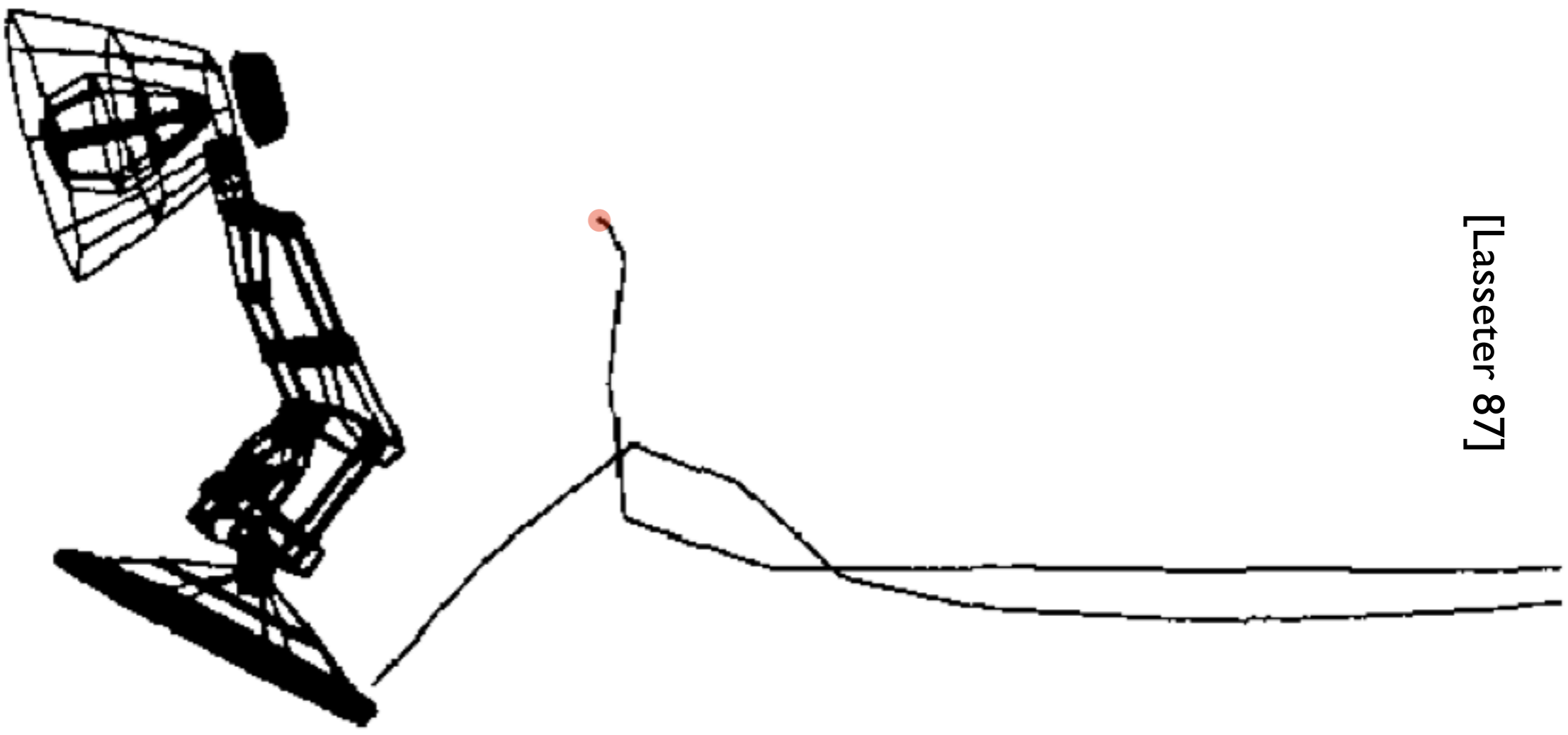
[Lasseter 87]



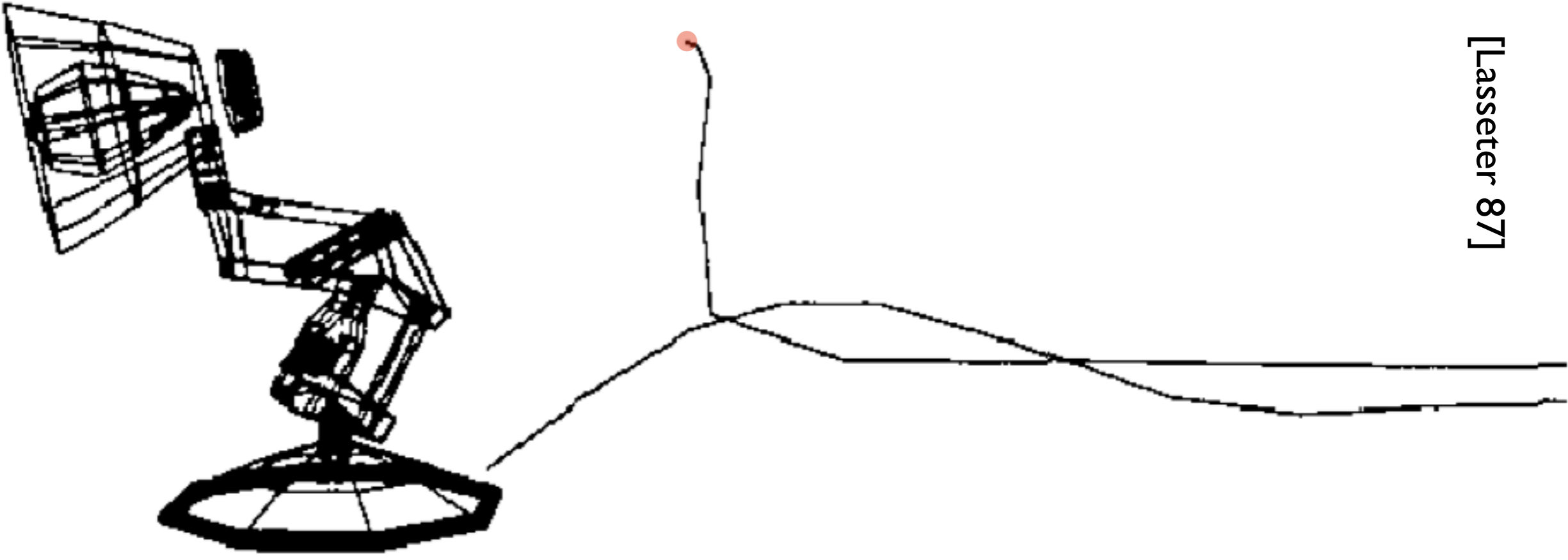
[Lasseter 87]



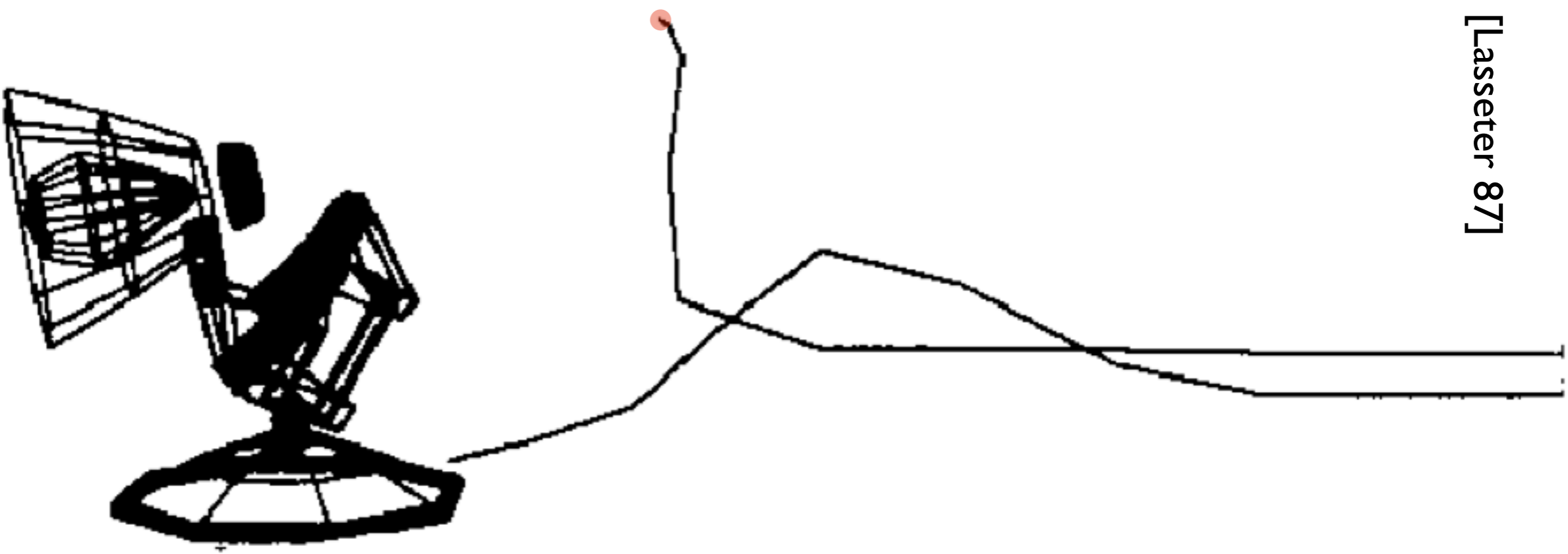
[Lasseter 87]



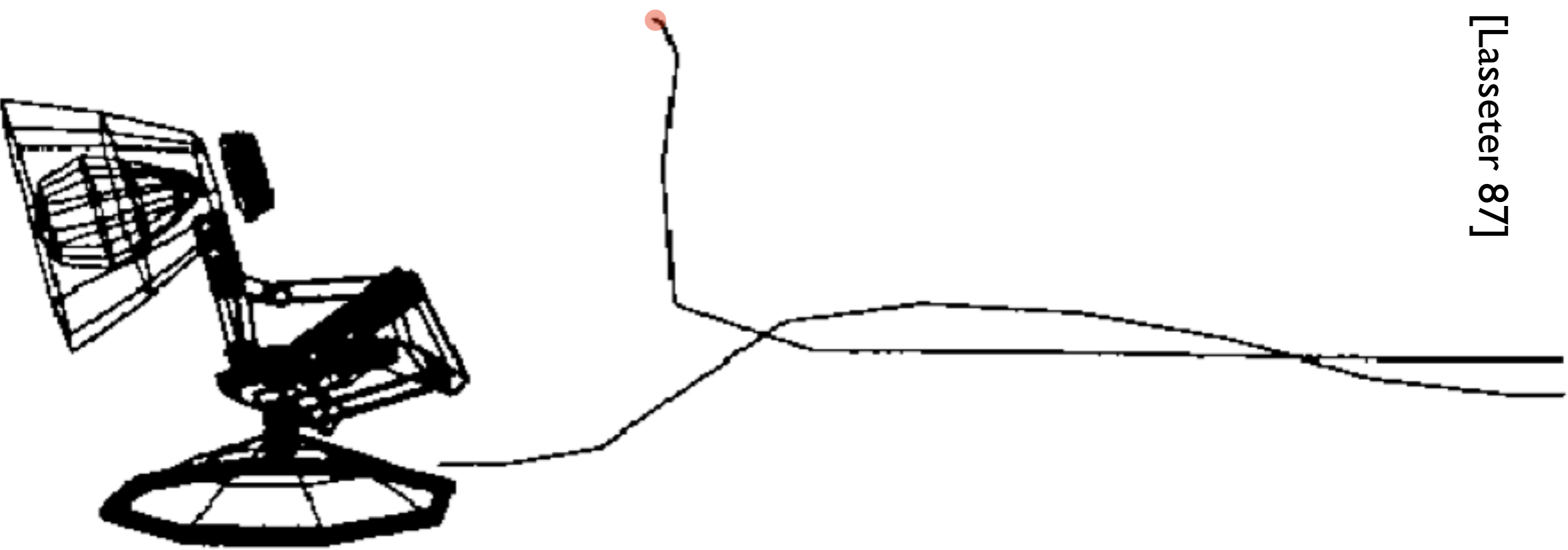
[Lasseter 87]



