

# CS 130 : Computer Graphics

Animation

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# Types of animation

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

**history**

# Gertie the Dinosaur

1914

12 minutes

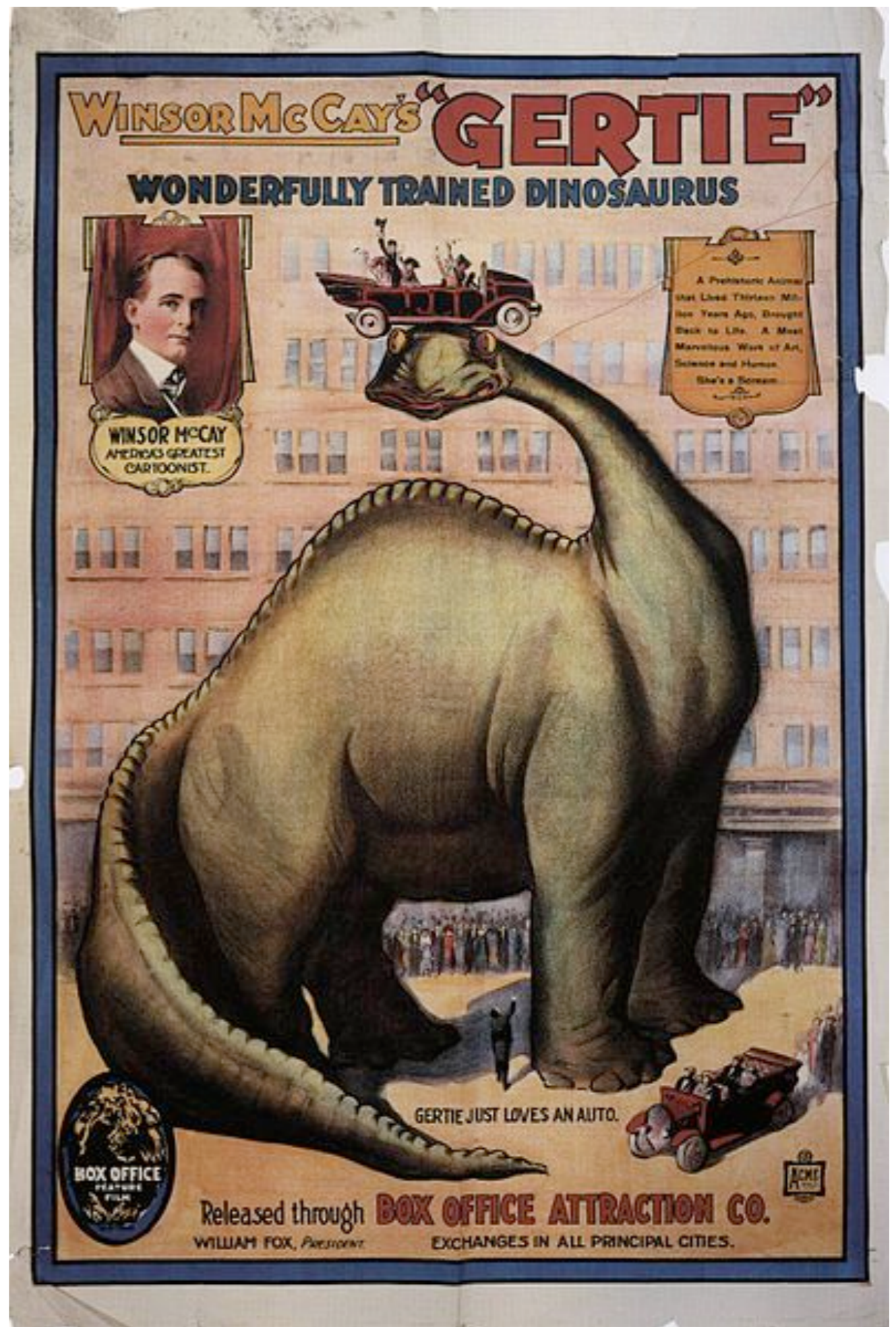
hand drawn

keyframe animation

registration

cycling

link





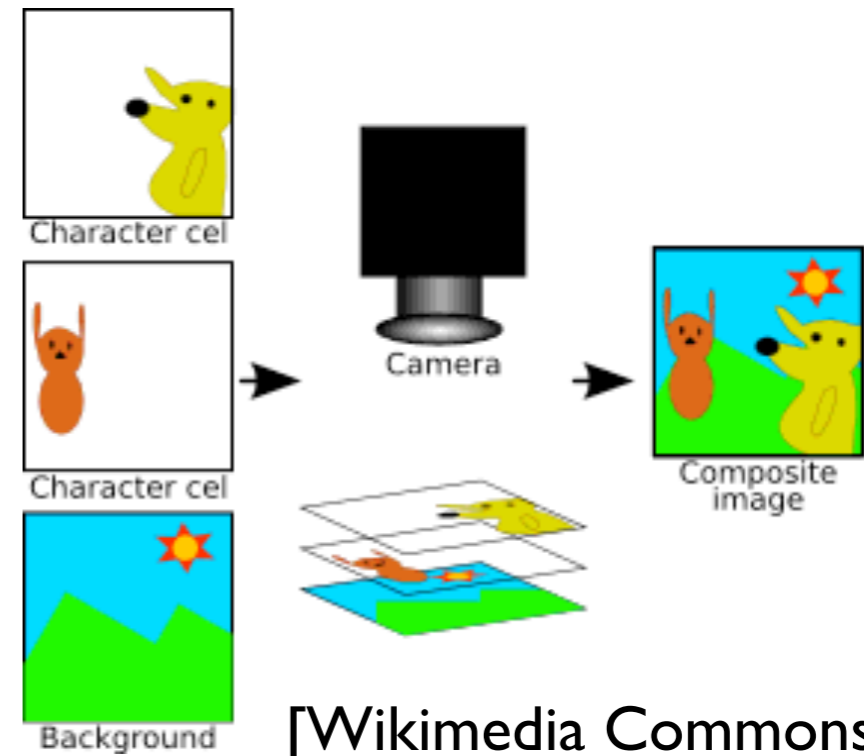
# Traditional animation

Cels

Multiplane camera

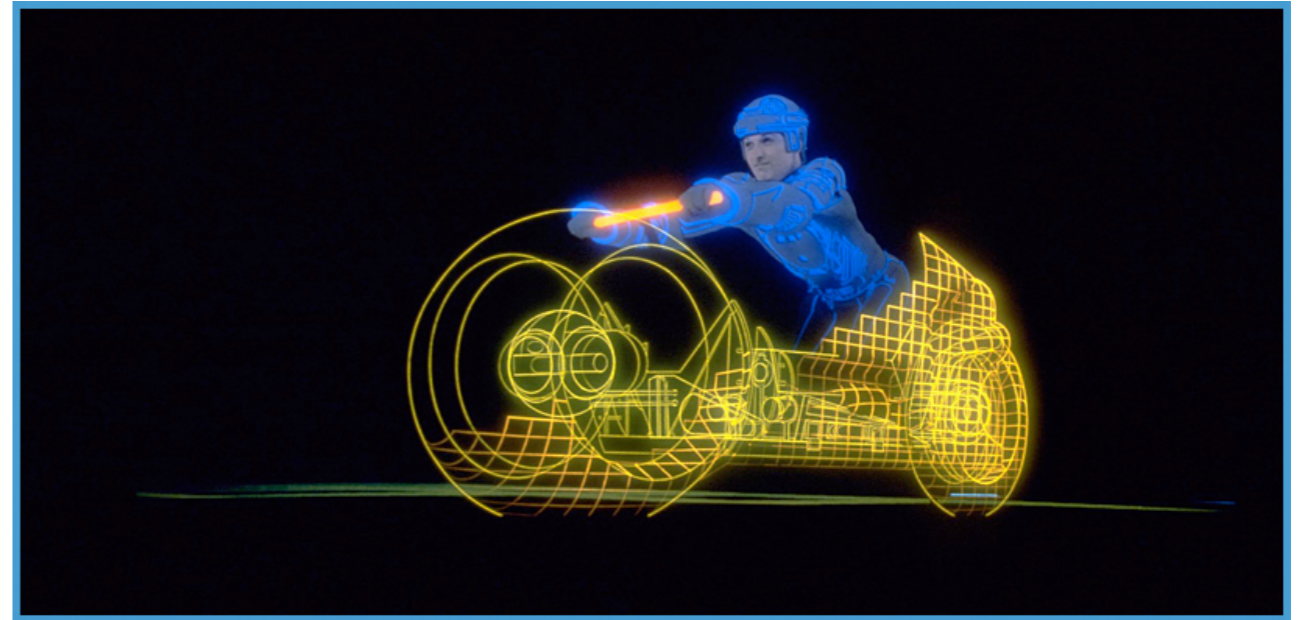


Sleeping Beauty, Disney, 1959



# 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





# Disney's Paperman

## Paperman and the Future of 2D Animation



**animation principles**



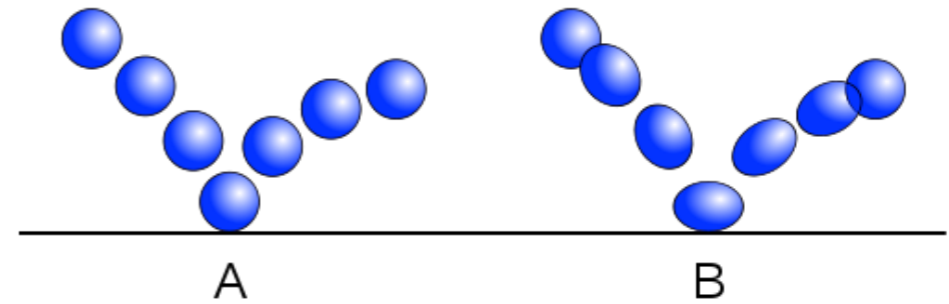


*The famous half-filled flour sack, guide to maintaining volume in any animatable shape, and proof that attitudes can be achieved with the simplest of shapes.*



