



Computer Animation

Thomas Funkhouser
Princeton University
COS 426, Fall 1999

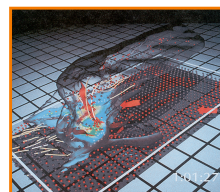


Computer Animation

- What is animation?
 - Make objects change over time according to scripted actions
- What is simulation?
 - Predict how objects change over time according to physical laws



Pixar

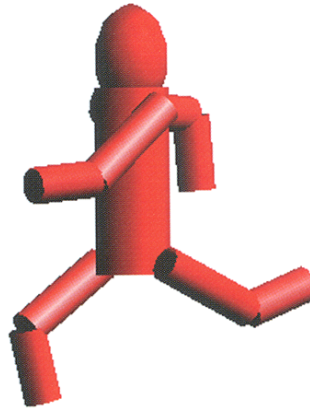


University of Illinois

Outline



- Principles of animation
- Keyframe animation
- Articulated figures



Angel Plate 1

Principles of Traditional Animation



- Squash and stretch
- Slow In and out
- Anticipation
- Exaggeration
- Follow through and overlapping action
- Timing
- Staging
- Straight ahead action and pose-to-pose action
- Arcs
- Secondary action
- Appeal

Disney

Principles of Traditional Animation



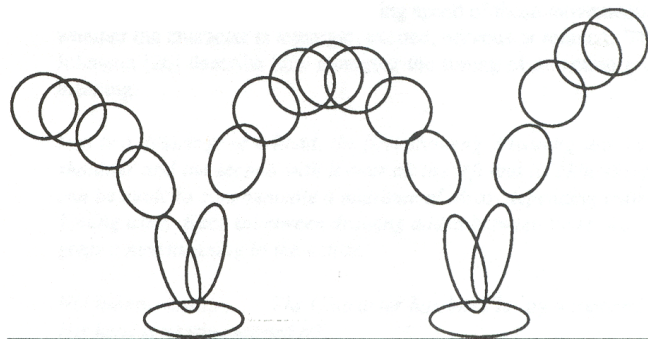
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Disney

Principles of Traditional Animation



- Squash and stretch



Lasseter '87

Principles of Traditional Animation



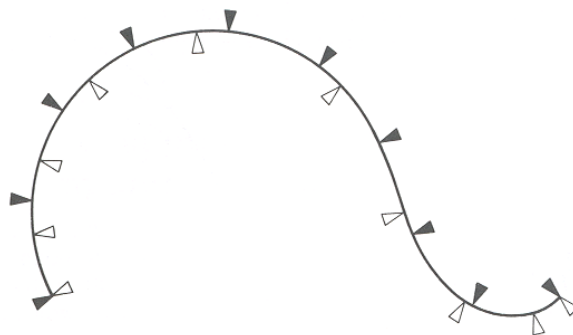
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Disney

Principles of Traditional Animation



- Slow In and Out



Watt Figure 13.5

Principles of Traditional Animation



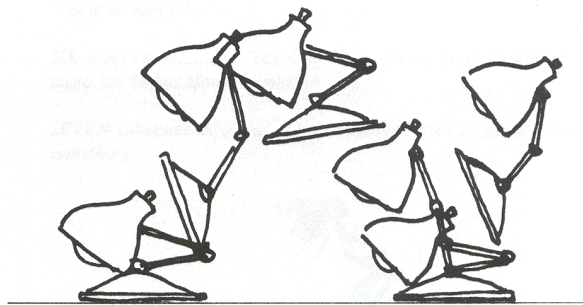
- Squash and stretch
- Slow In and out
- **Anticipation**
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Disney

Principles of Traditional Animation



- Anticipation (and squash & stretch)



Lasseter '87

Principles of Traditional Animation



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Disney

Computer Animation



- Animation pipeline
 - 3D modeling
 - Motion specification
 - Motion simulation
 - Shading, lighting, & rendering
 - Postprocessing