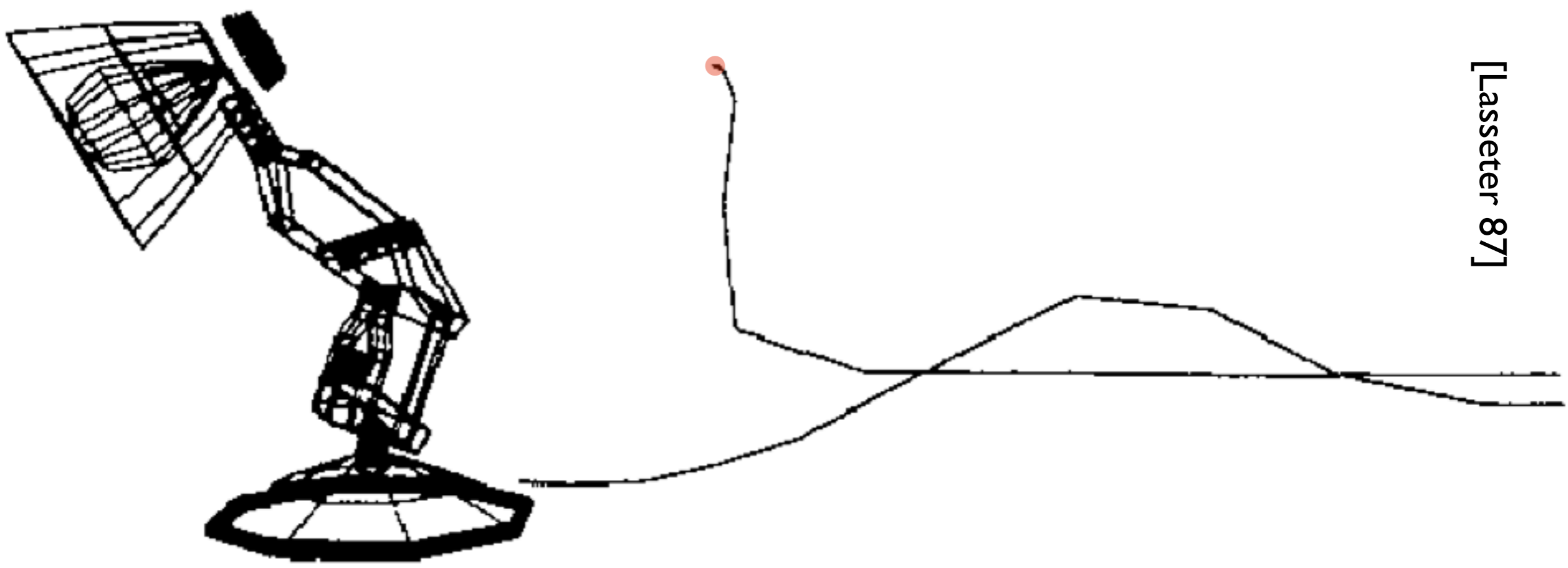
[Lasseter 87]



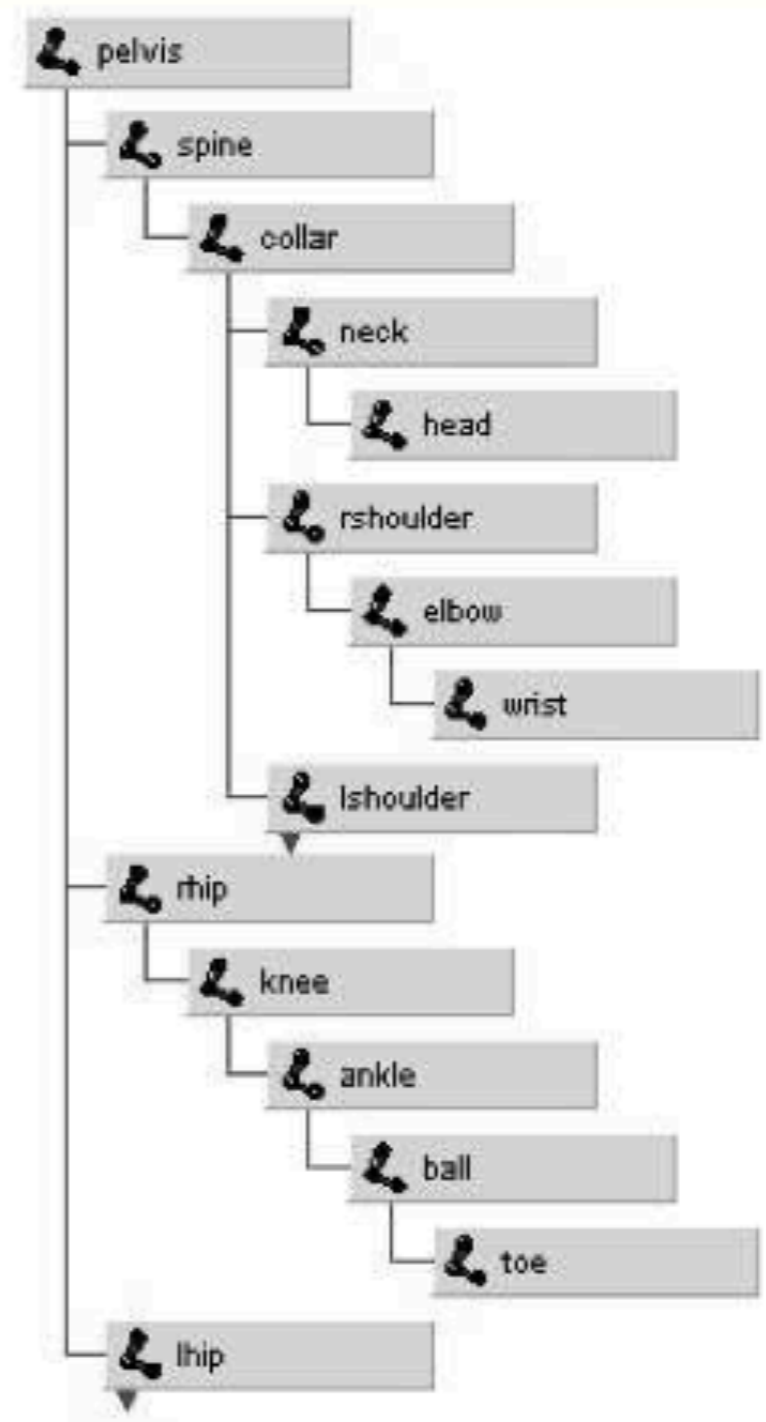
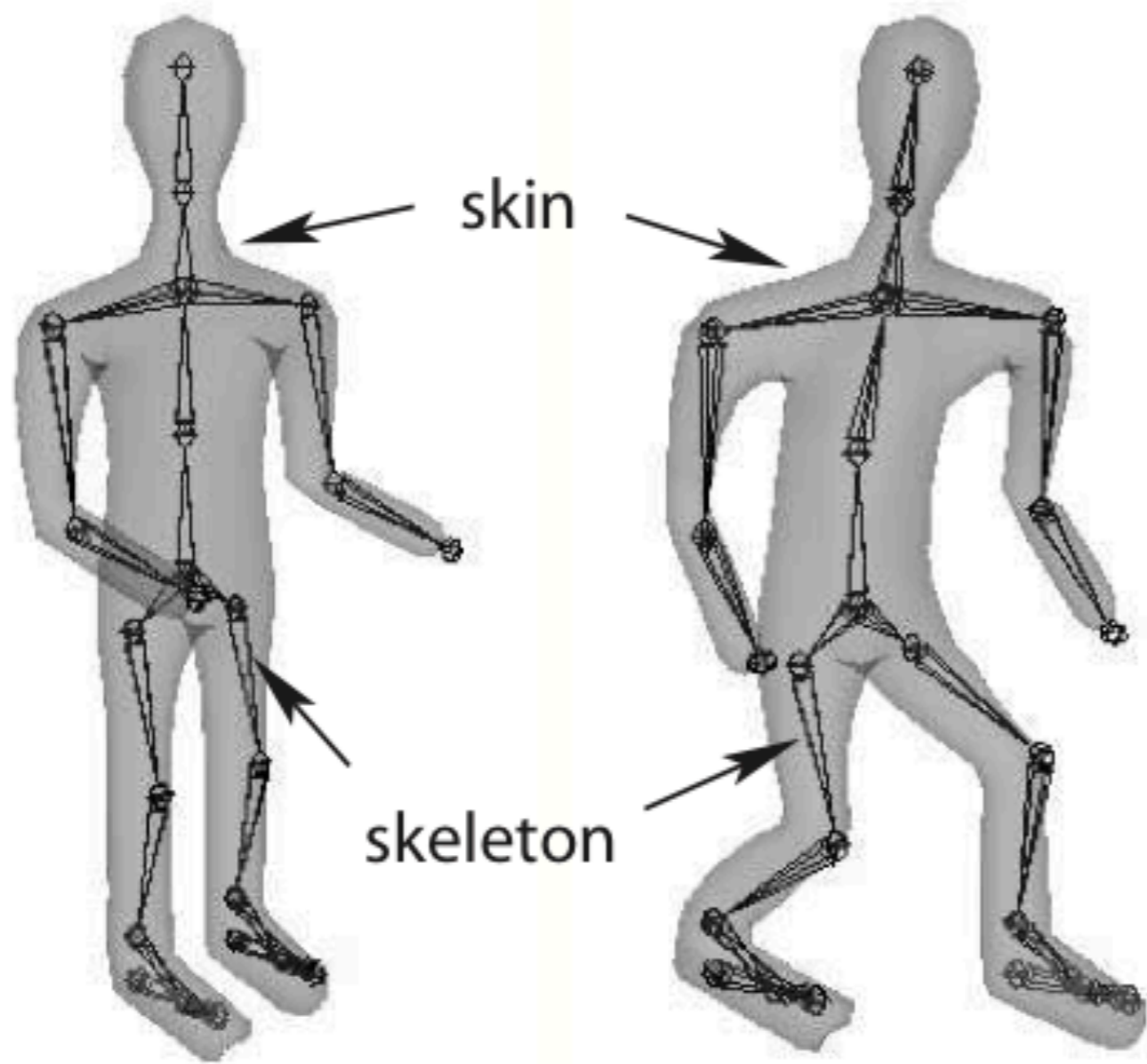
[Lasseter 87]



[Lasseter 87]