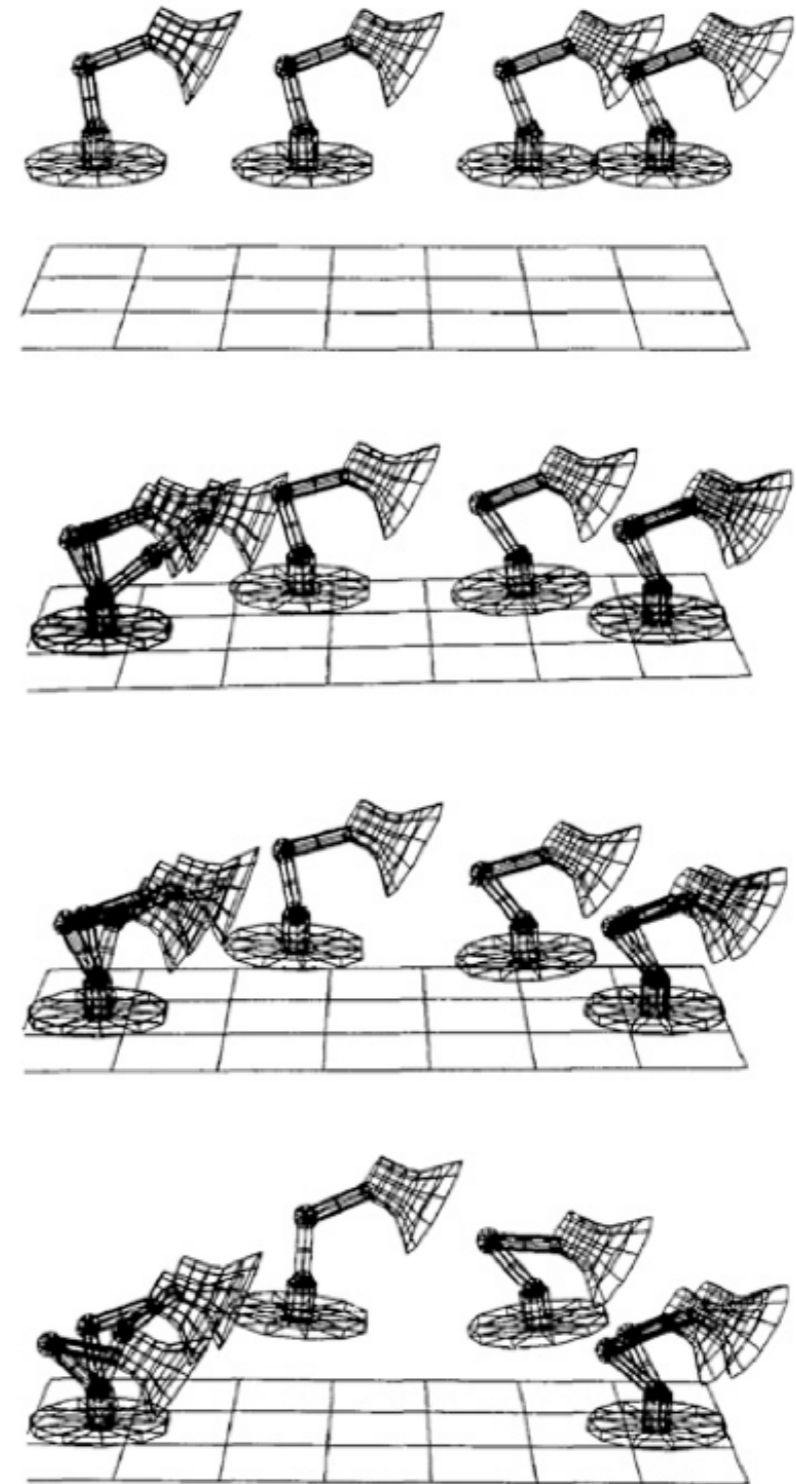
# 12 principles of animation

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



# Physics-based animation

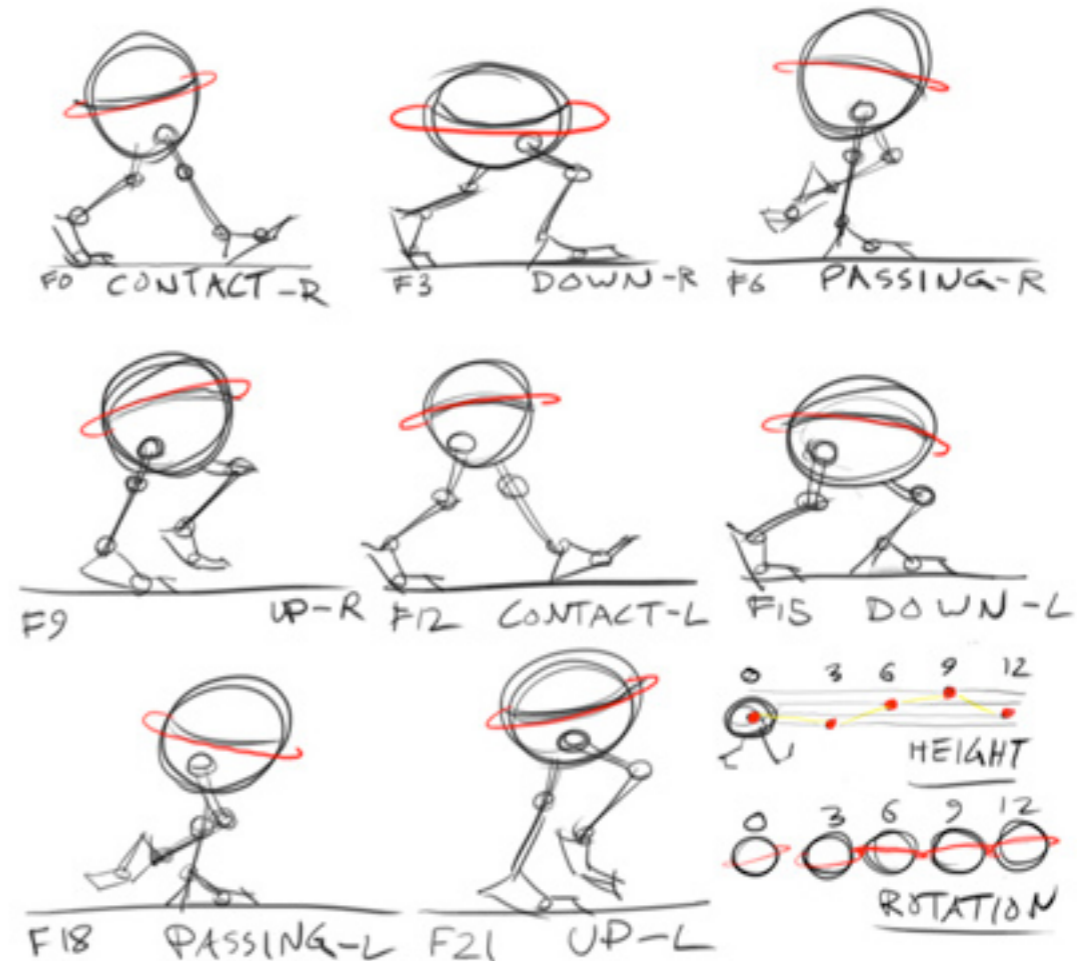
- Many animation principles follow from underlying physics
- anticipation, follow through, secondary action, squash and stretch, ...
- *Spacetime Constraints*, Witkin and Kass 1988



**keyframe animation**

# Keyframe animation

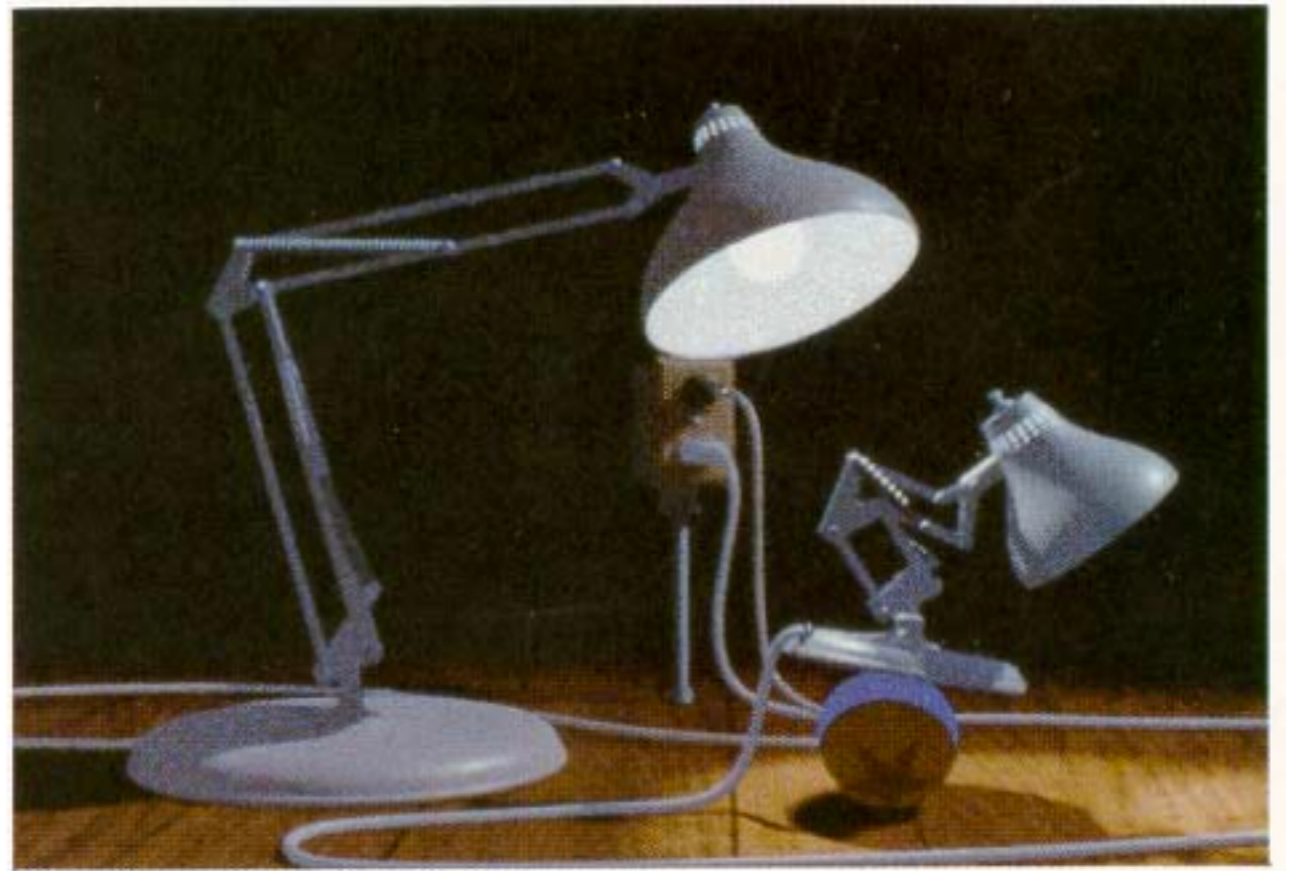
- draw a series of poses
- fill in the frames in between (“inbetweening”)
- computer animation uses interpolation