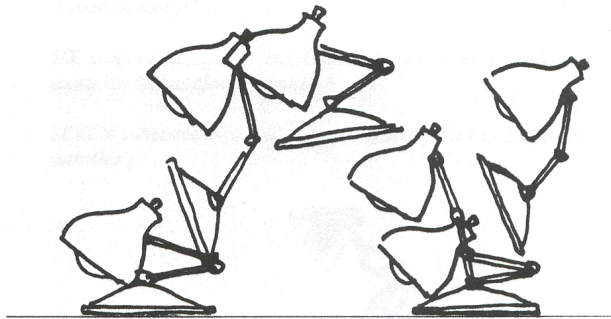


Pixar

Keyframe Animation



- Define character poses at specific time steps called “keyframes”

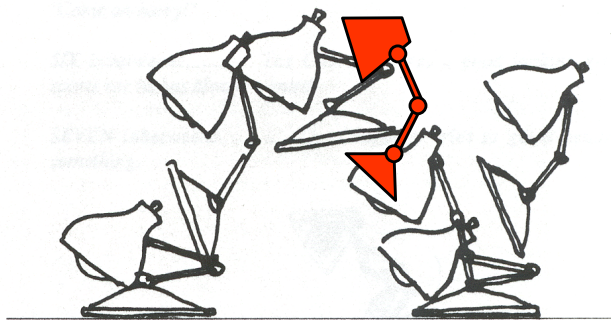


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Keyframe Animation



- Interpolate variables describing keyframes to determine poses for character in between

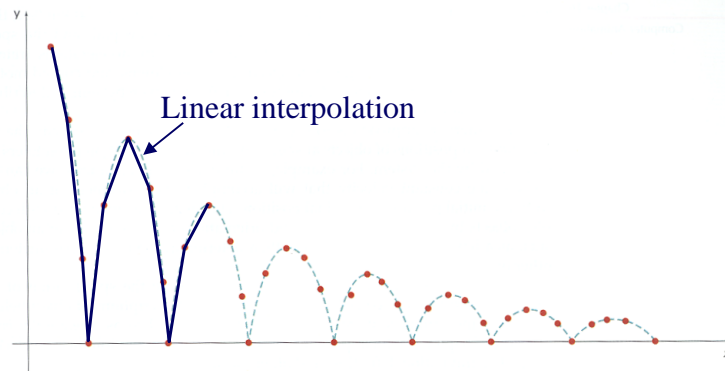


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Keyframe Animation



- Inbetweening:
 - Linear interpolation - usually not enough continuity

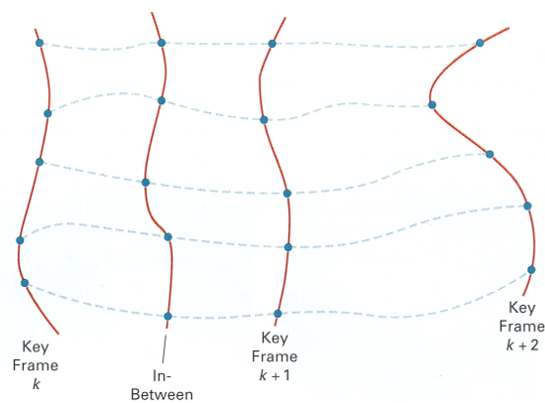


H&B Figure 16.16

Keyframe Animation



- Inbetweening:
 - Spline interpolation - maybe good enough

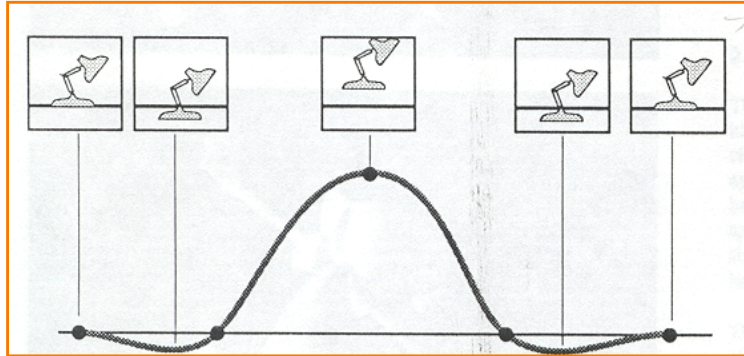


H&B Figure 16.11

Keyframe Animation



- Inbetweening:
 - Cubic spline interpolation - maybe good enough
 - » May not follow physical laws