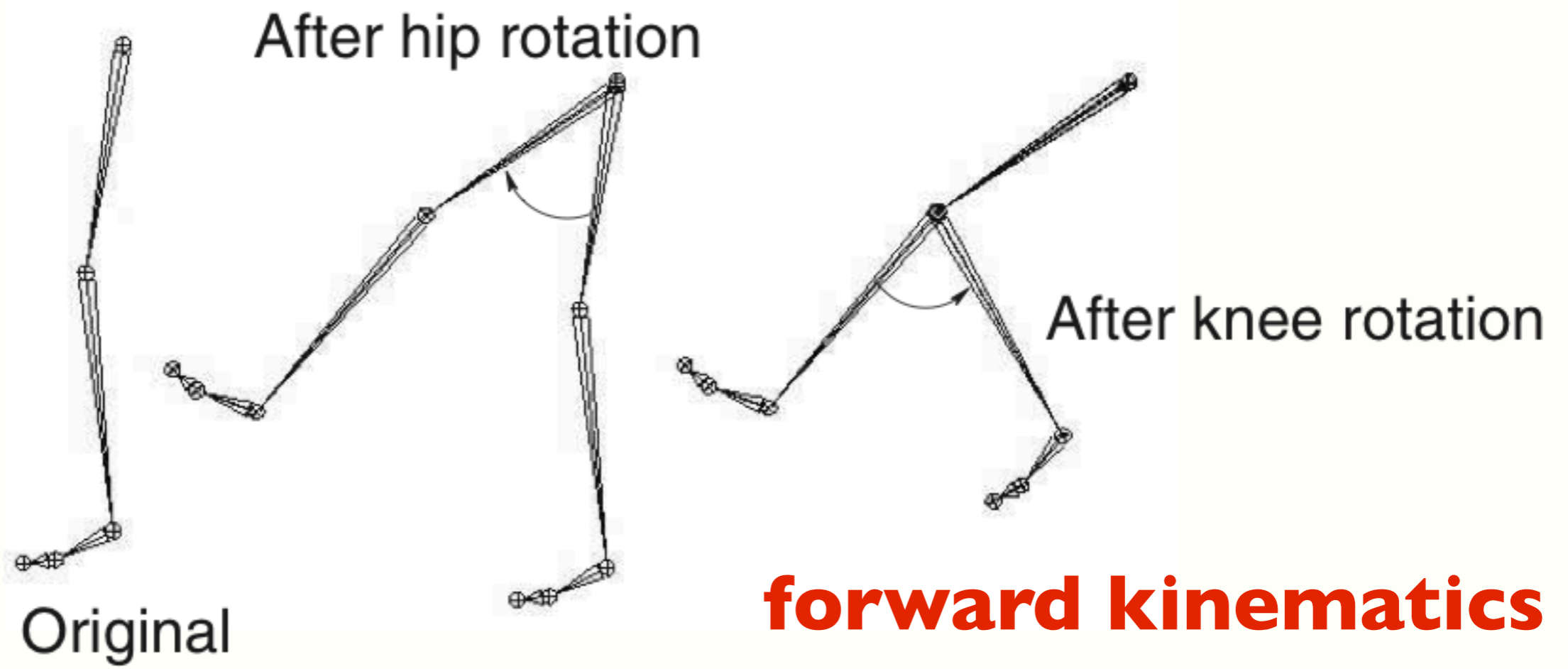


[Lasseter 87]

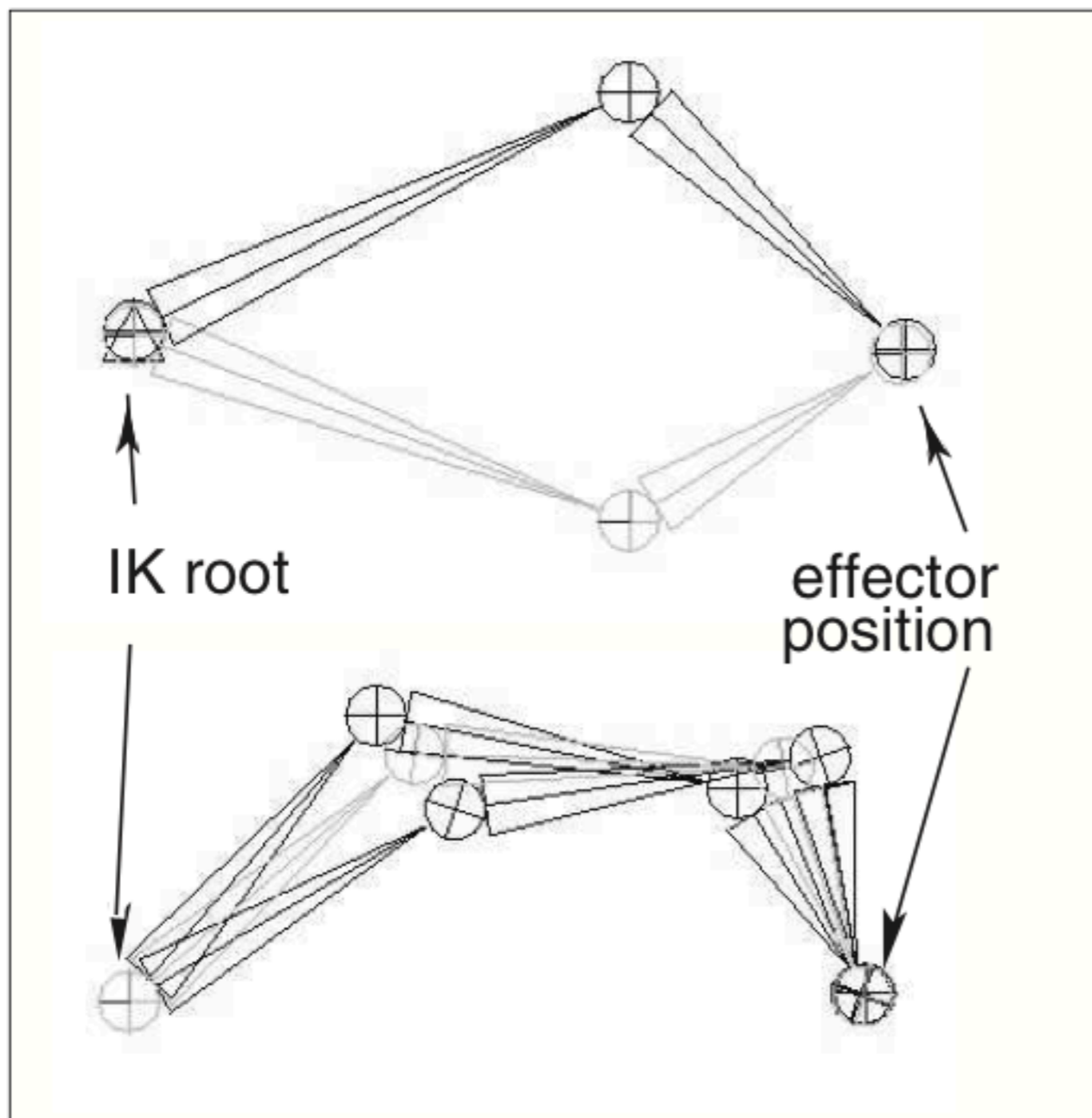


[Shirley and Marschner]

- forward kinematics - set joint angles starting at a root and working down the tree
- inverse kinematics - set end effector (e.g., hand) and solve for state of dofs up to root



[Shirley and Marschner]



multiple possible
states of joints

inverse kinematics

[Shirley and Marschner]