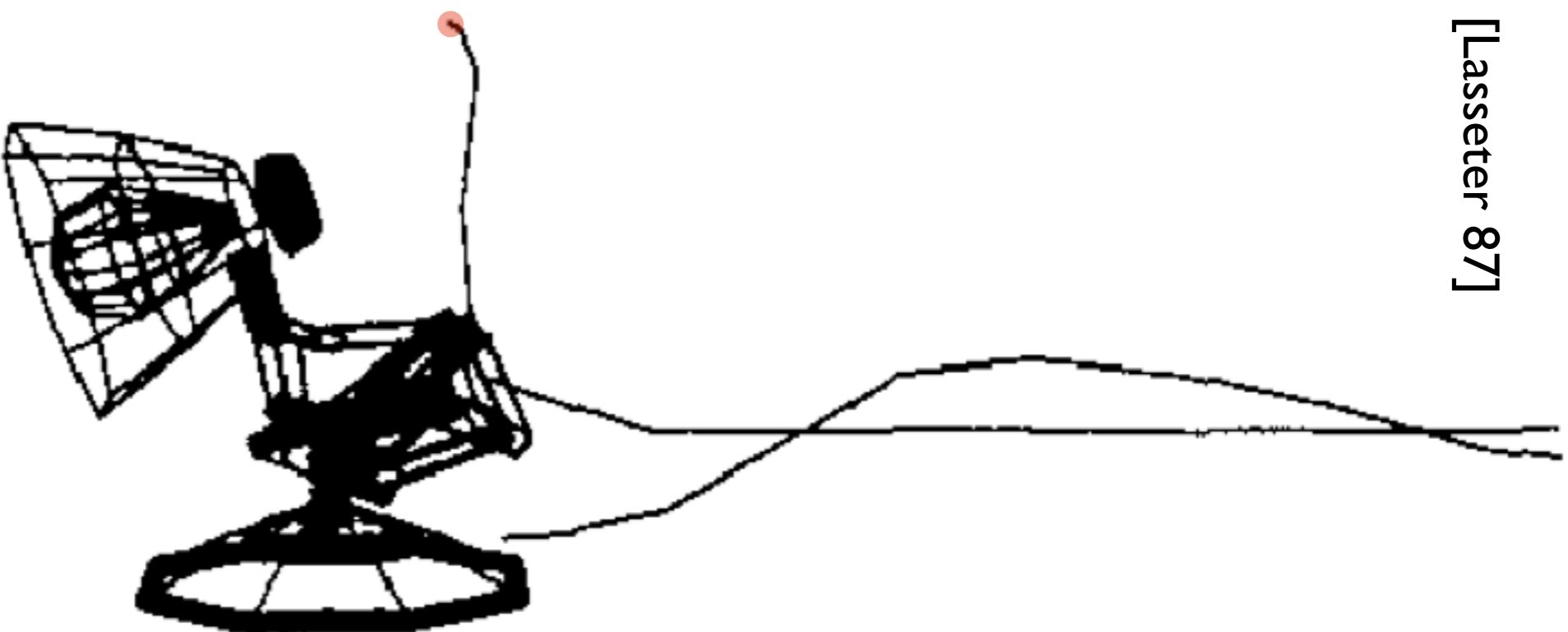


<http://anim.tmog.net>

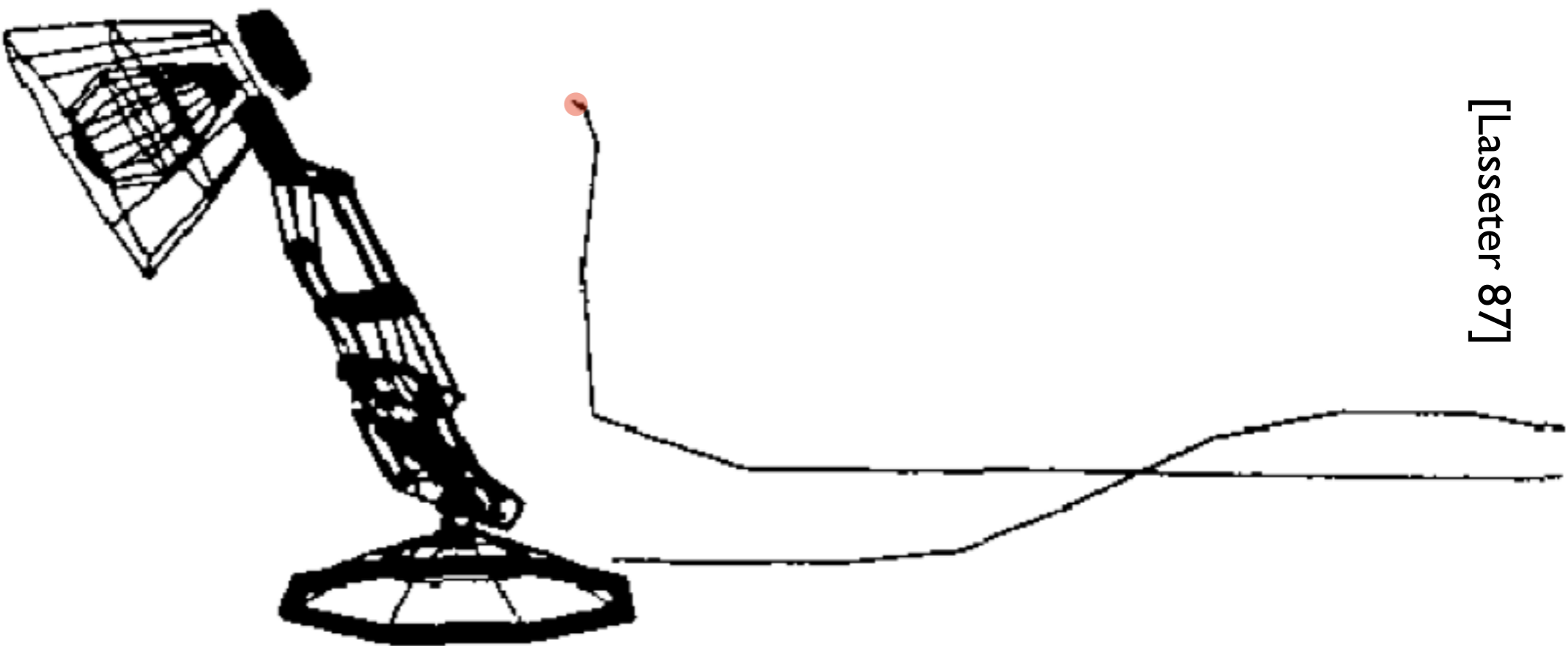


*Luxo Jr.*

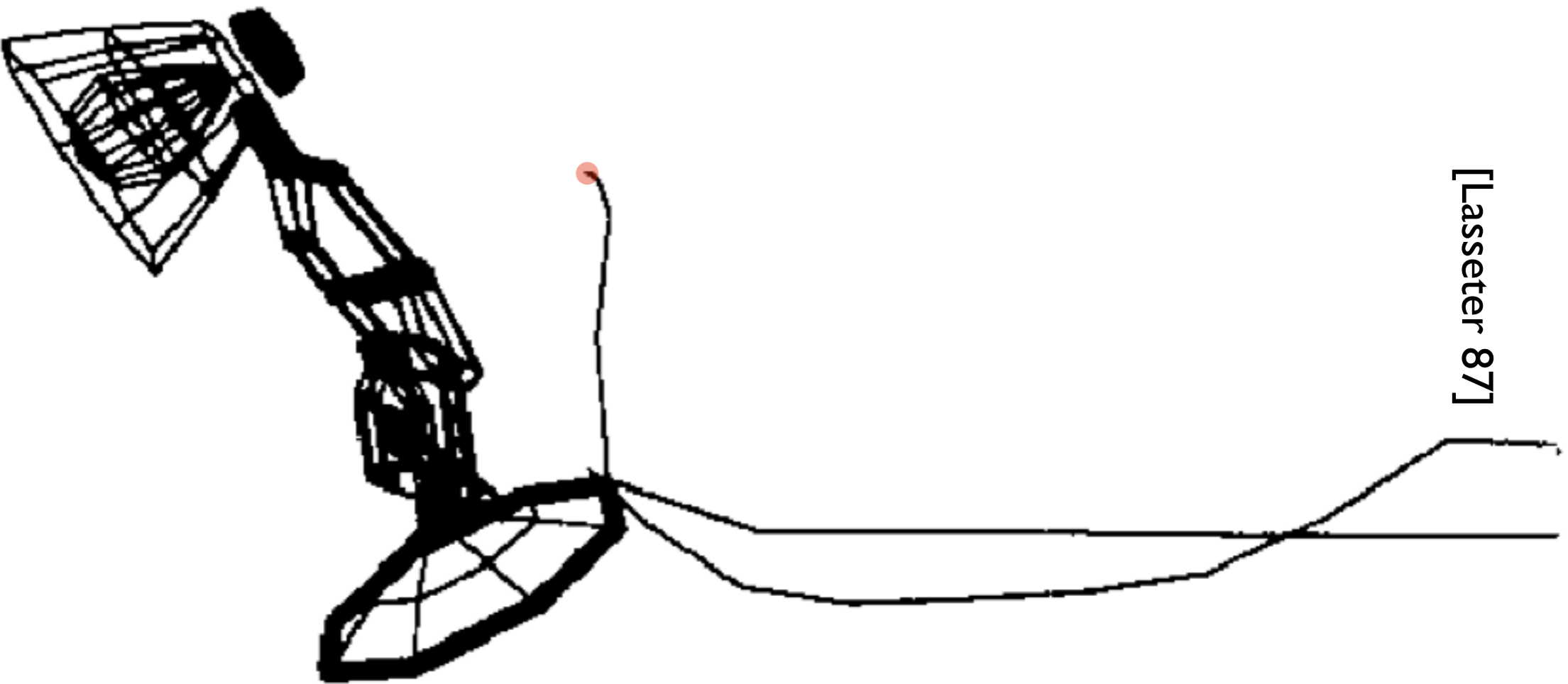




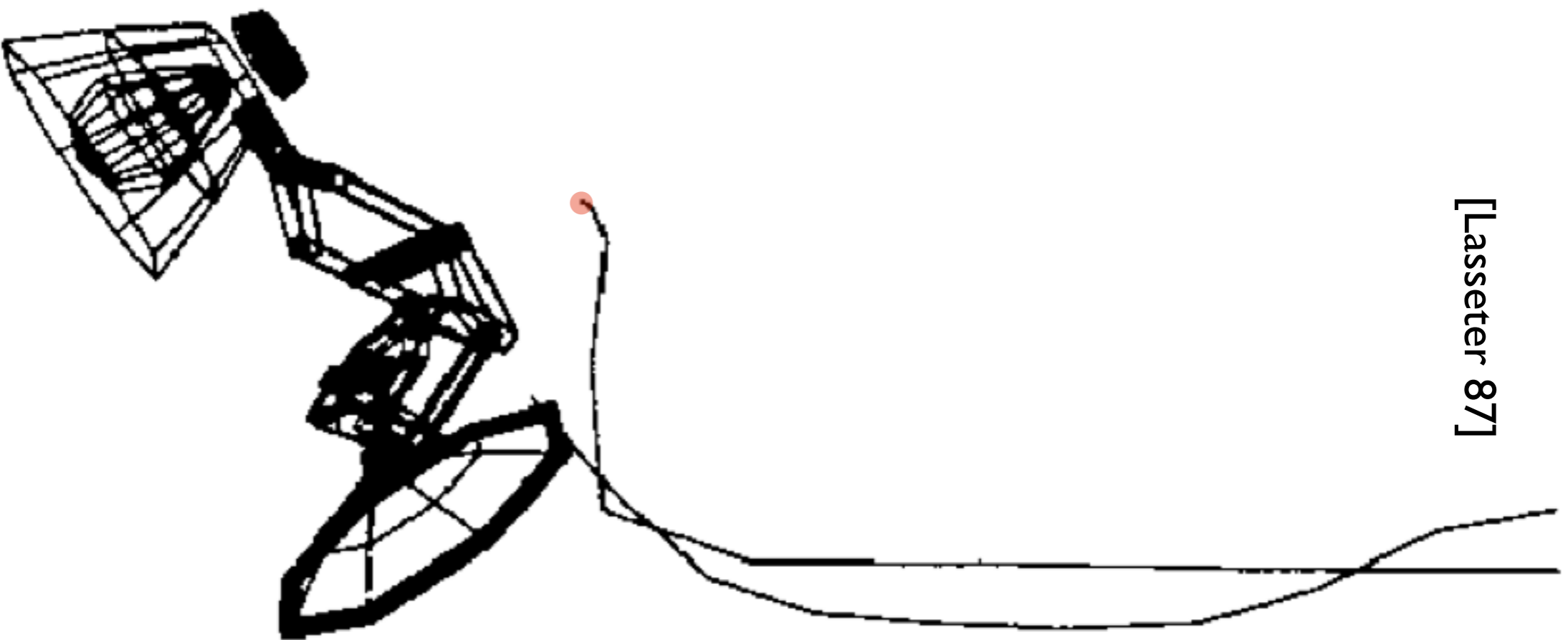
[Lasseter 87]



[Lasseter 87]

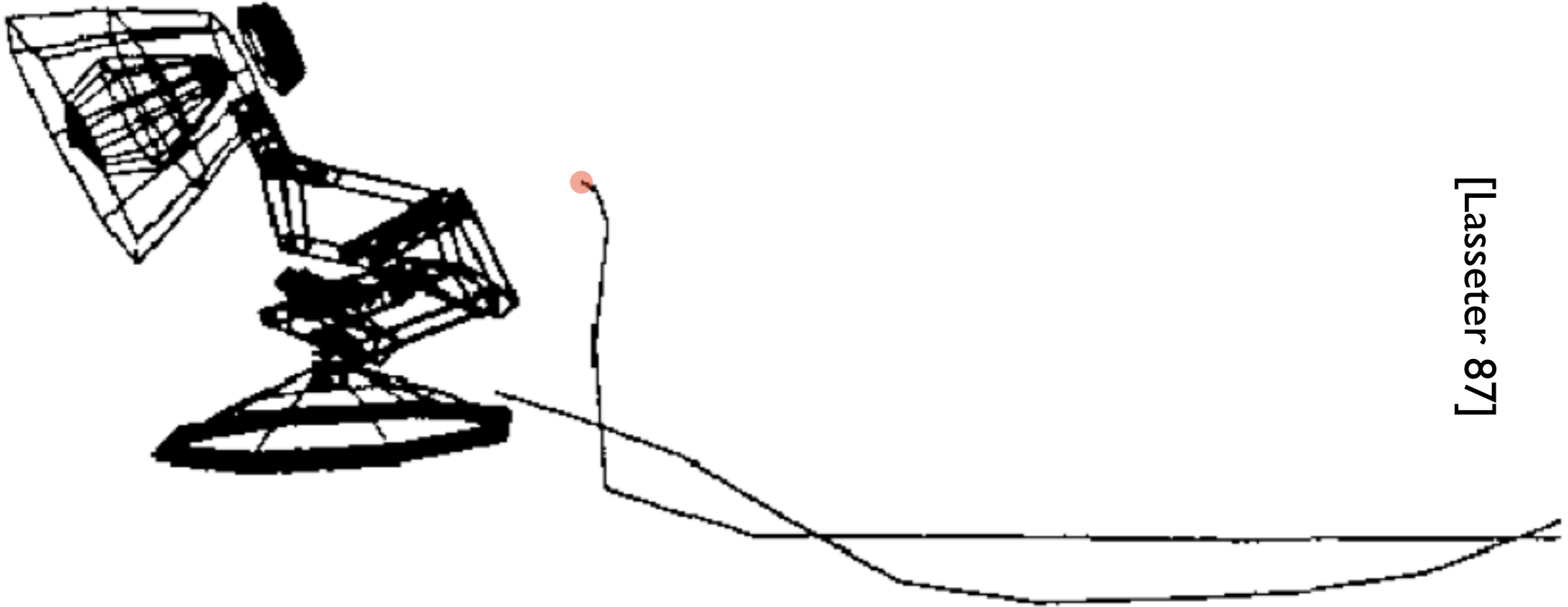


[Lasseter 87]

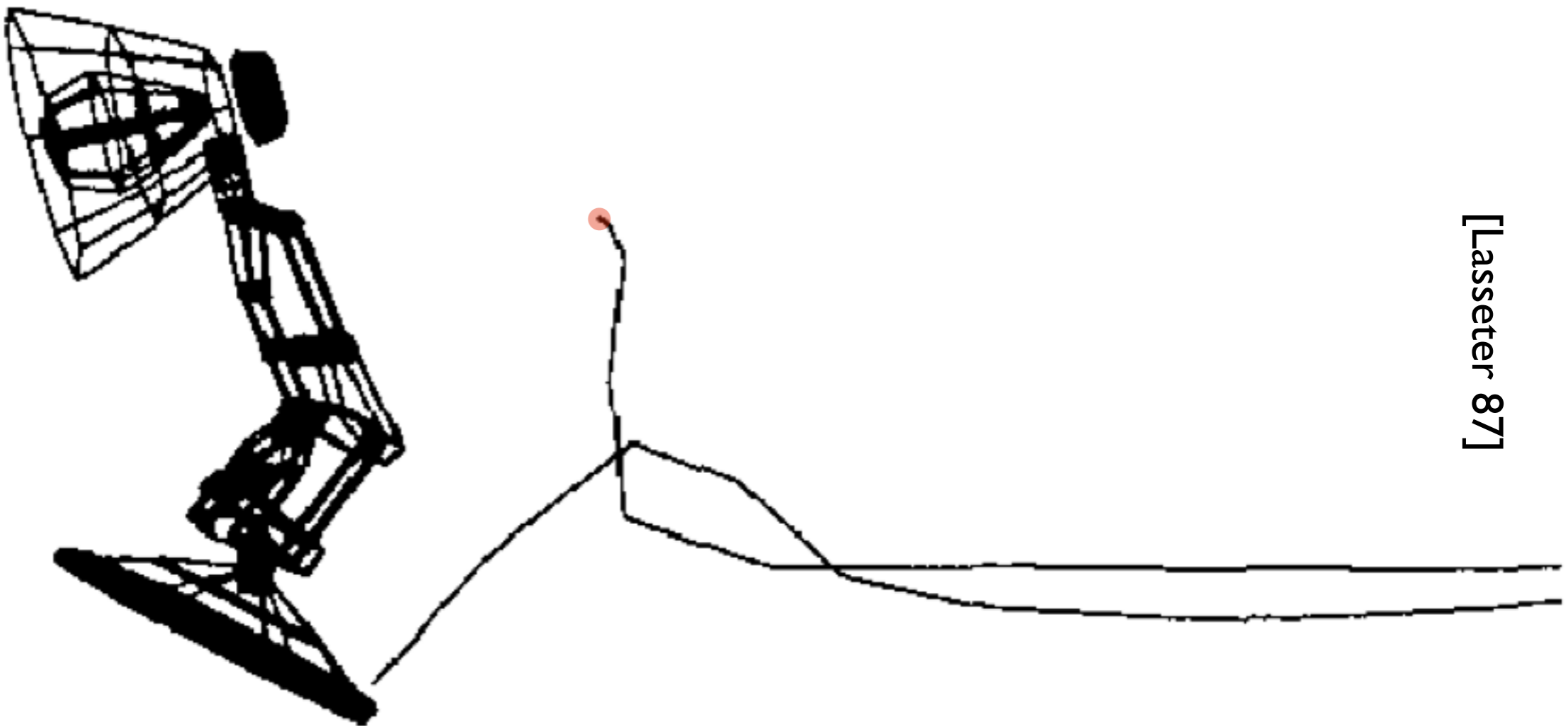


[Lasseter 87]