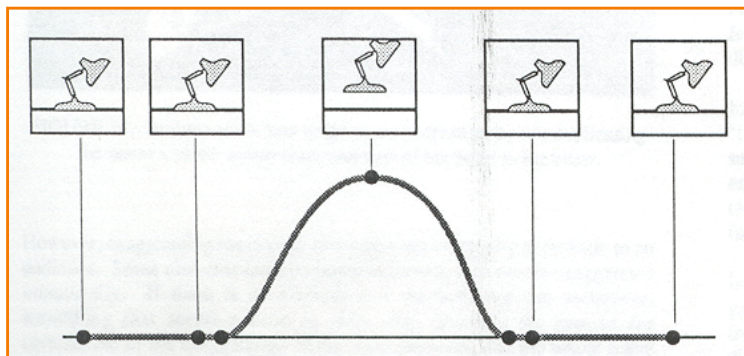


Lasseter '87

Keyframe Animation



- Inbetweening:
 - Cubic spline interpolation - maybe good enough
 - » May not follow physical laws

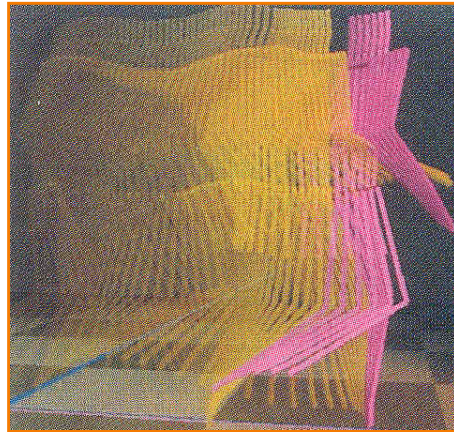


Lasseter '87

Keyframe Animation



- Inbetweening:
 - Inverse kinematics or dynamics

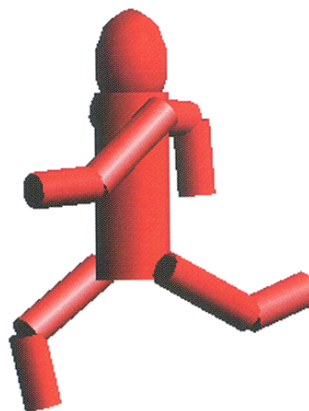


Rose et al. '96

Outline



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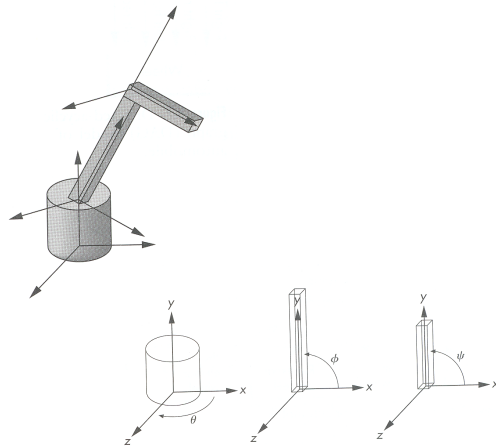
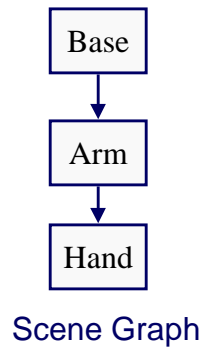


Angel Plate 1

Articulated Figures



- Character poses described by set of rigid bodies connected by “joints”

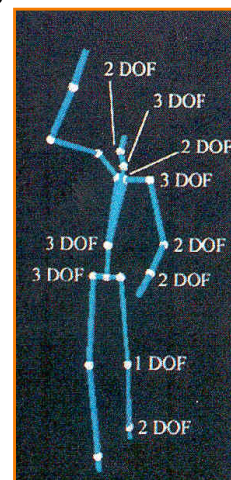
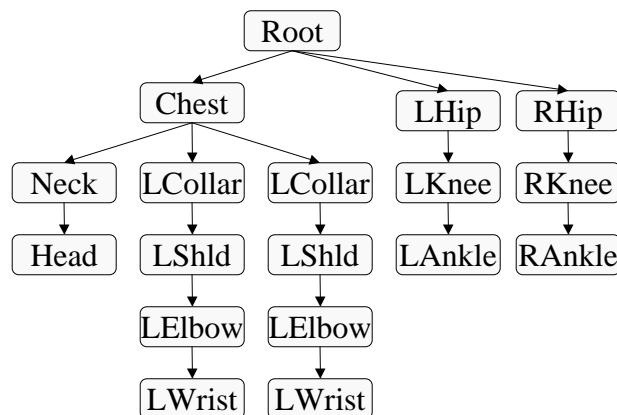