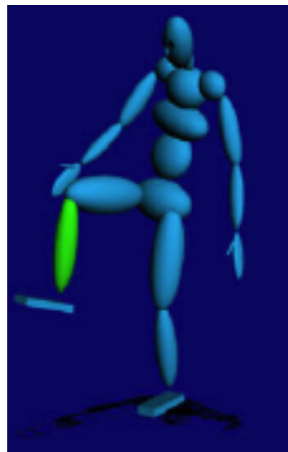
Keyframe character DOFs



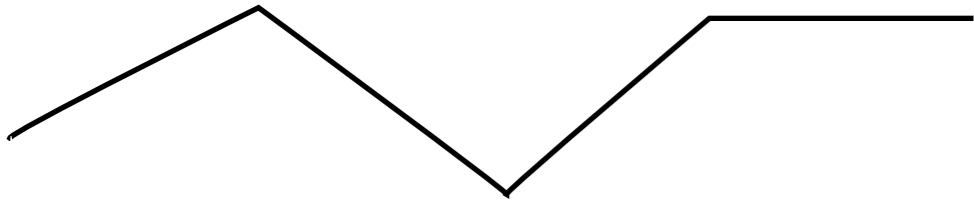
3 translational DOFs

48 rotational DOFs

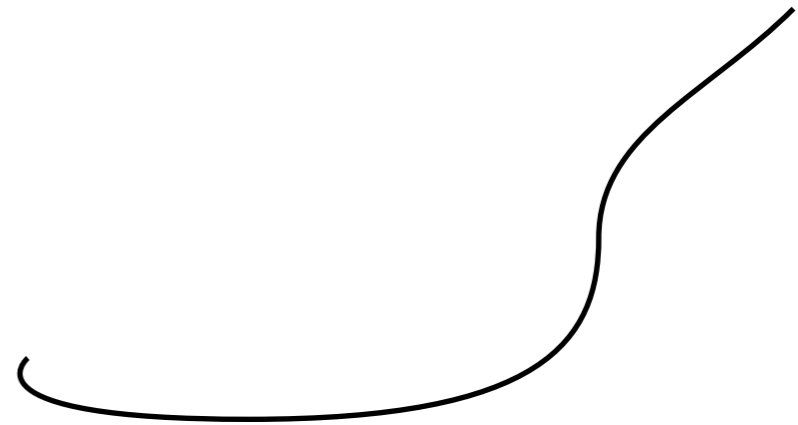
Each joint can have up to 3 DOFs



Interpolation of keyframes

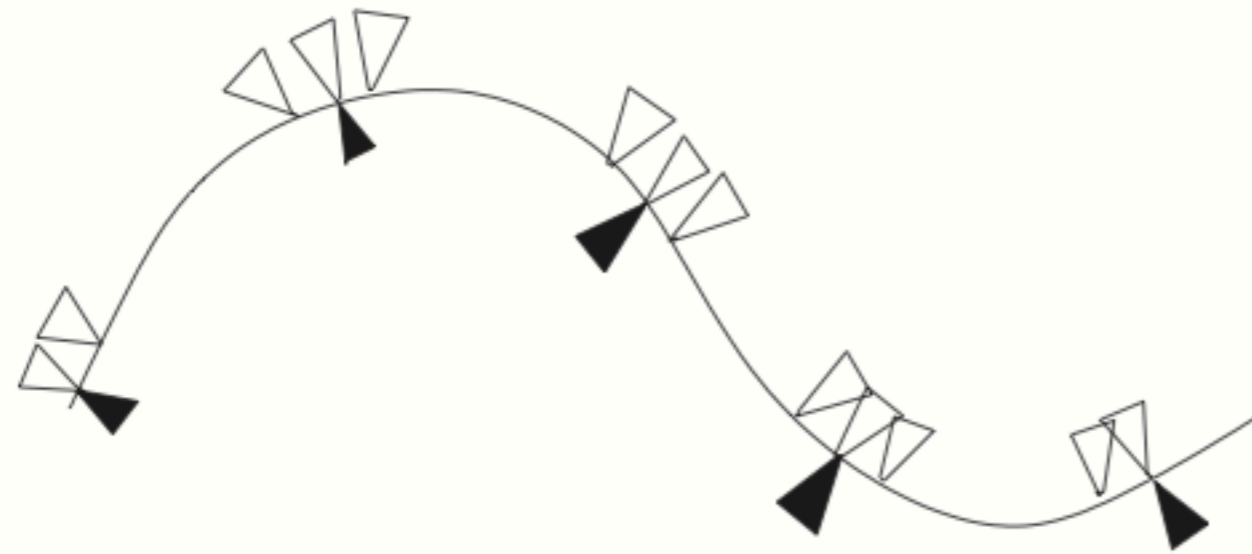
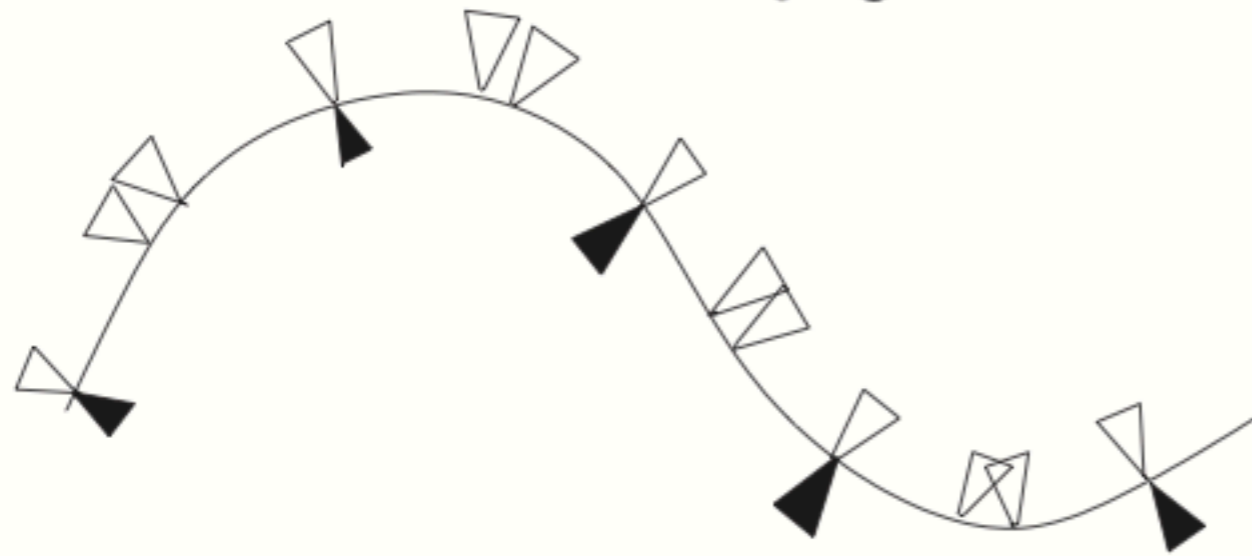
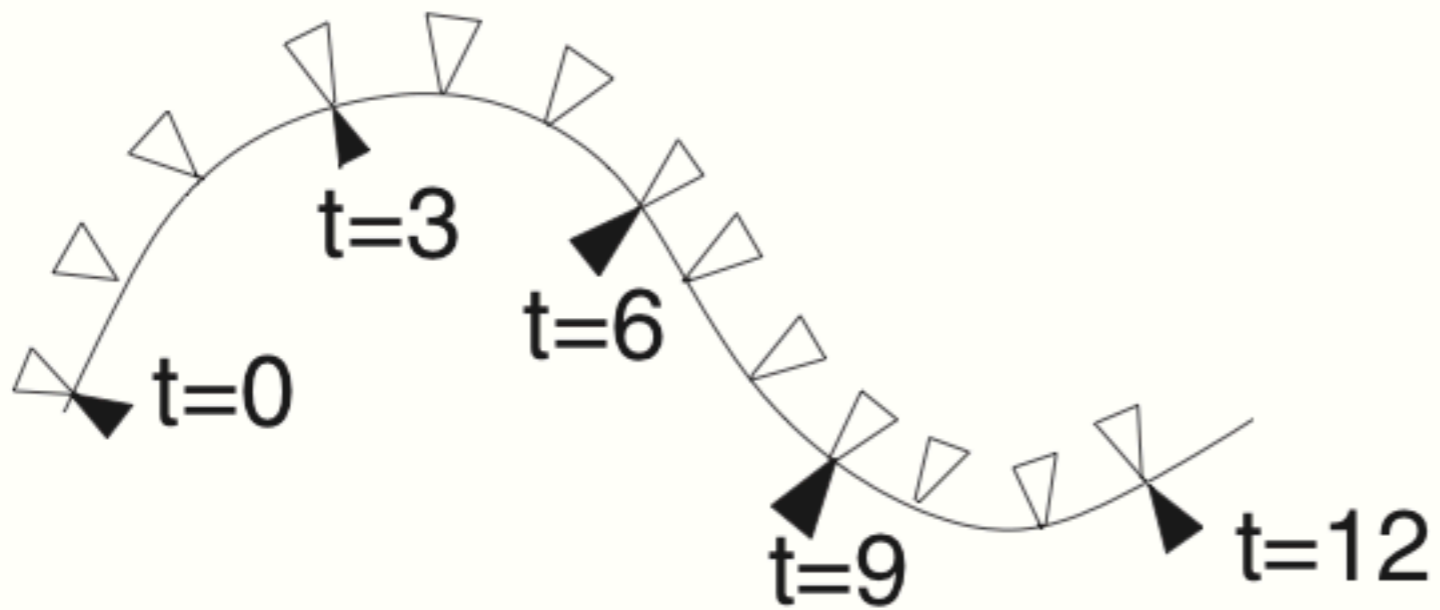


linear interpolation



spline interpolation

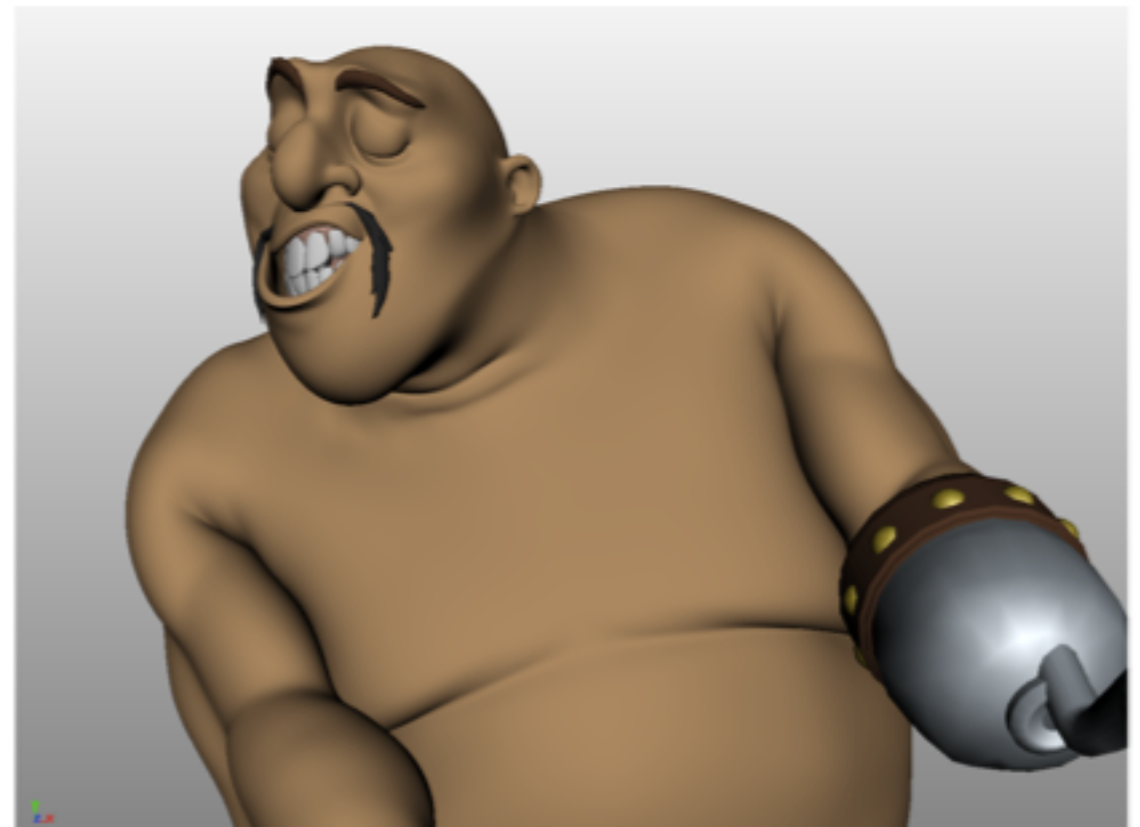
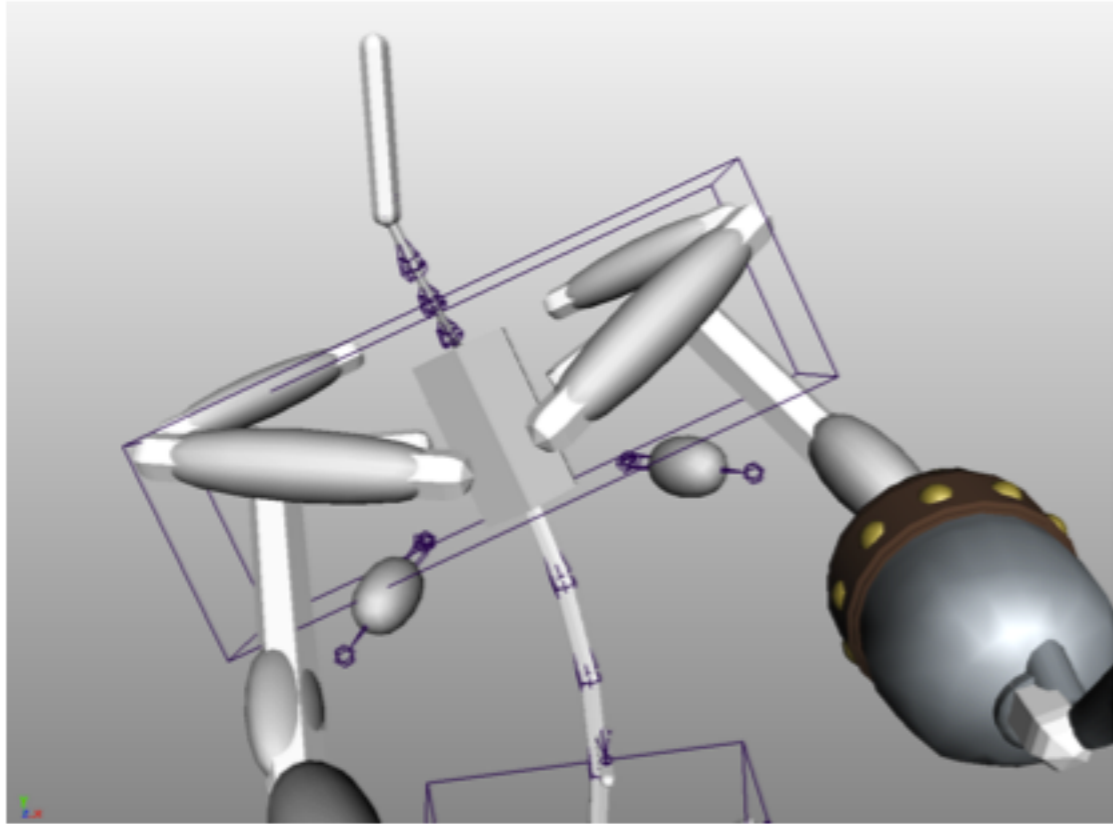
Straightforward to interpolate position but what about orientation?