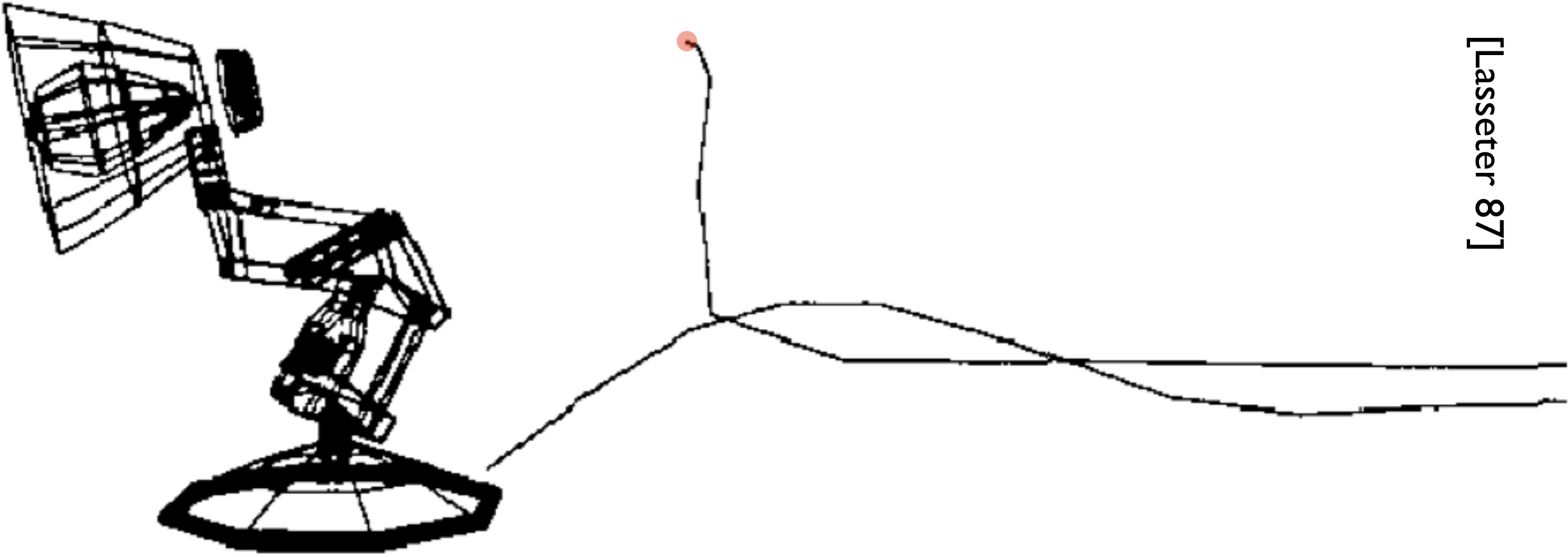




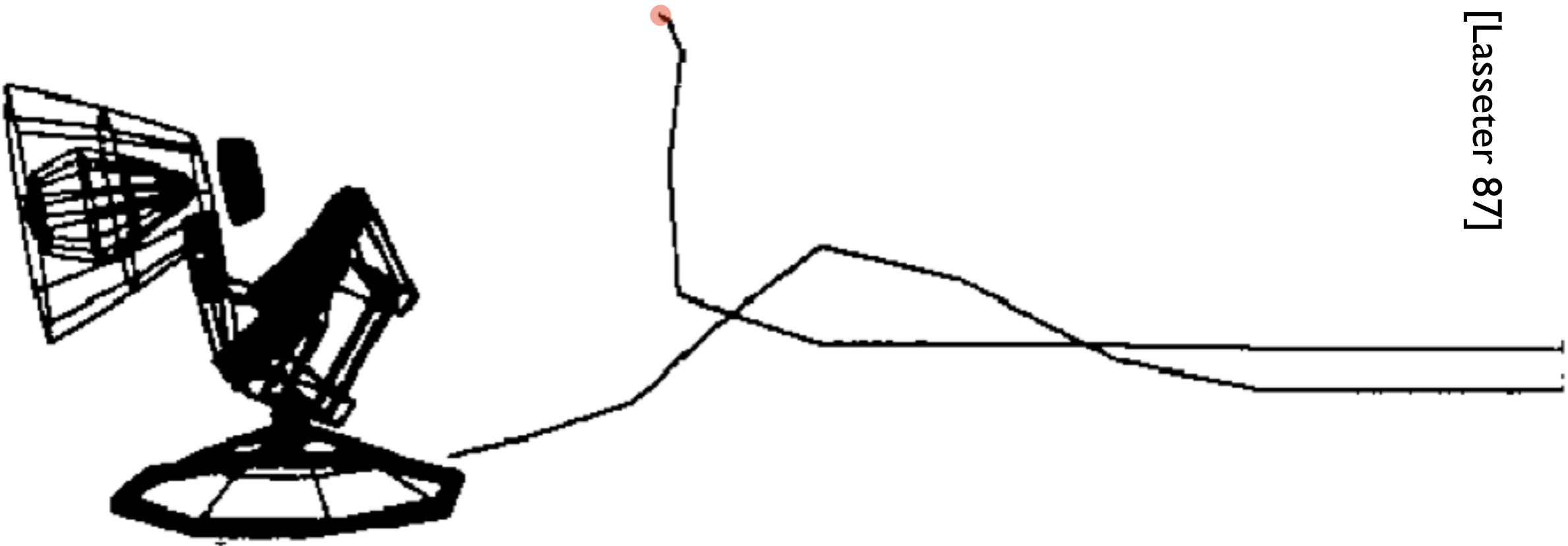
[Lasseter 87]



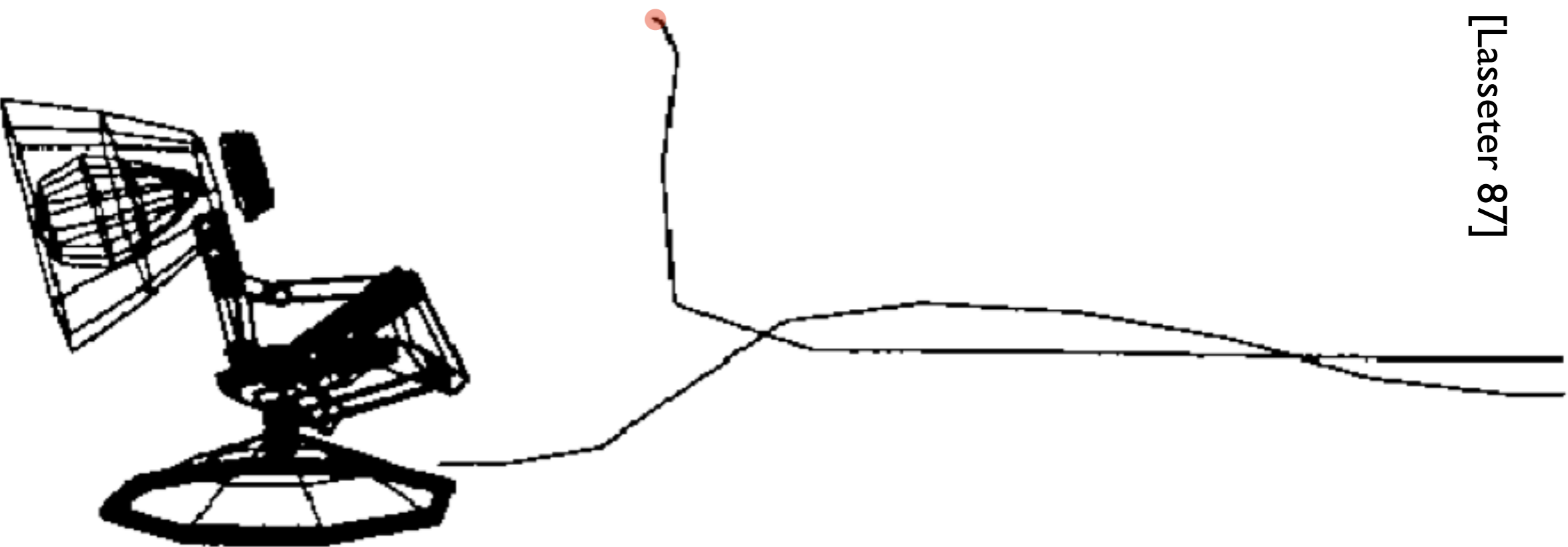
[Lasseter 87]



[Lasseter 87]

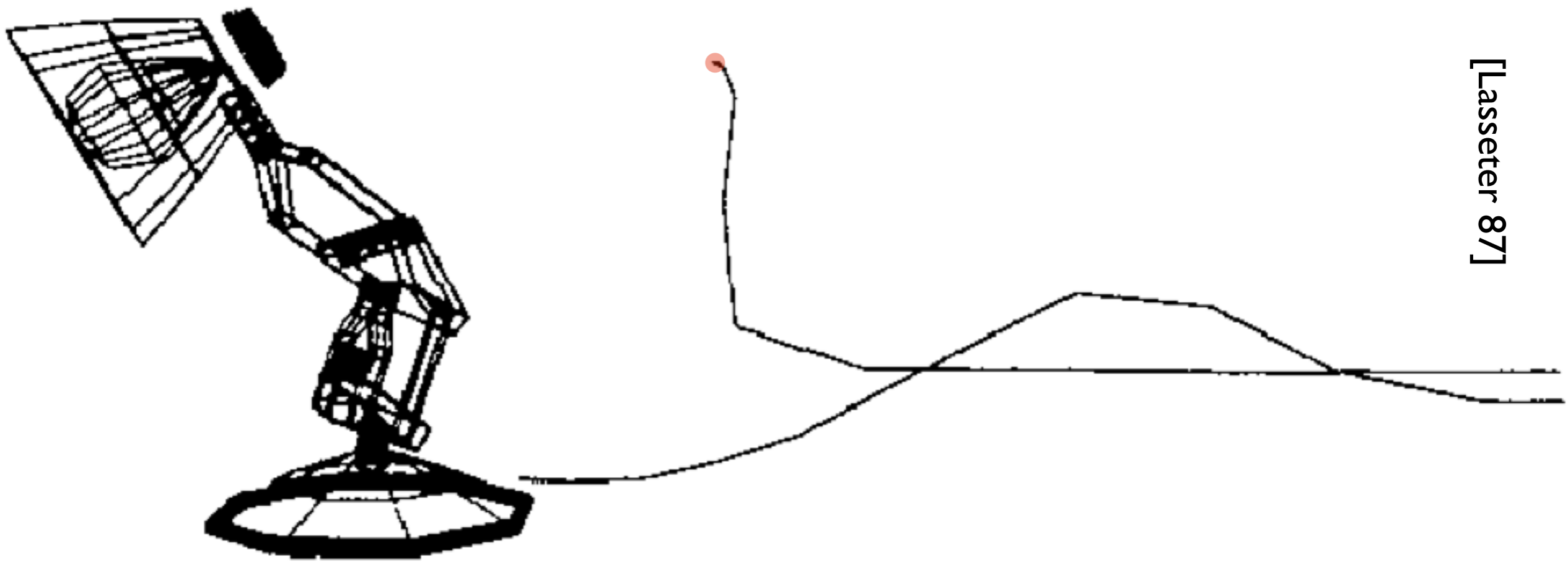


[Lasseter 87]

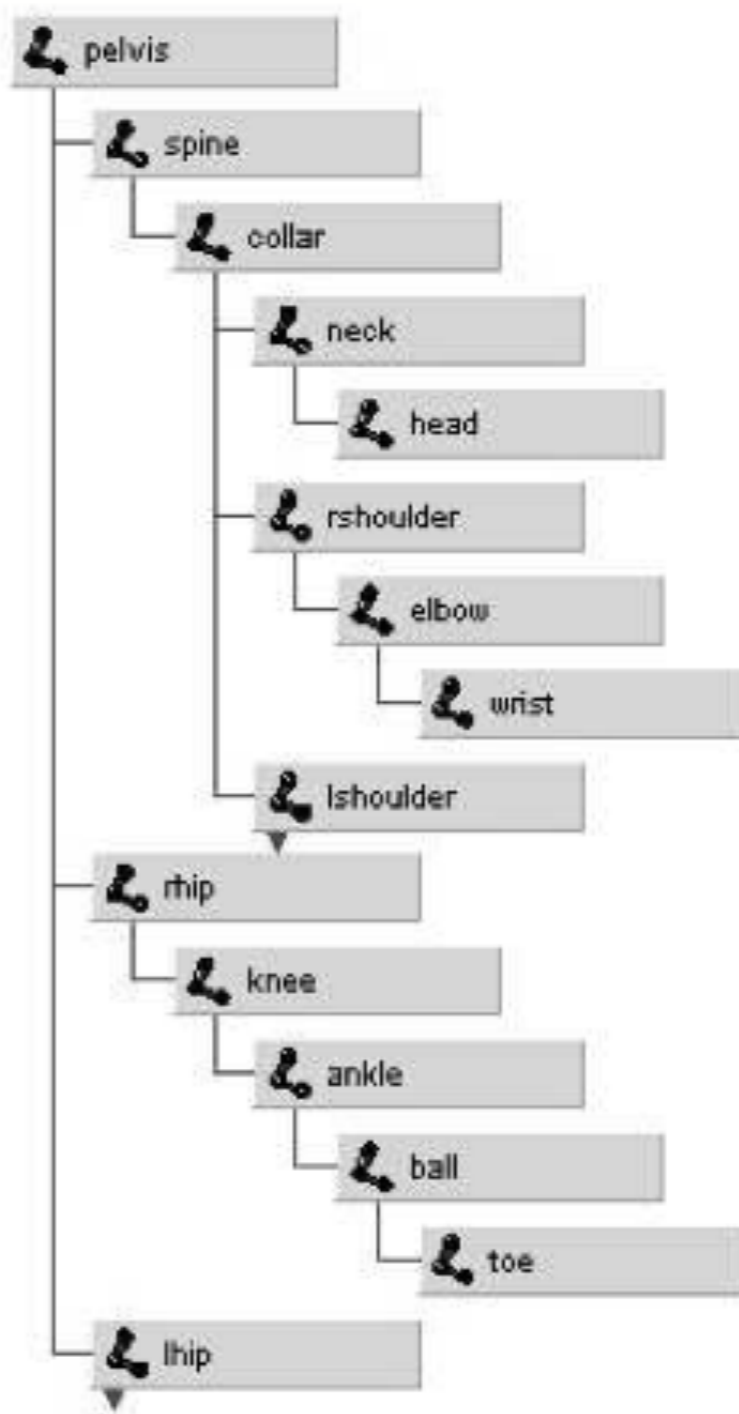
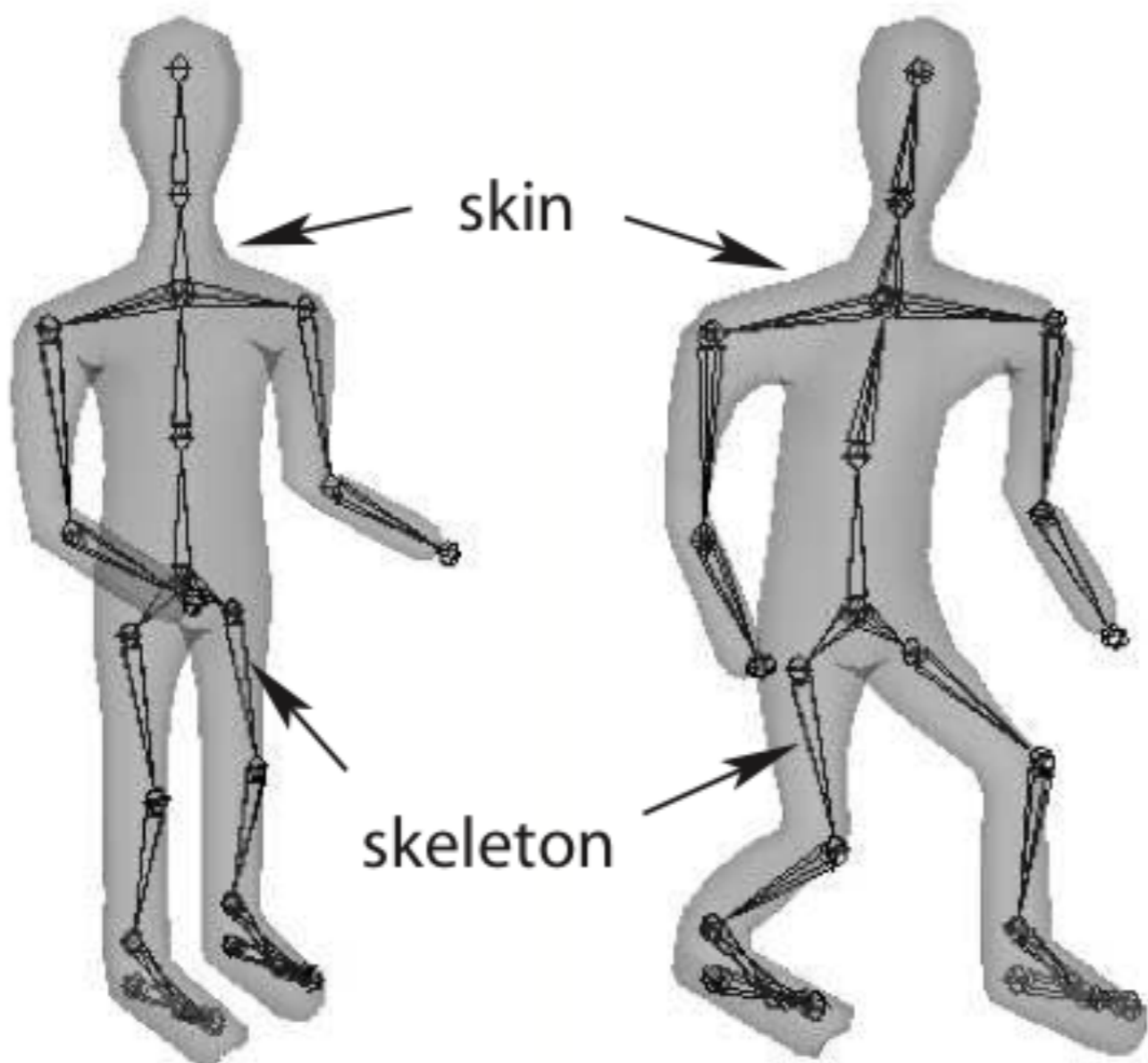