need to consider
both
shape of motion
and
speed of motion

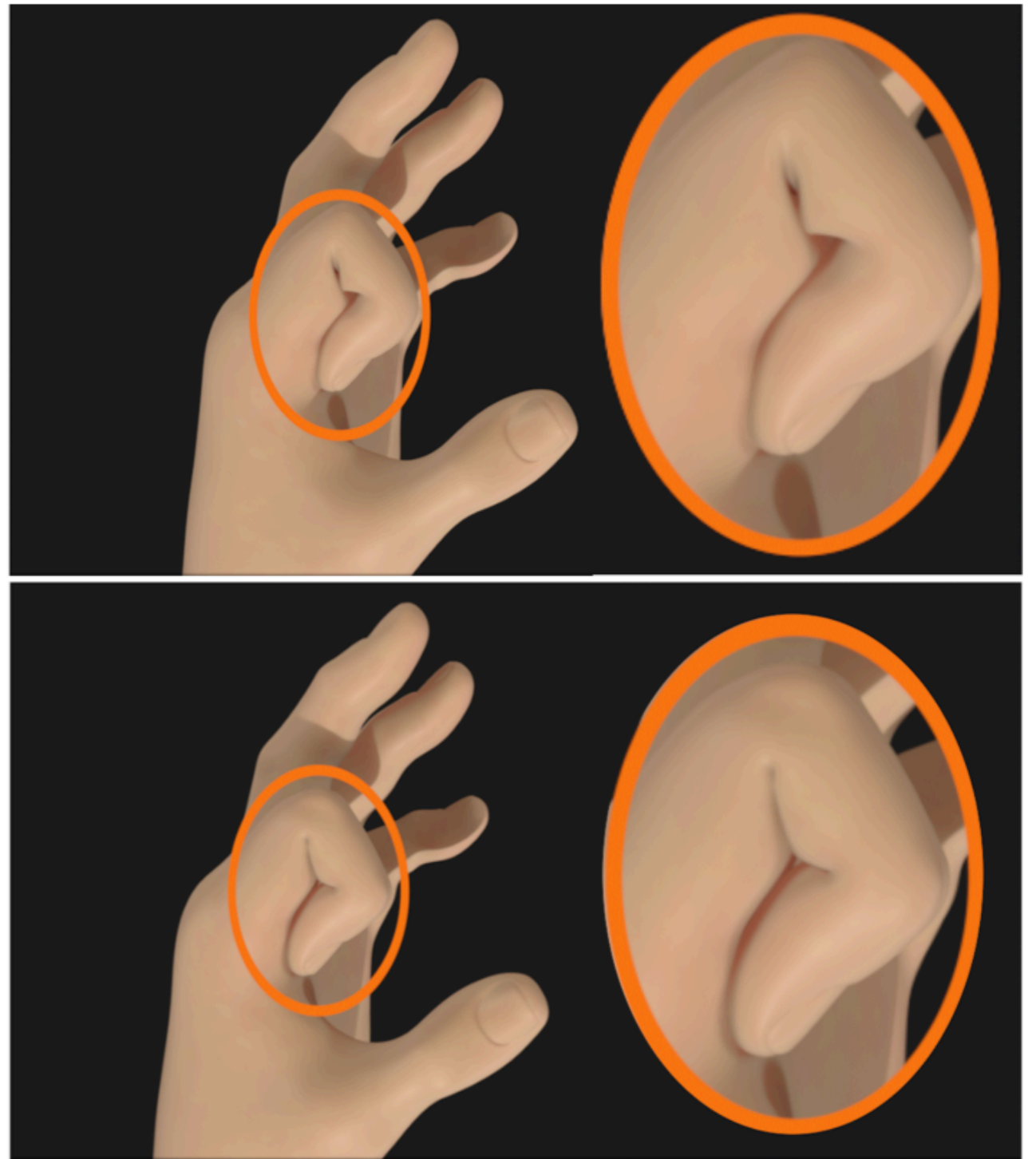
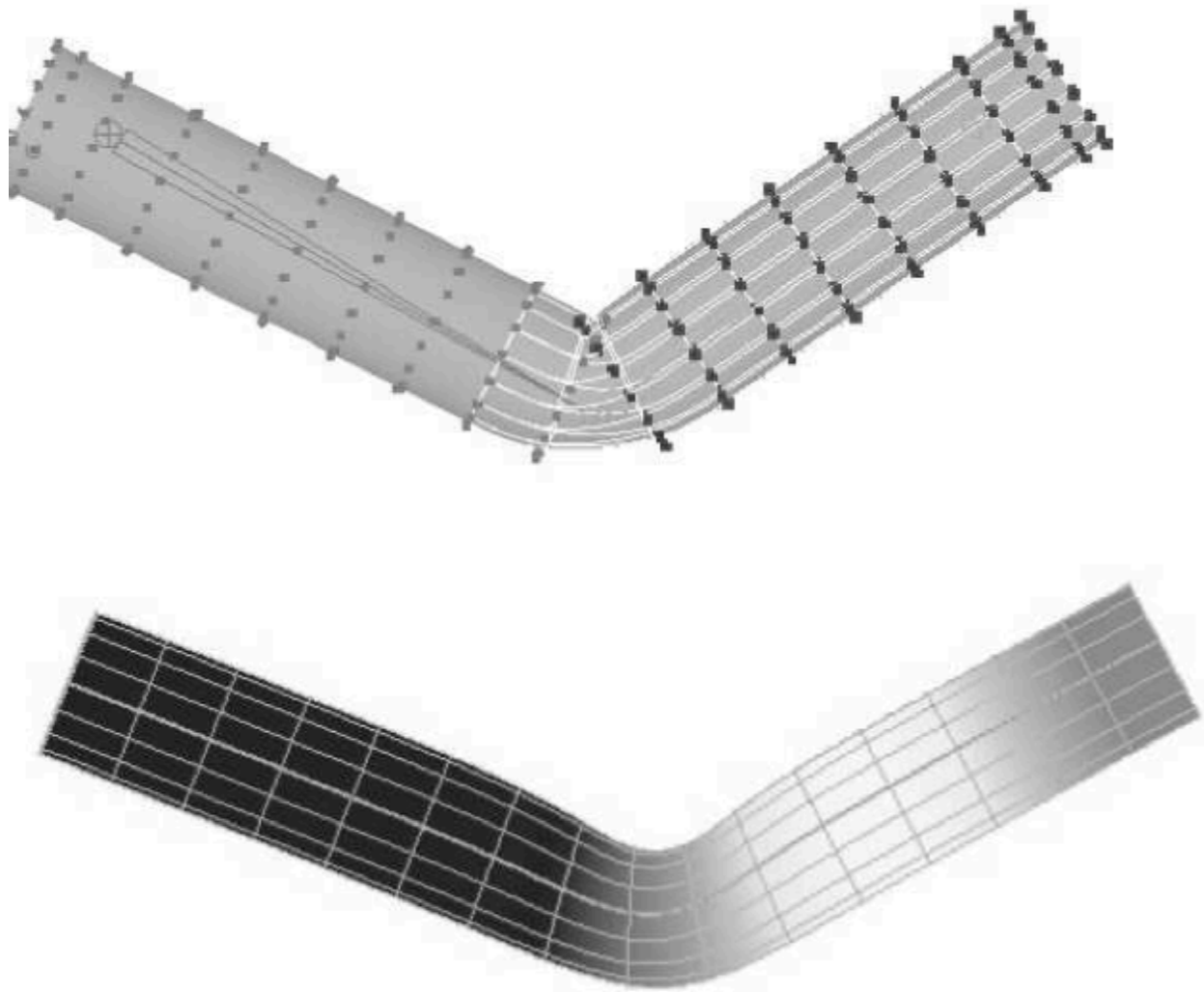
[Shirley and Marschner]

Character Skinning

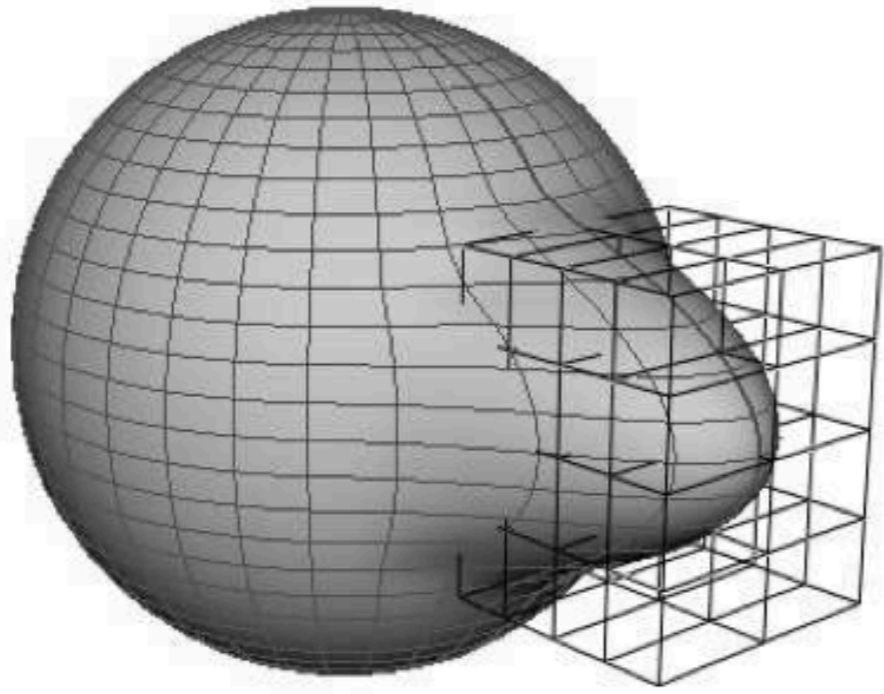


[McAdams et al. 2011]

Character Skinning

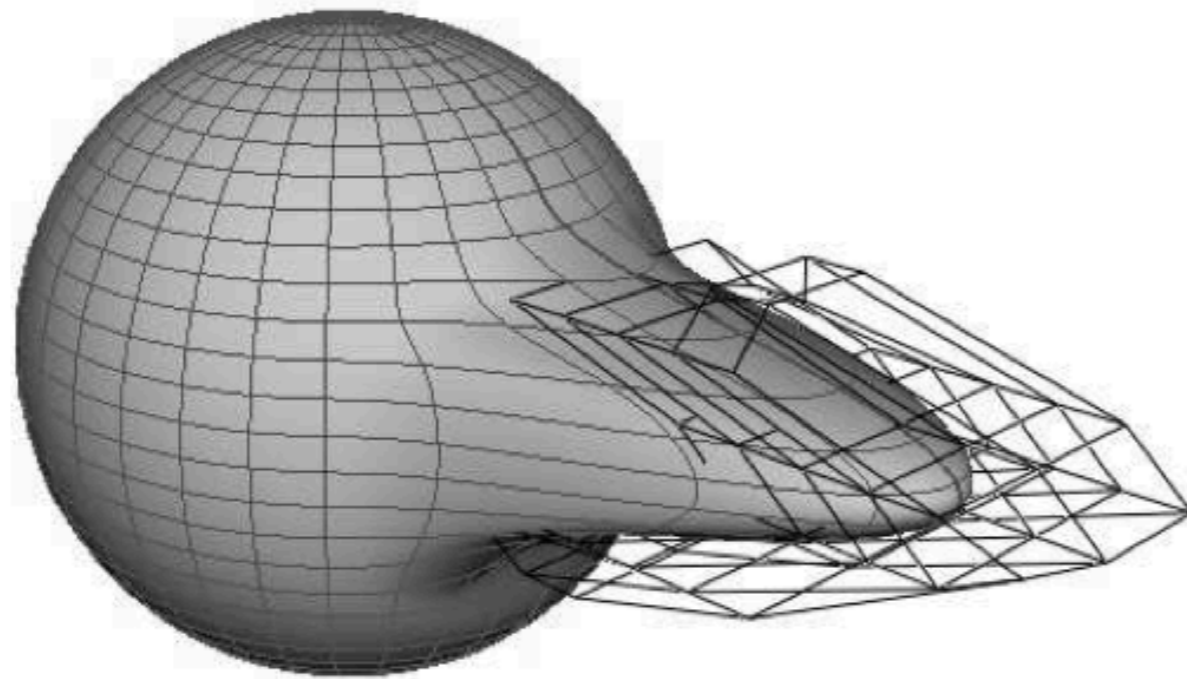


[McAdams et al. 2011]



free form deformation

[Sederberg 1986]



[Shirley and Marschner]

facial animation



©2004 Disney/Pixar





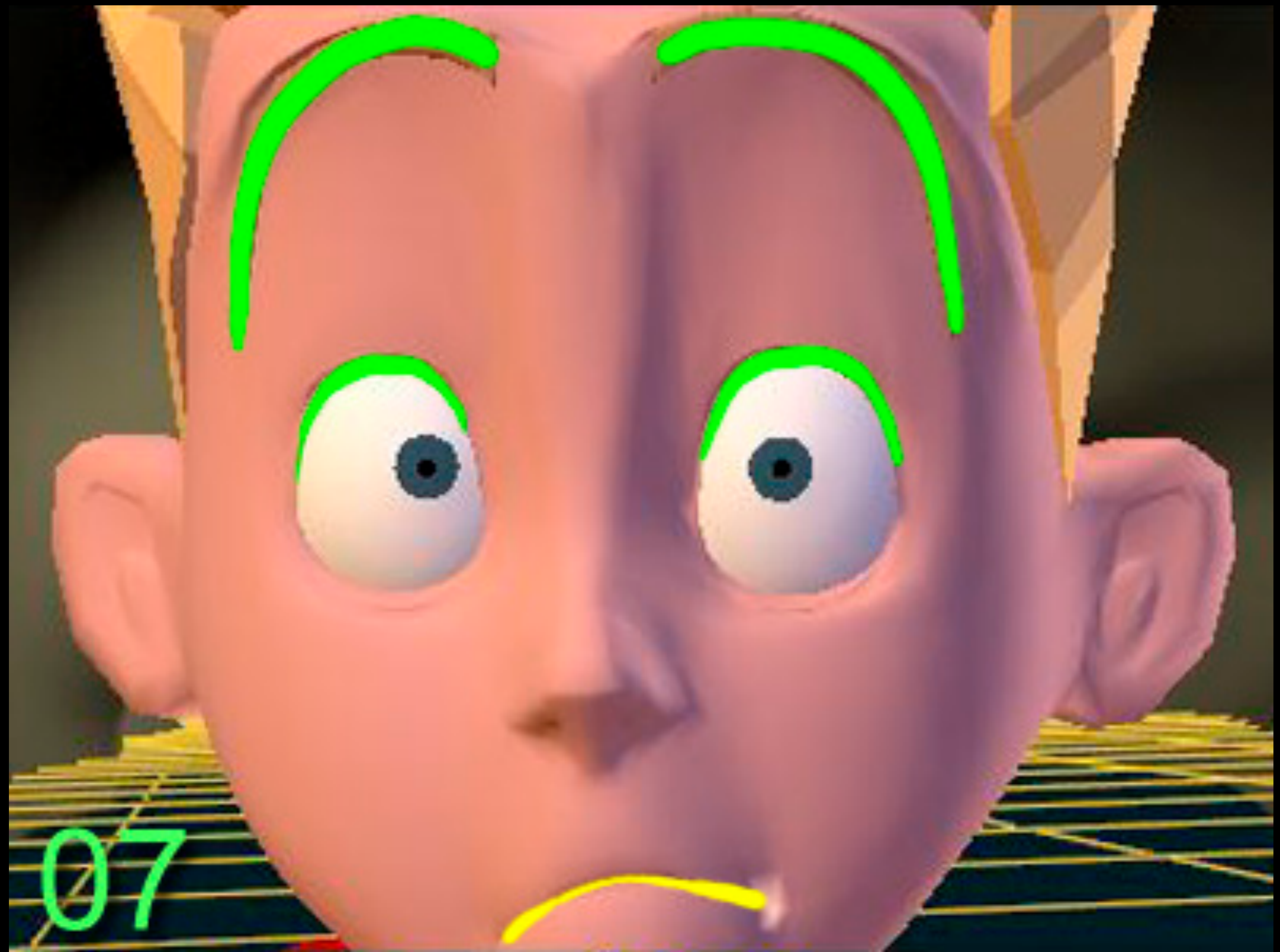


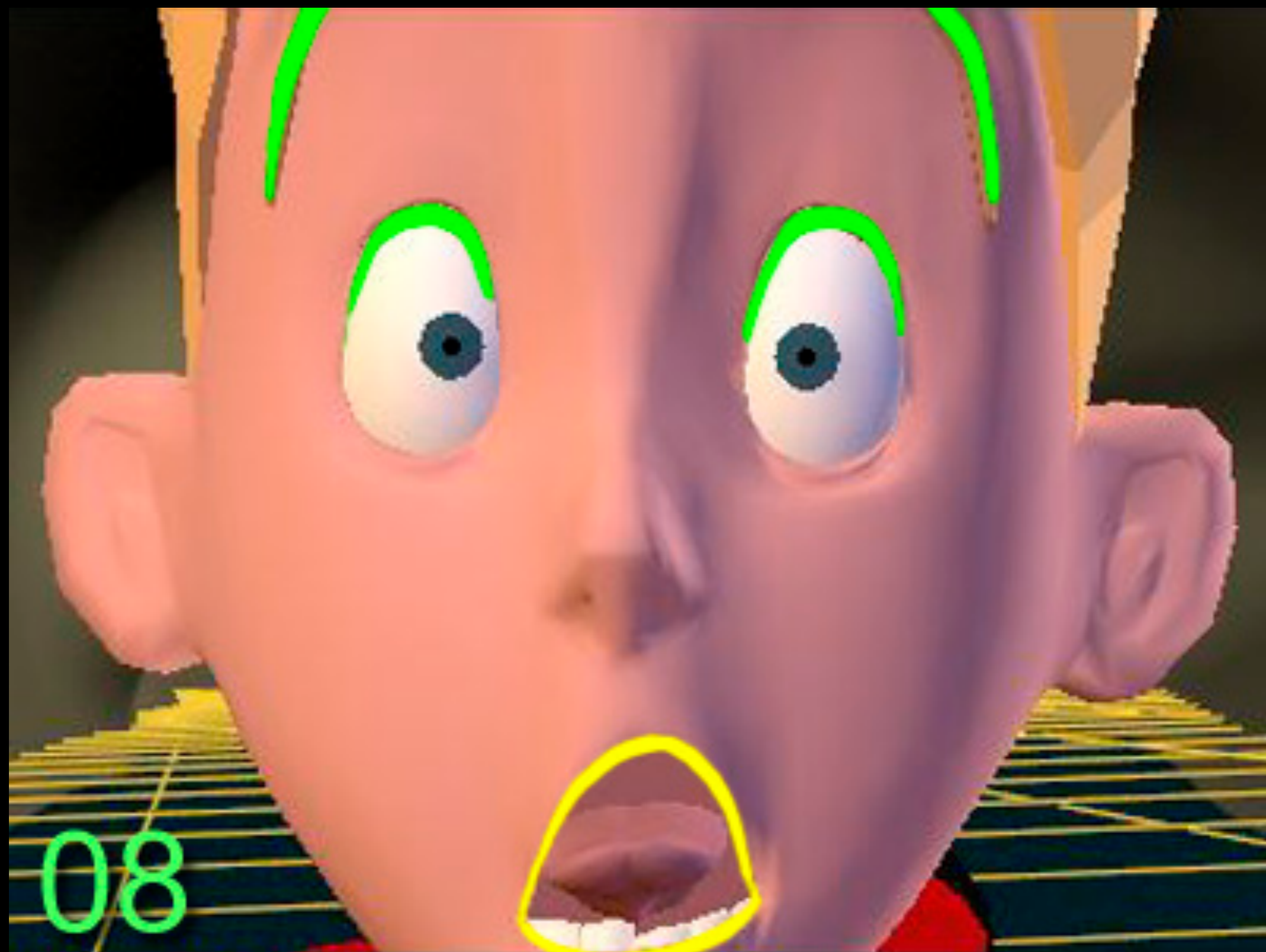


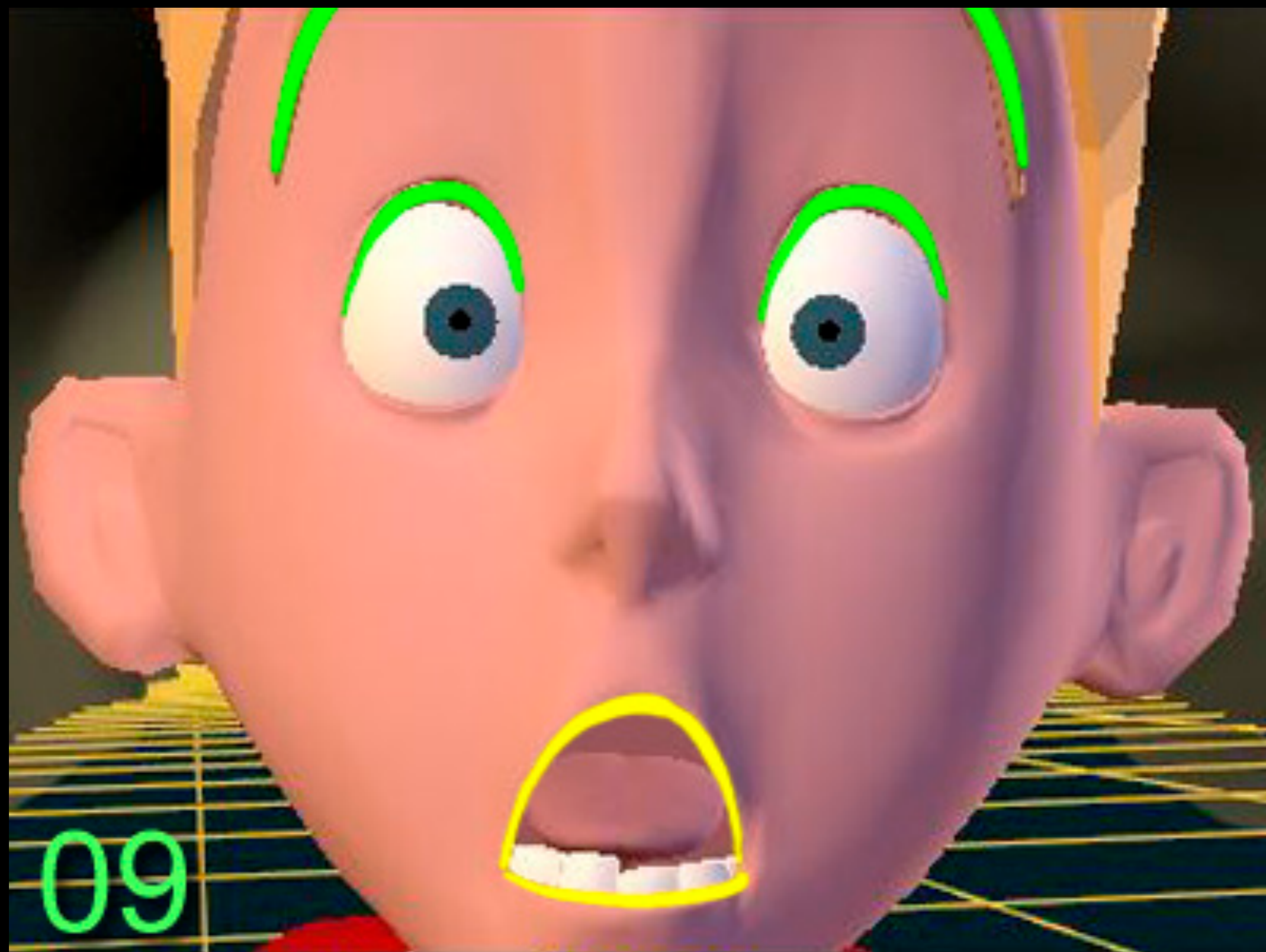