[Lasseter 87]

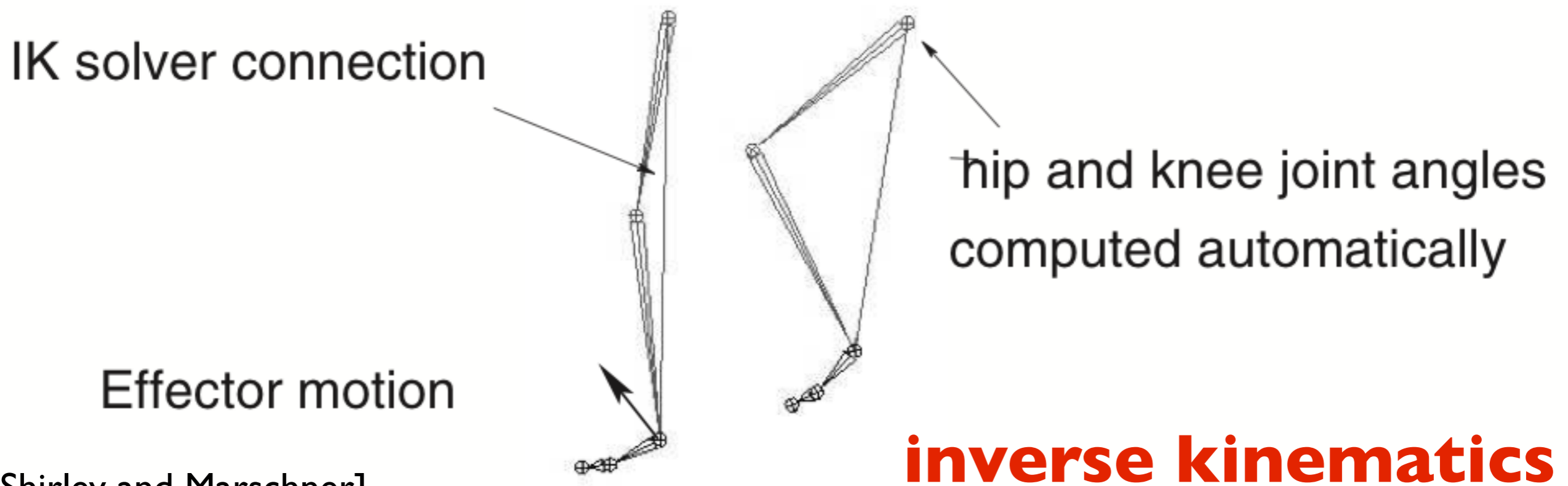
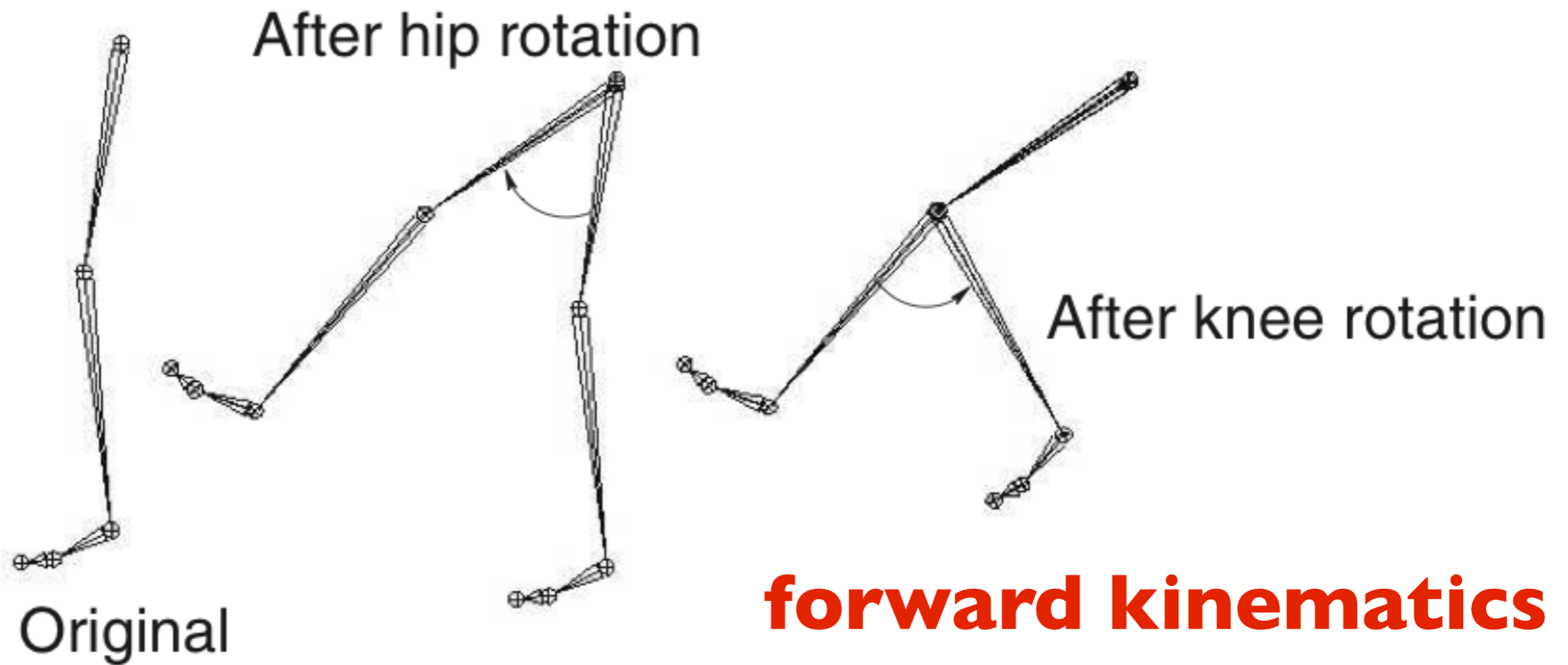


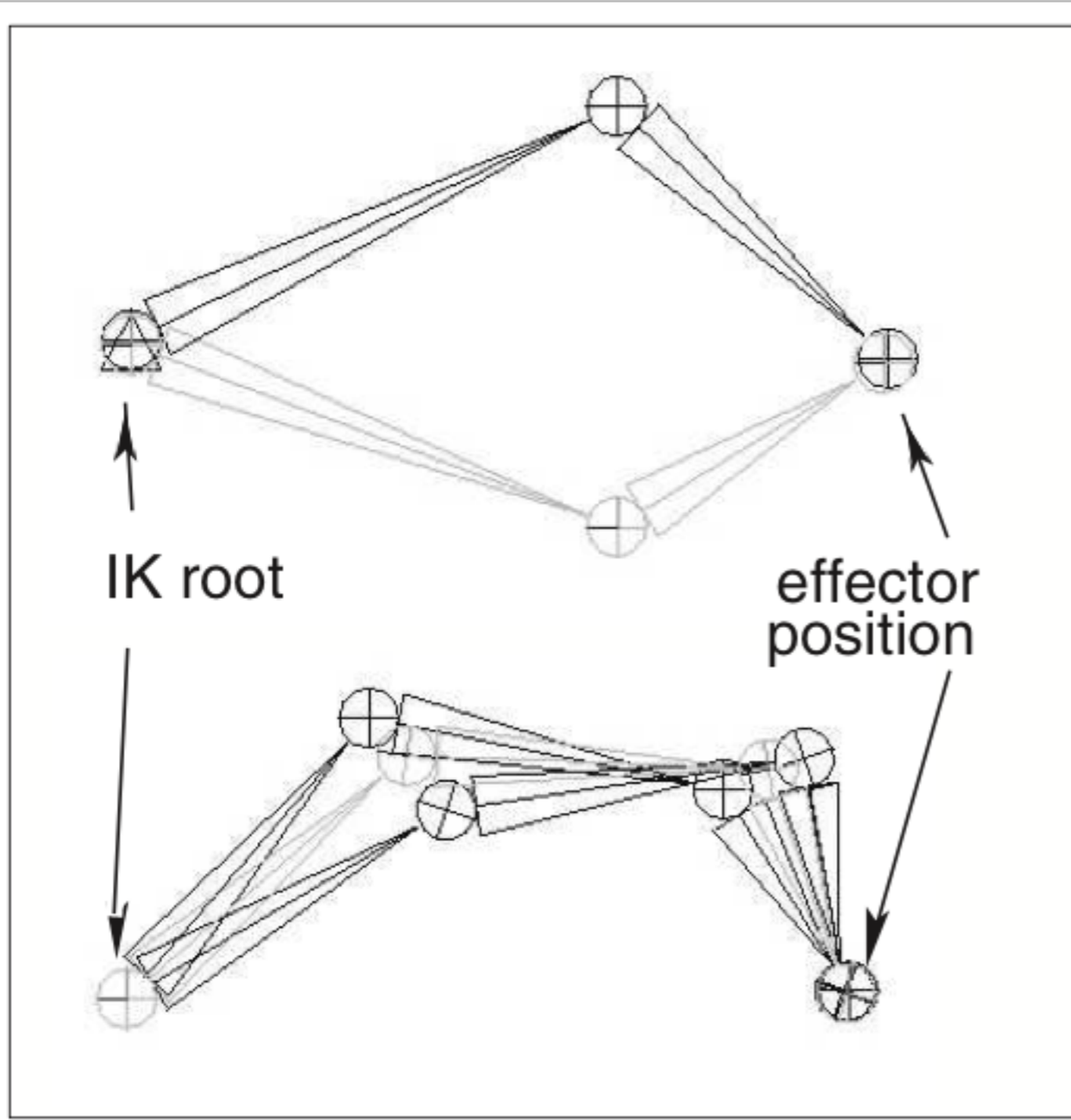


[Lasseter 87]



[Shirley and Marschner]





multiple possible  
states of joints

**inverse kinematics**

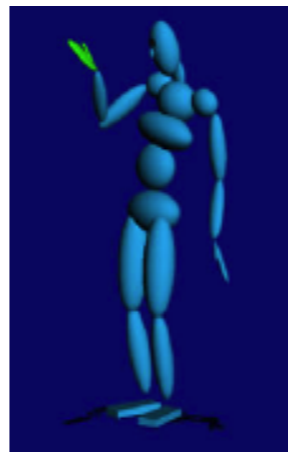
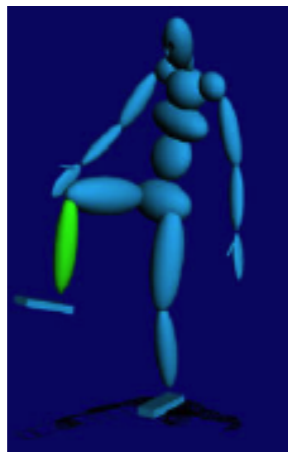
# Keyframe character DOFs



3 translational DOFs

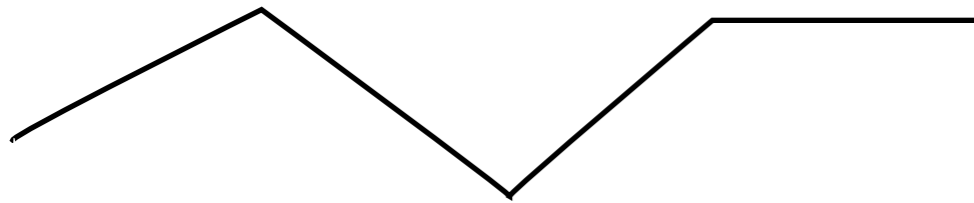
48 rotational DOFs

Each joint can have up to 3 DOFs

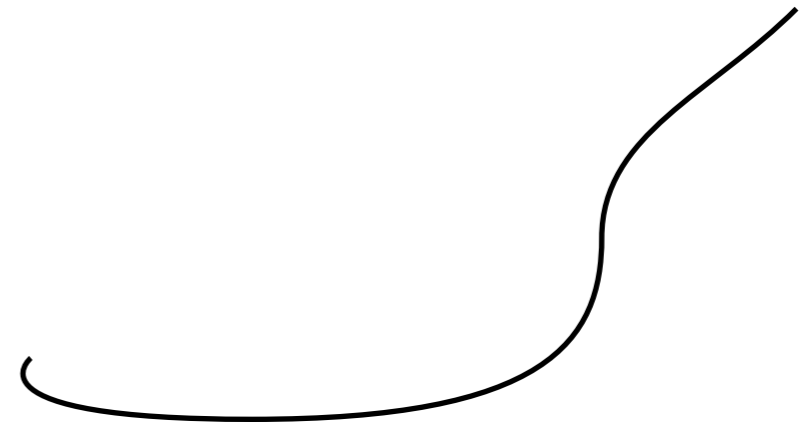




# Interpolation of keyframes

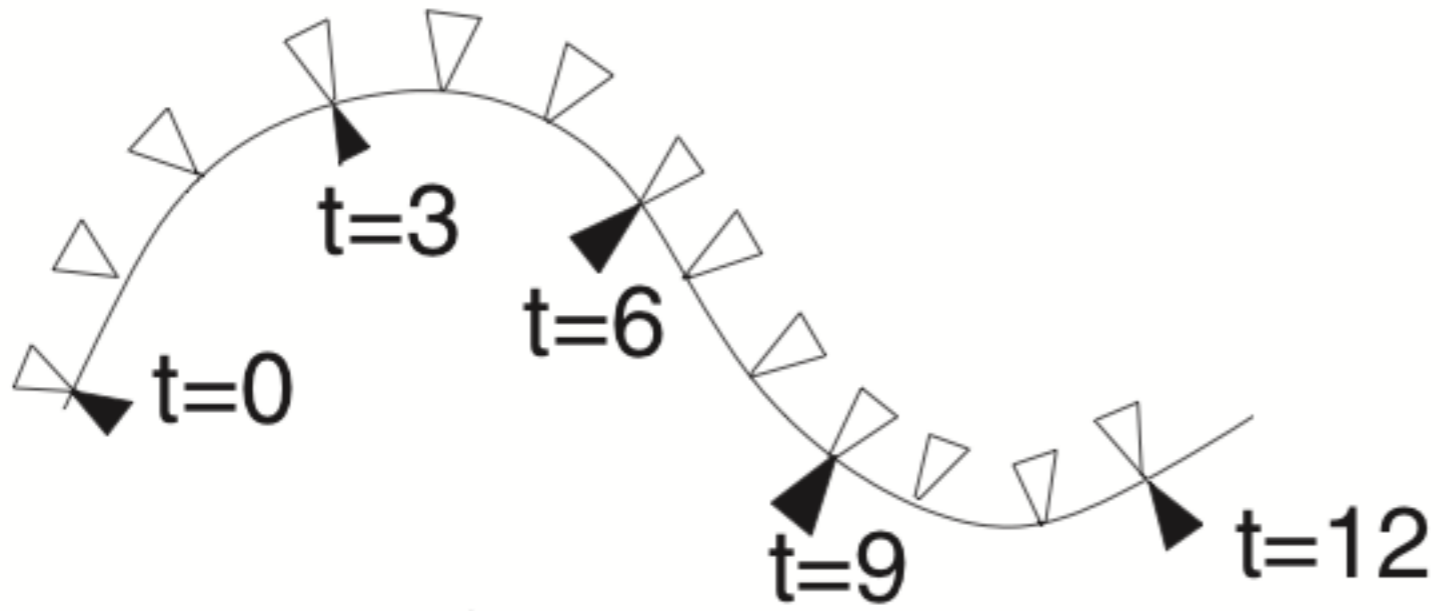


linear interpolation

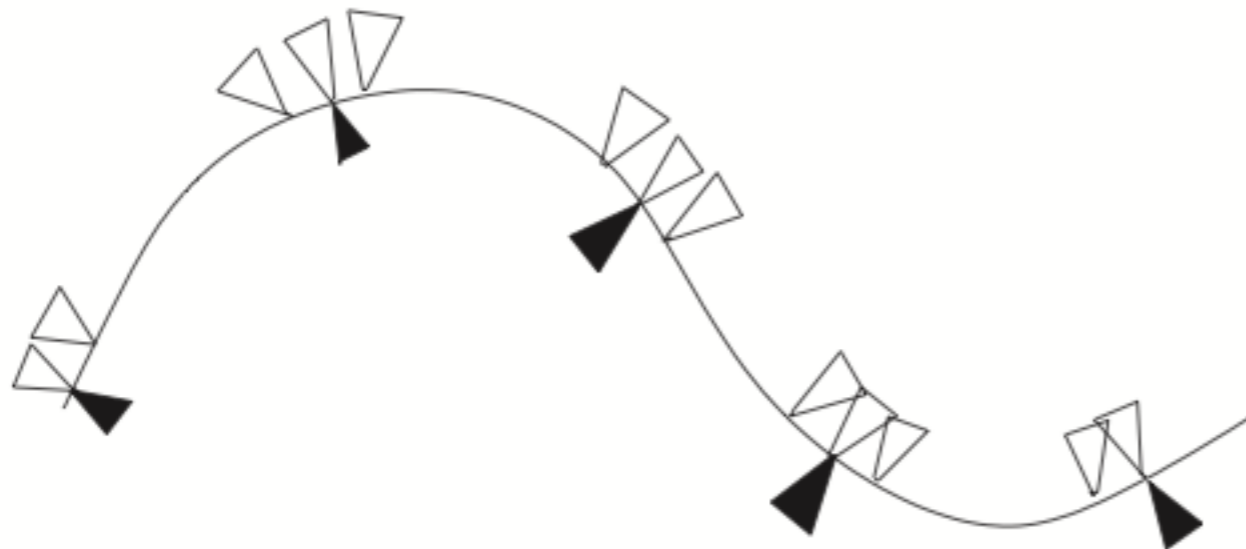
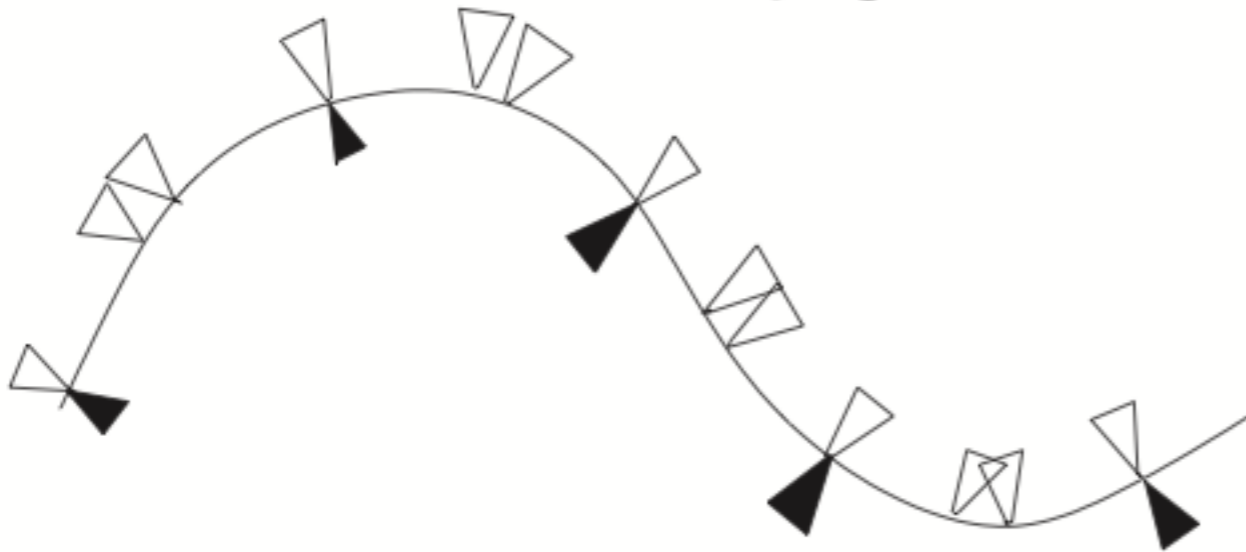


spline interpolation

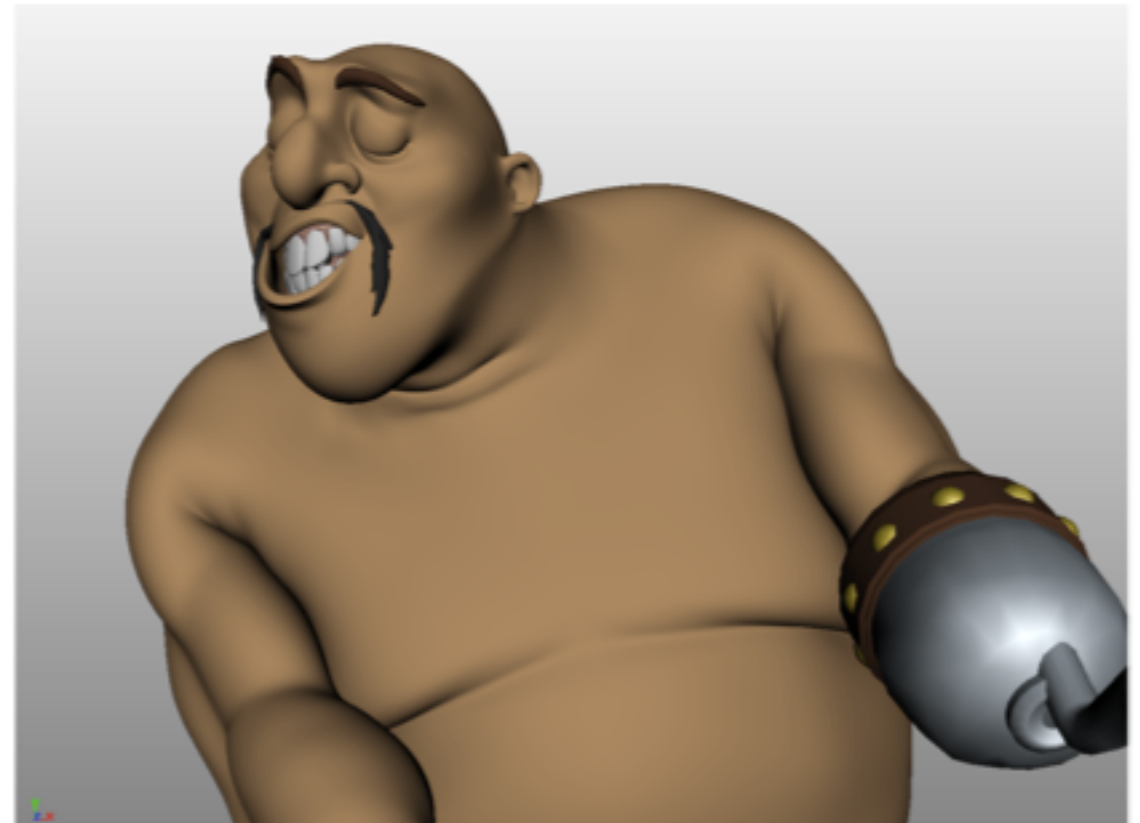
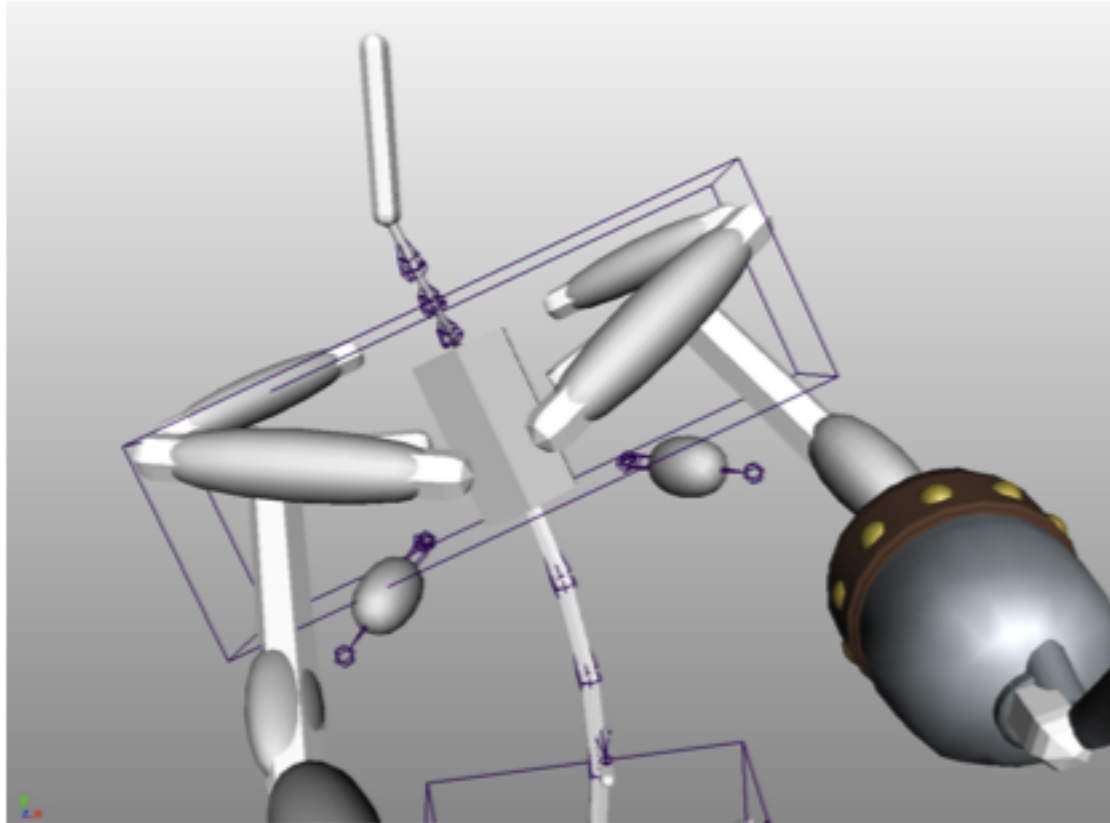
Straightforward to interpolate position but what about orientation?