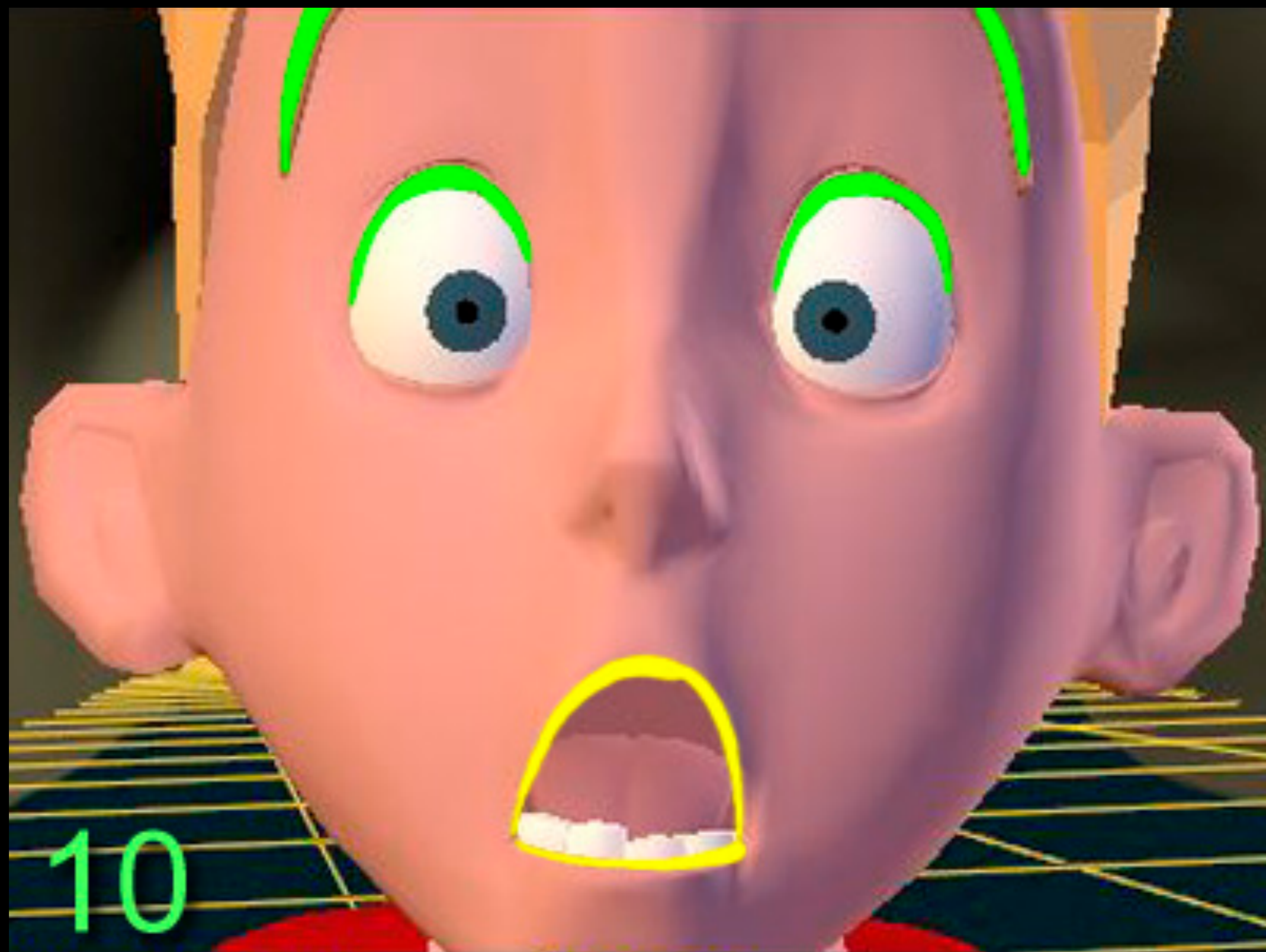




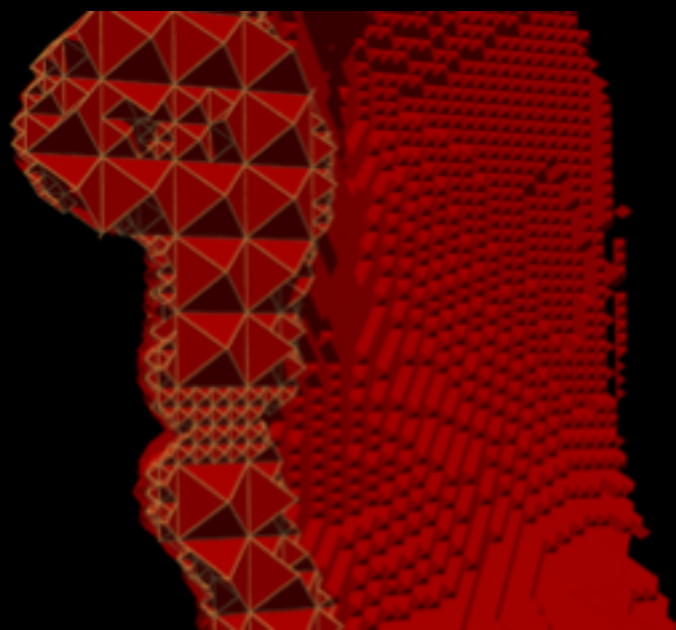




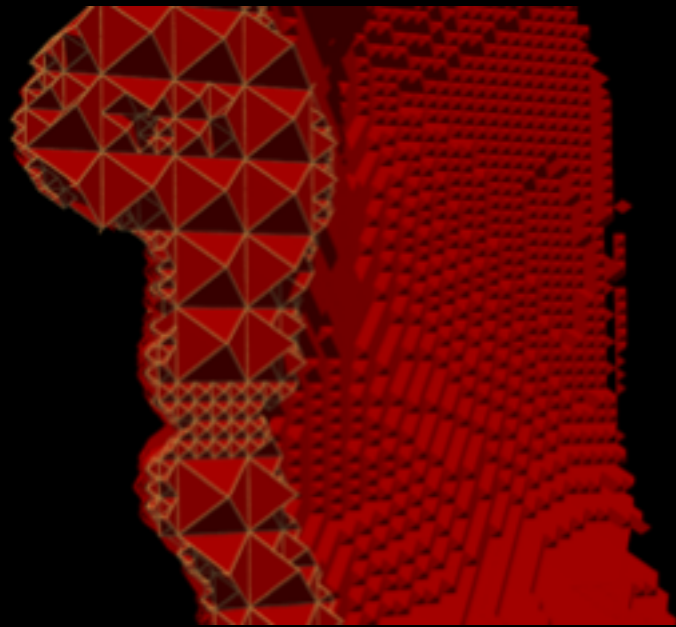
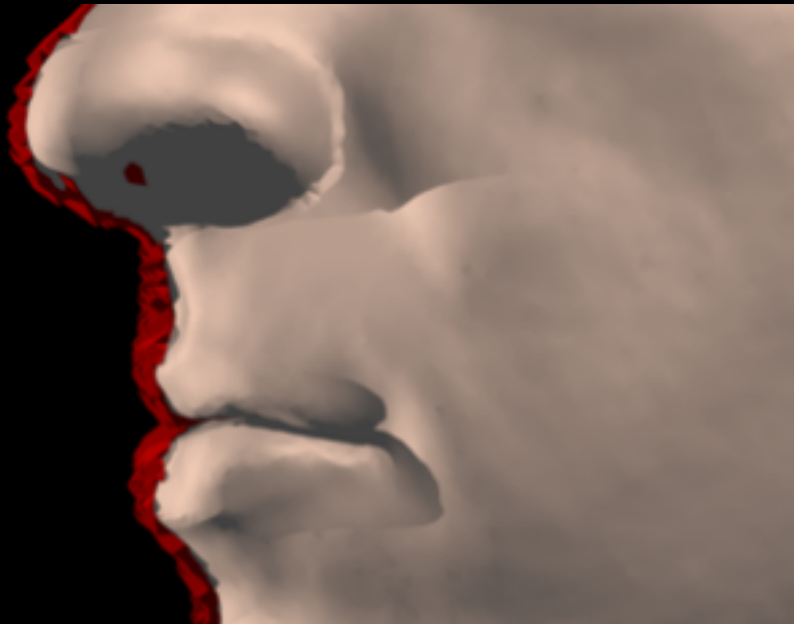