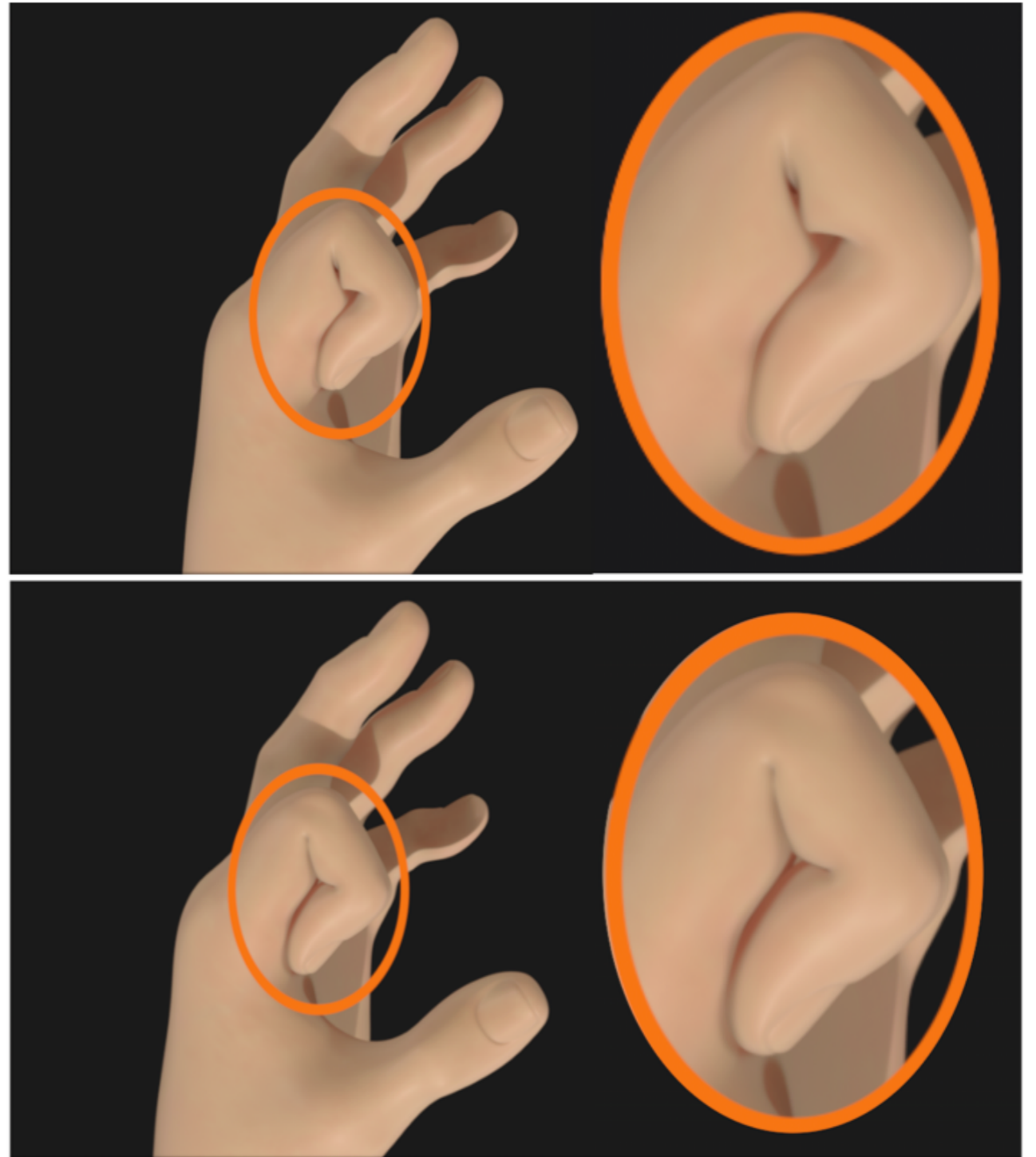
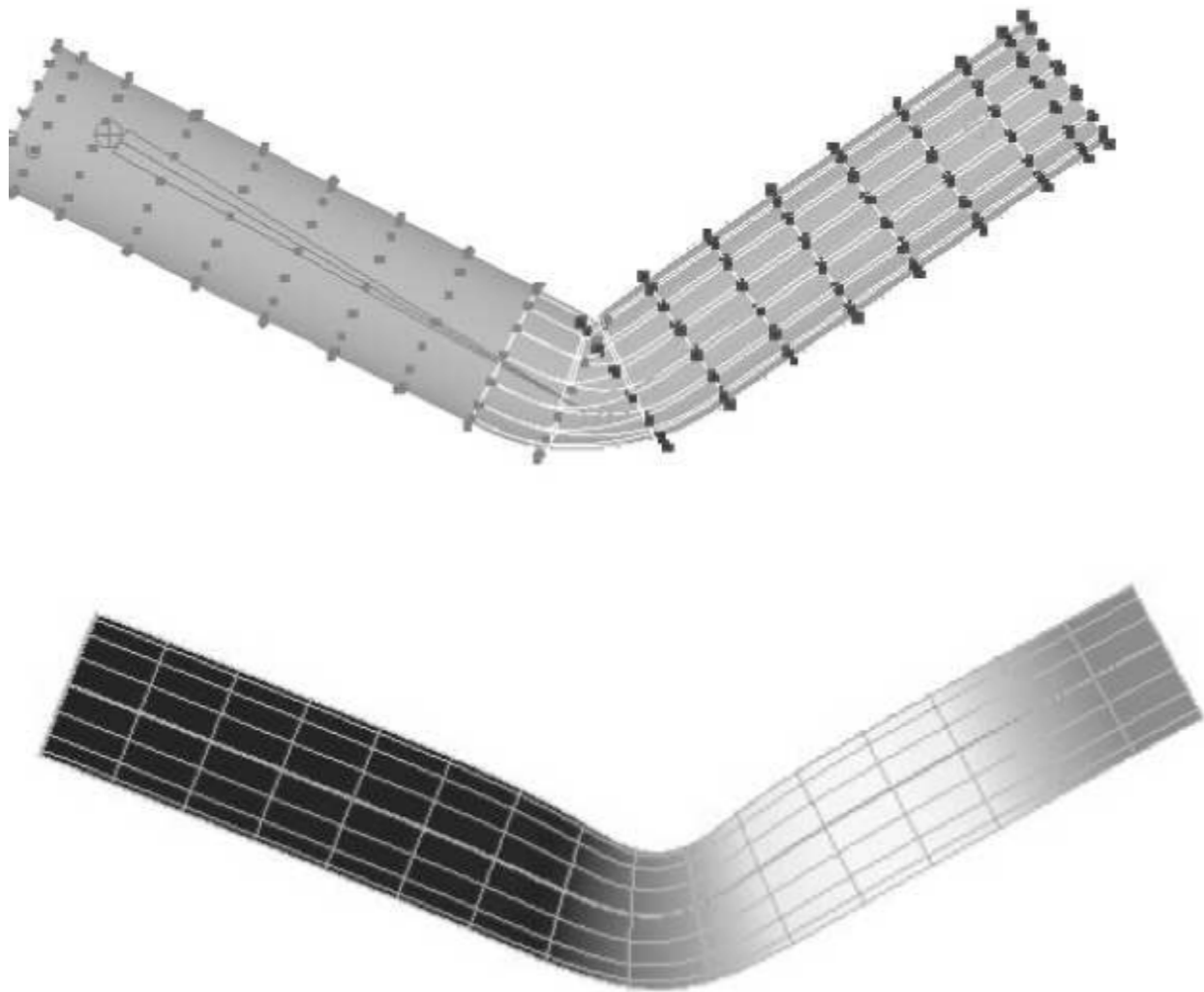
need to consider  
both  
**shape** of motion  
and  
**speed** of motion



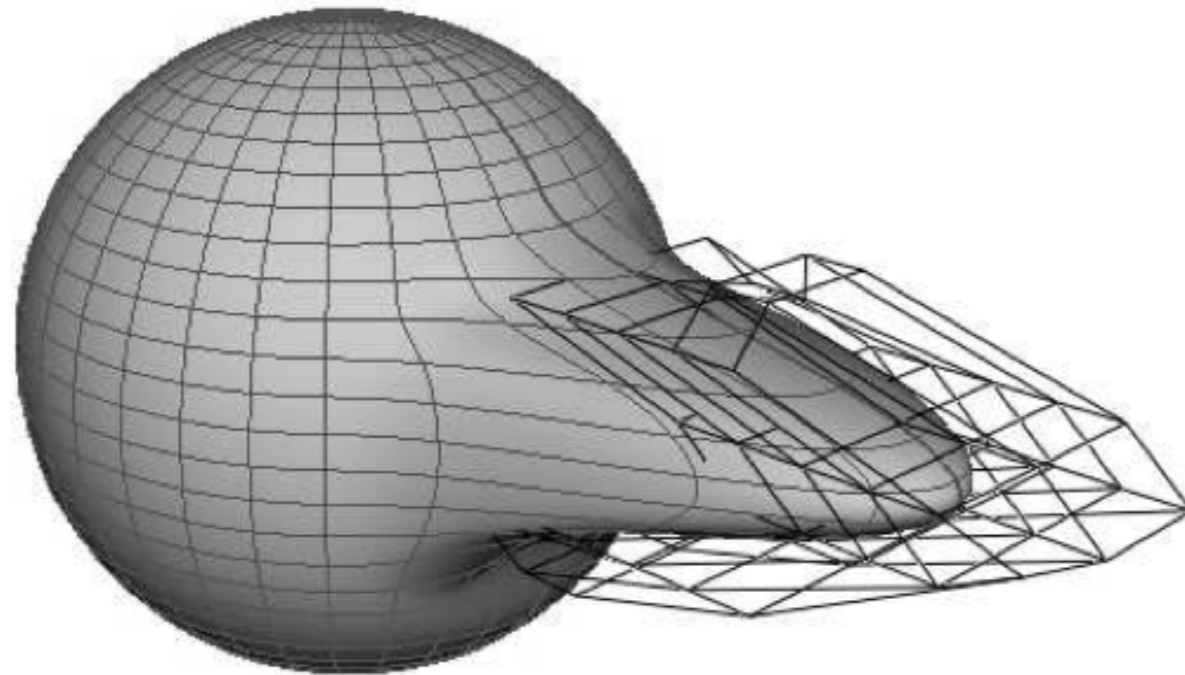
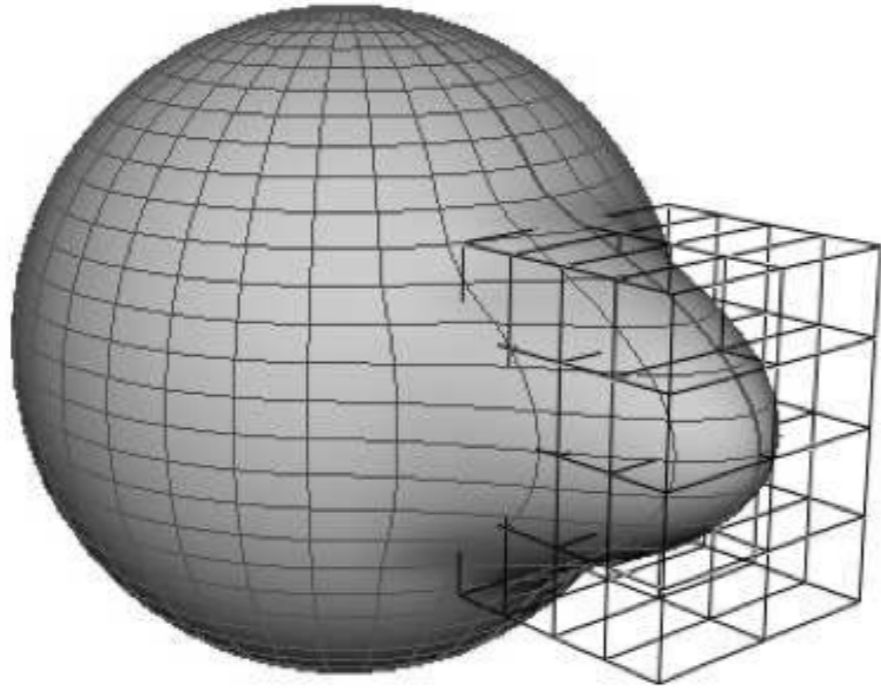
# Character Skinning



# Character Skinning



[McAdams et al. 2011]



# free form deformation

[Sederberg 1986]



**facial animation**



©2004 Disney/Pixar









02



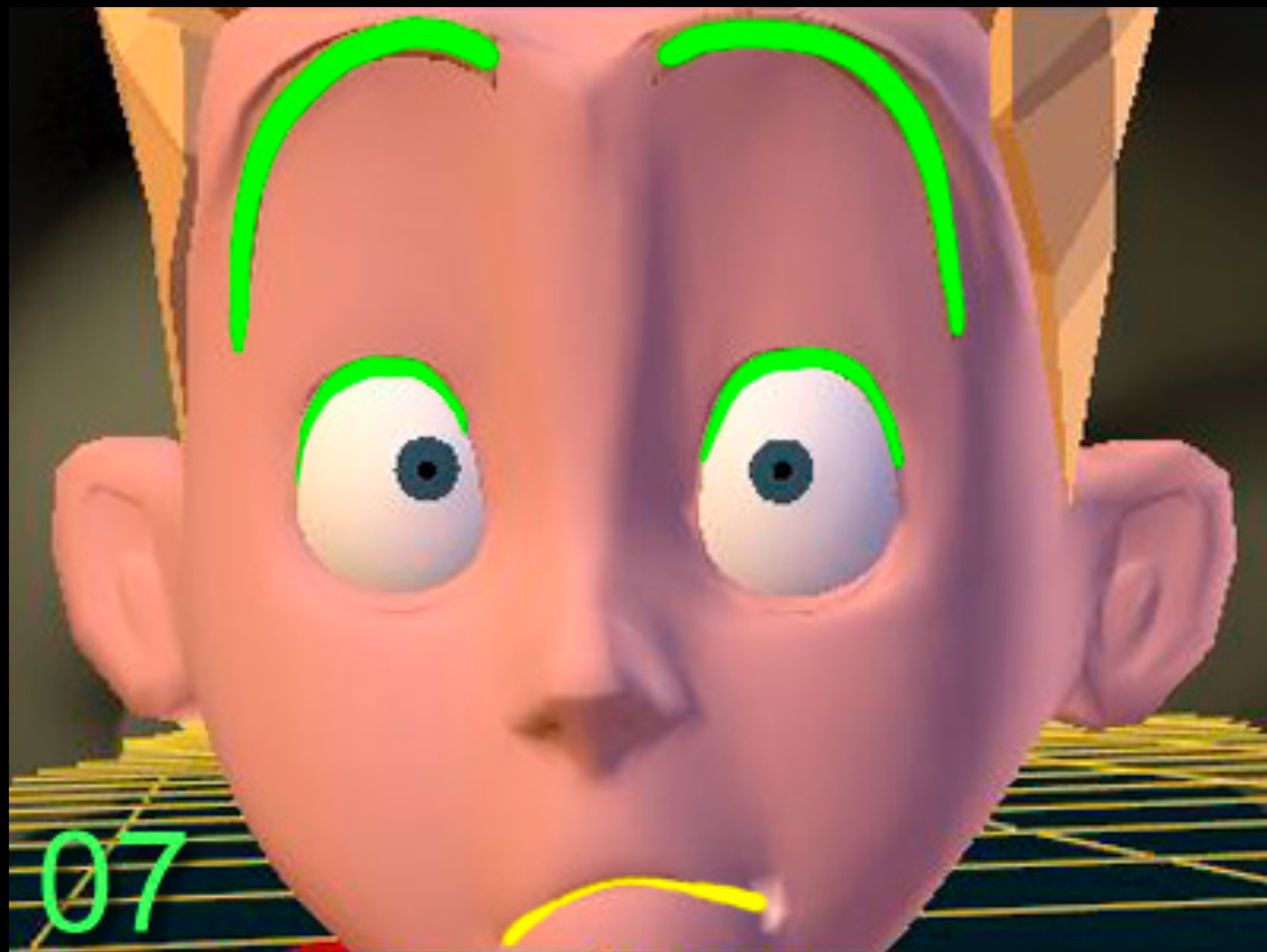


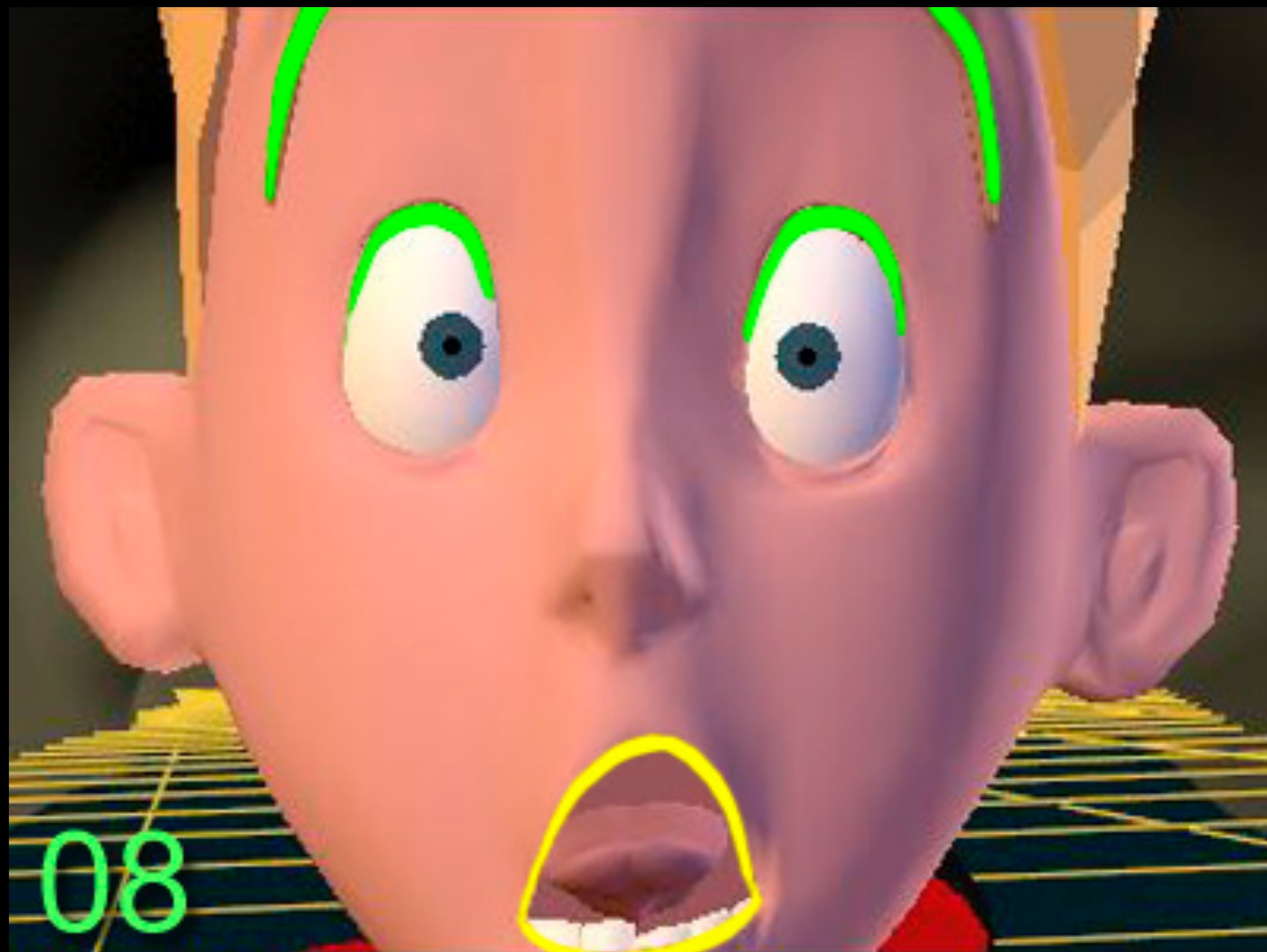




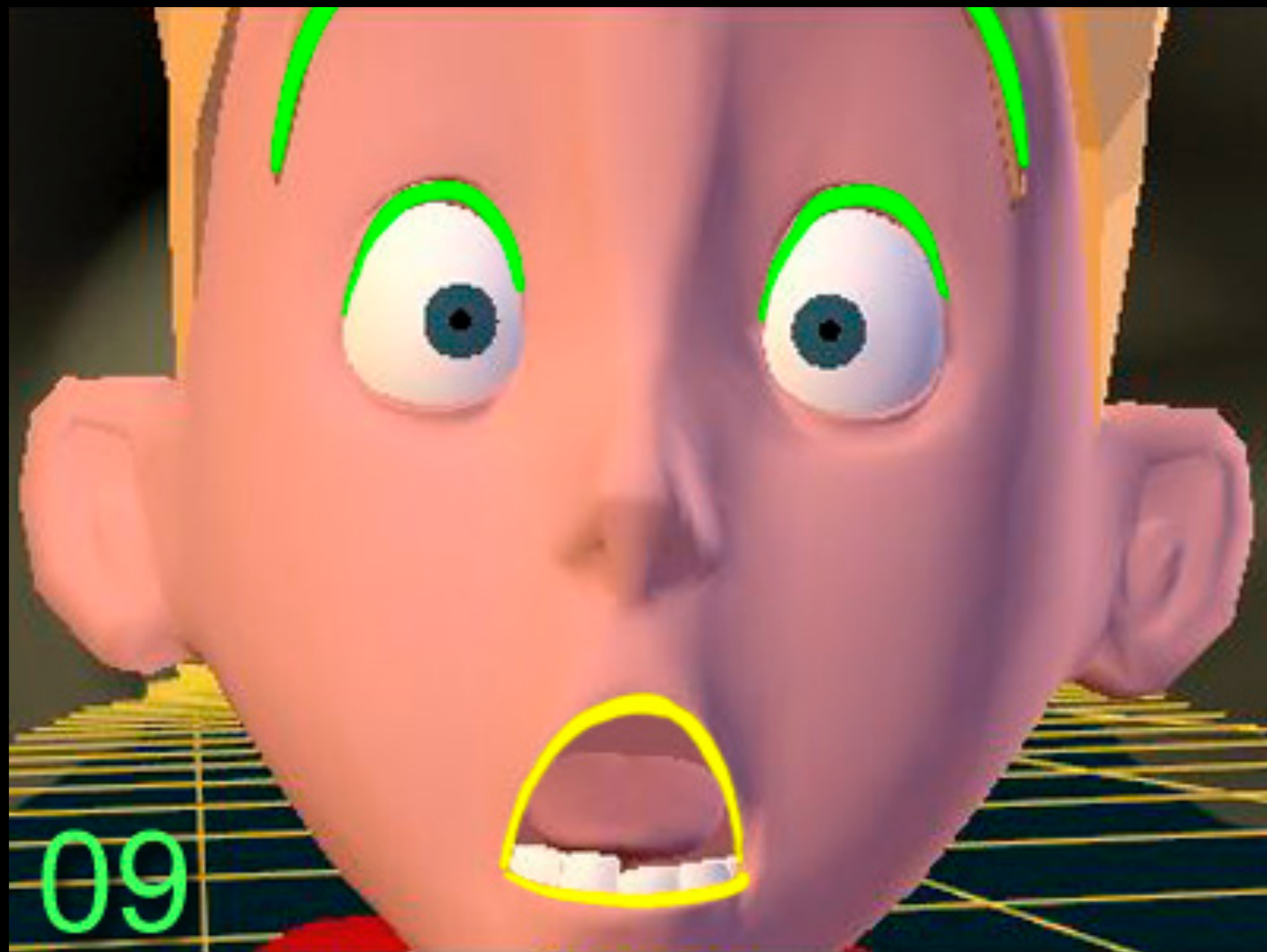


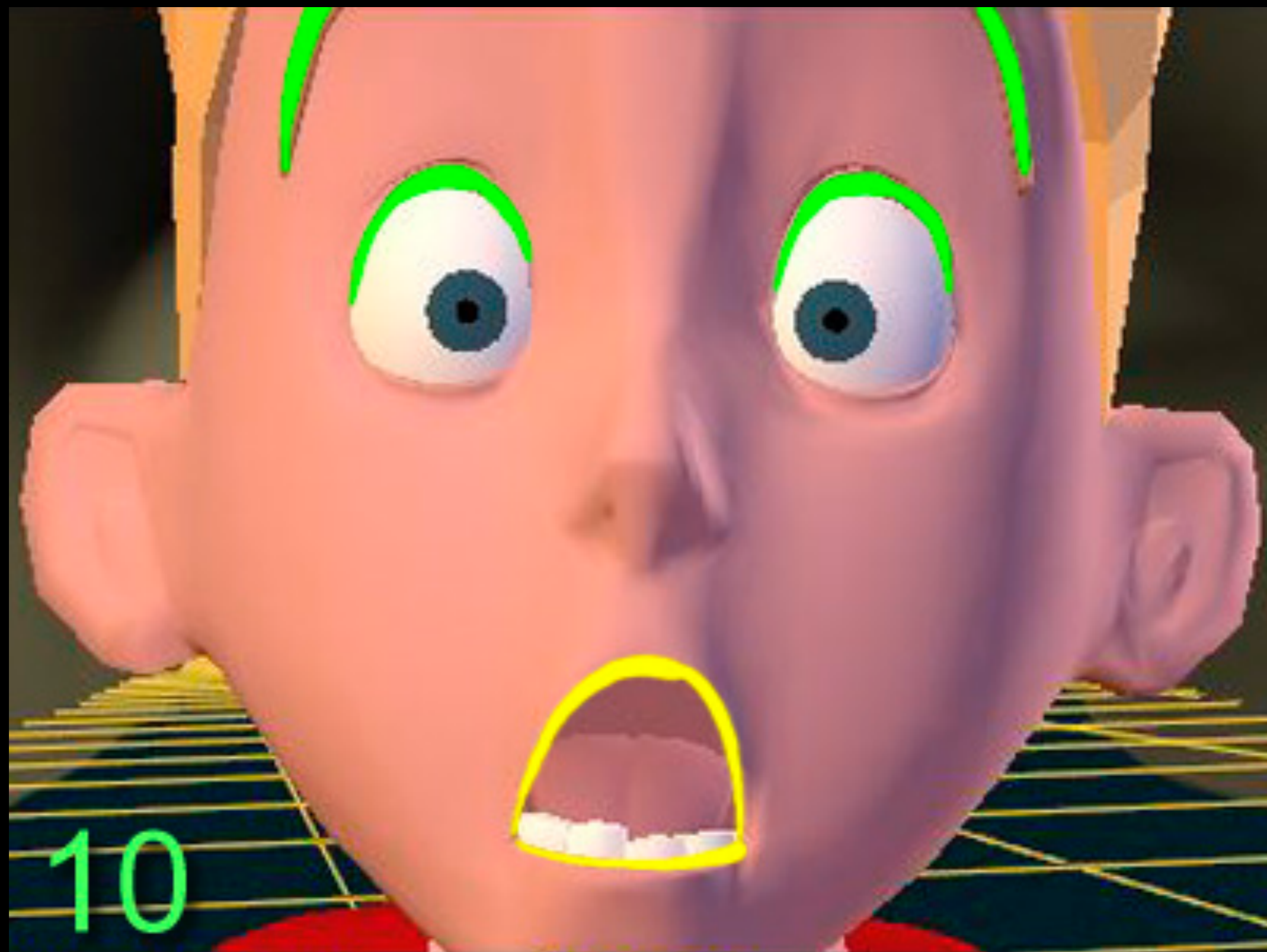




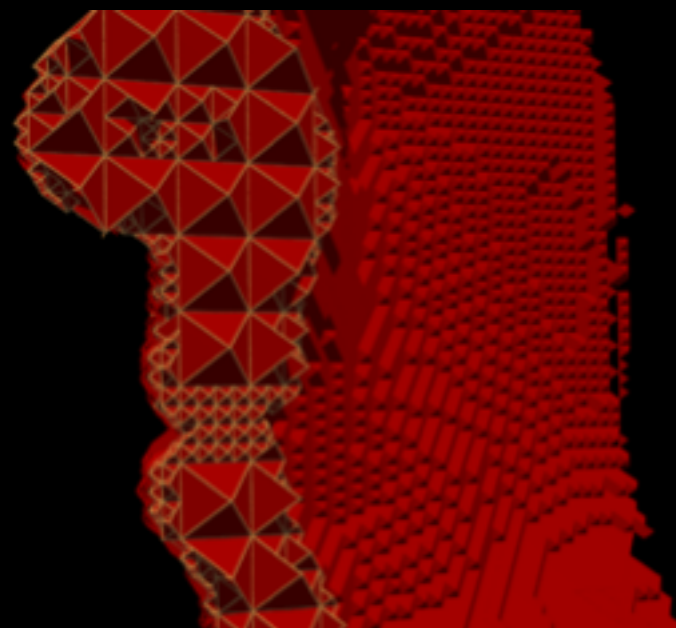








# Facial animation

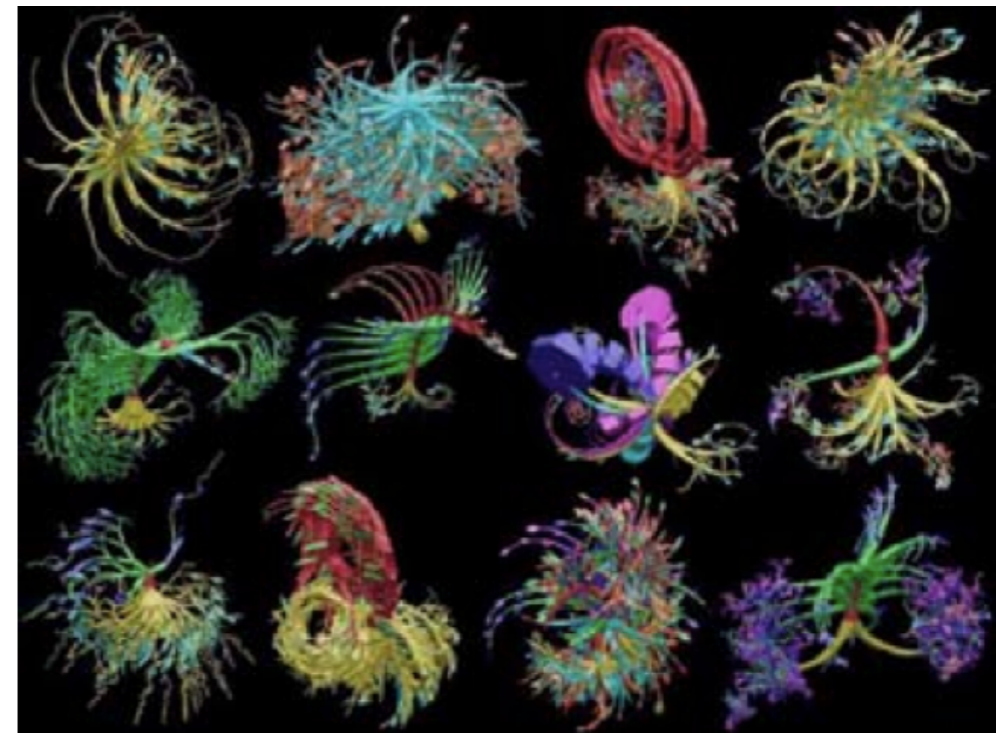


**procedural animation**



# Artificial life

- plants - movement and growth
- evolving artificial life





# Crowd simulation



[Treuille et al. 2006]