Facial animation



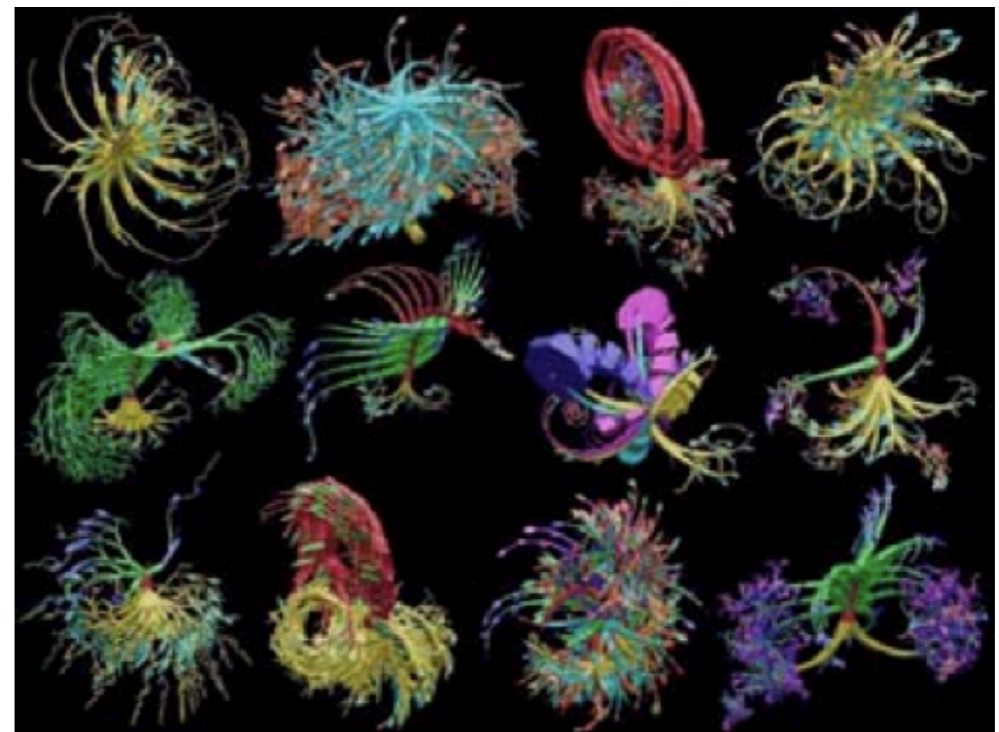
Facial animation



procedural animation

Artificial life

- plants - movement and growth
- evolving artificial life



Crowd simulation



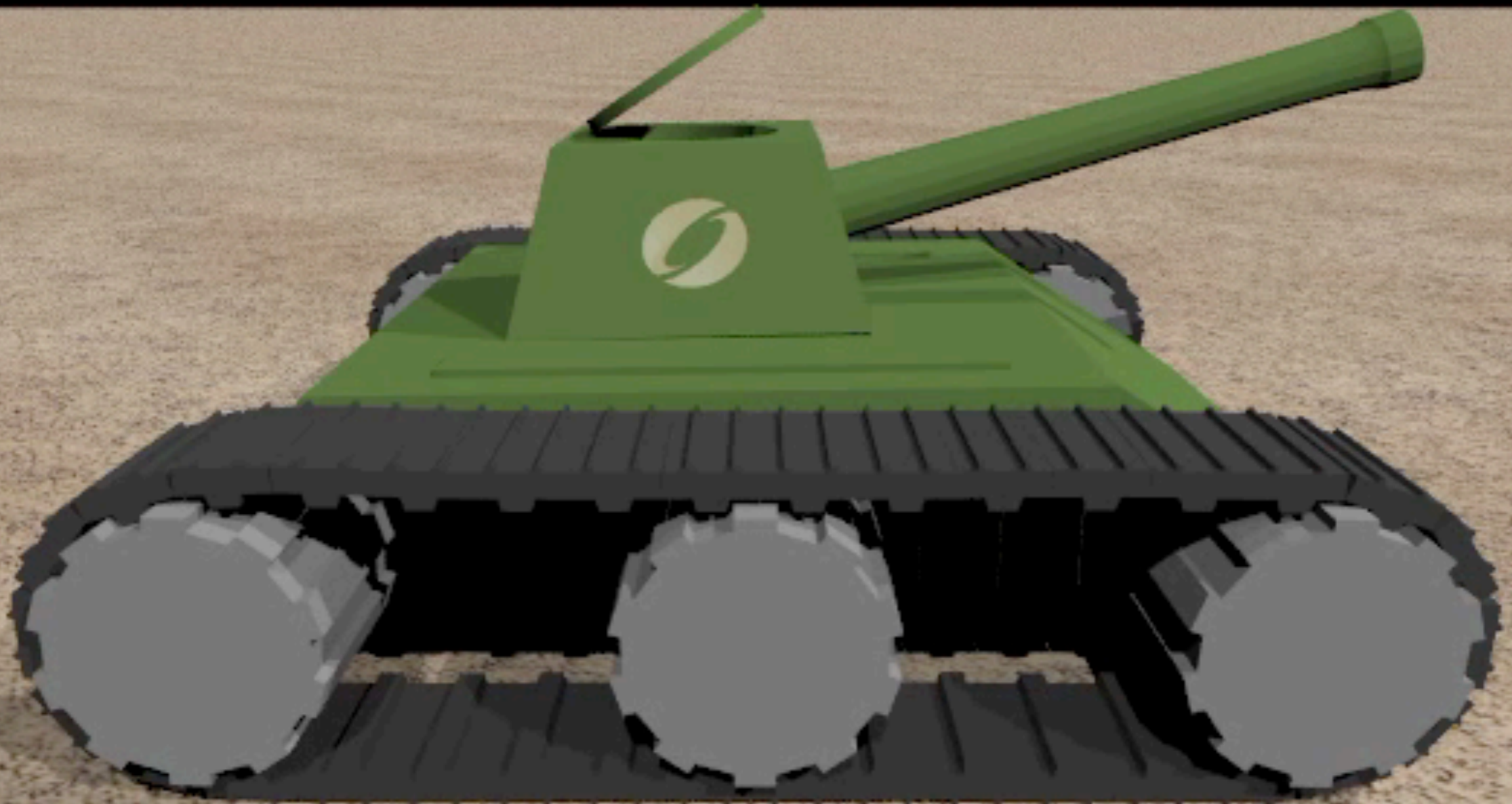
[Treuille et al. 2006]

- agent-based, model behavior
- also, “global effects” – e.g., incompressibility
- emergent phenomena

physics-based animation

Rigid body simulation

[Weinstein et al 2006]



Deformable object simulation



[Molino et al. 2004]



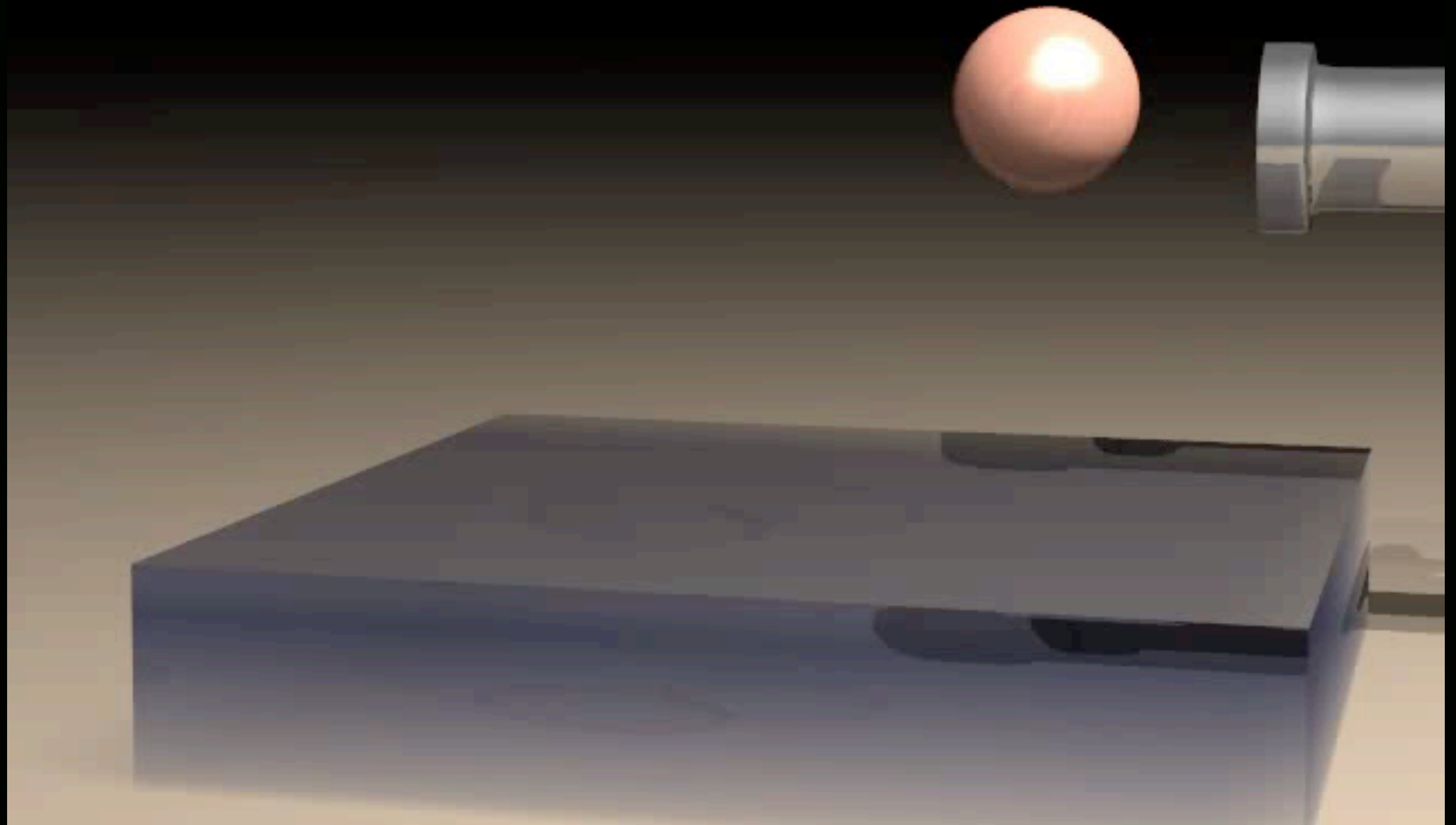
[Selle et al. 2008]

Fluid simulation

[Losasso et al. 2006]

Fluid simulation

[Losasso et al. 2006]



Control of virtual character

[Shinar et al. 2008]

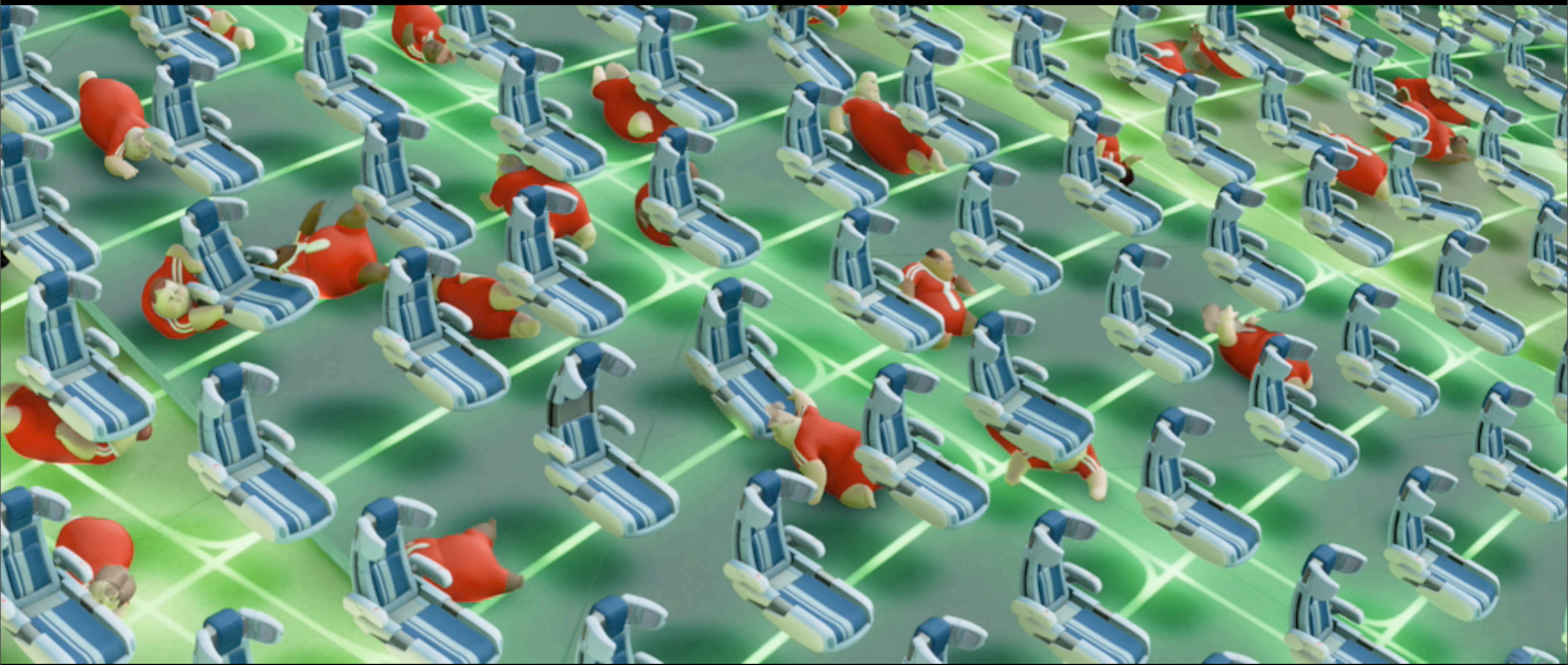
Control of virtual character

[Shinar et al. 2008]



issues: control algorithms, interaction with environment

rigid/deformable simulator in Pixar's *WALL-E*



rigid/deformable simulator in Pixar's *WALL-E*



Disney's Paperman

Paperman and the Future of 2D Animation



trailer: <http://www.youtube.com/watch?v=mM6cLnscmO8>

making of: http://www.youtube.com/watch?v=TZJLtujW6FY&feature=youtube_gdata_player