Angel Figures 8.8 & 8.9

Articulated Figures



- Well-suited for humanoid characters

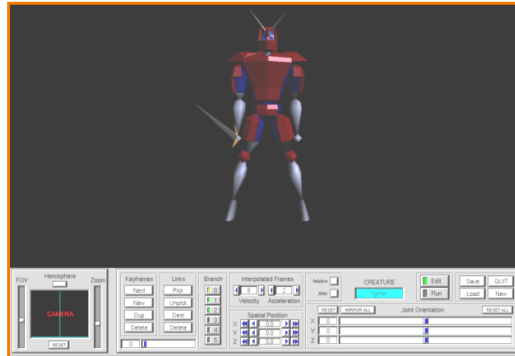


Rose et al. '96

Articulated Figures



- Joints provide handles for moving articulated figure

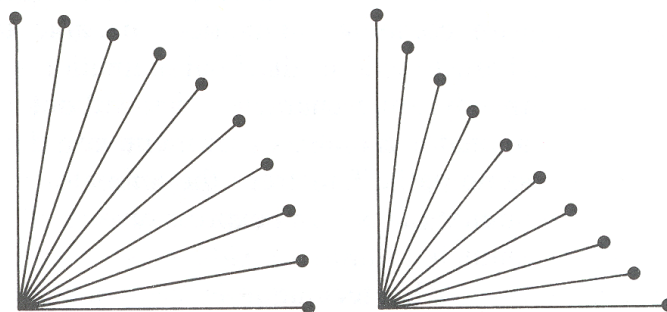


Mike Marr, COS 426, Princeton University, 1995

Articulated Figures



- Inbetweening
 - Compute joint angles between keyframes

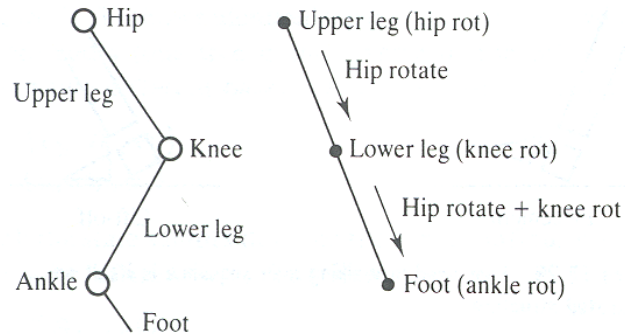


Watt & Watt

Example: Walk Cycle



- Articulated figure:

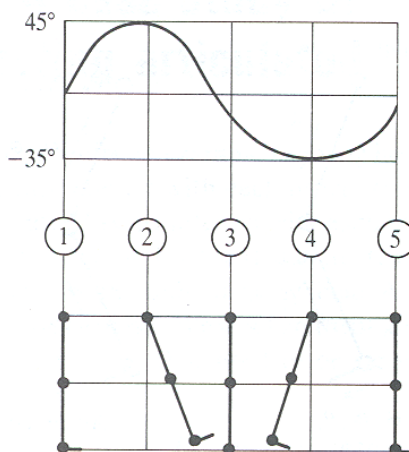


Watt & Watt

Example: Walk Cycle



- Hip joint orientation:

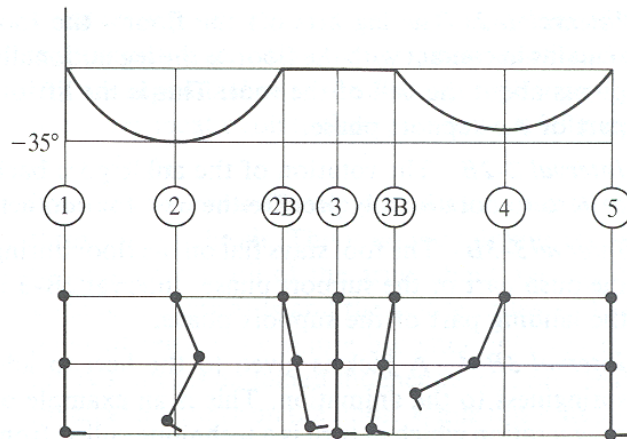


Watt & Watt

Example: Walk Cycle



- Knee joint orientation:

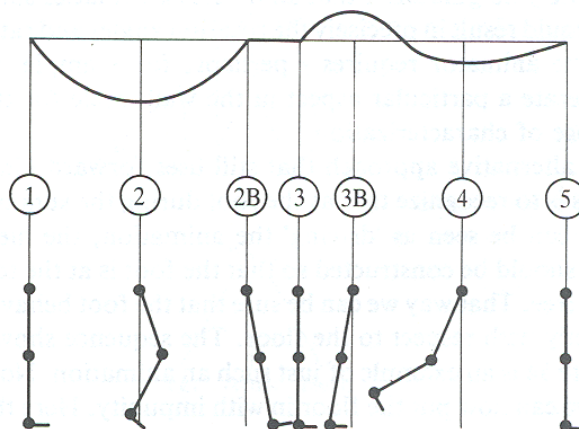


Watt & Watt

Example: Walk Cycle

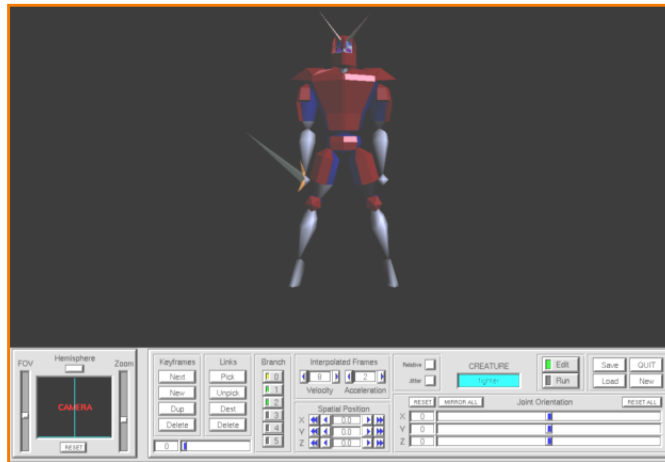


- Ankle joint orientation:



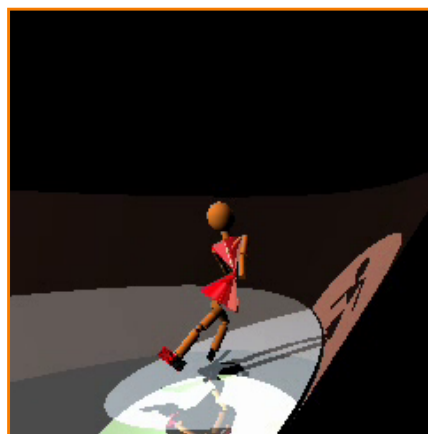
Watt & Watt

Example: Run Cycle



Mike Marr, COS 426, Princeton University, 1995

Example: Ice Skating



(Mao Chen, Zaijin Guan, Zhiyan Liu, Xiaohu Qie,
CS426, Fall98, Princeton University)

Example: Ballboy



Fujito, Milliron, Ngan, & Sanocki
Princeton University

Challenges of Animation

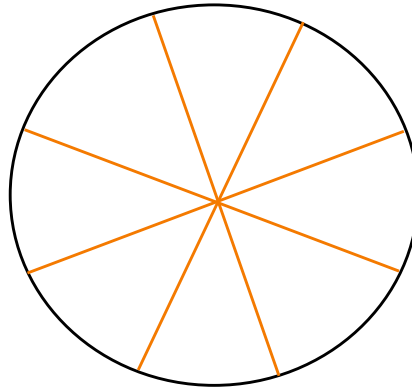


- Temporal aliasing
 - Motion blur

Temporal Aliasing



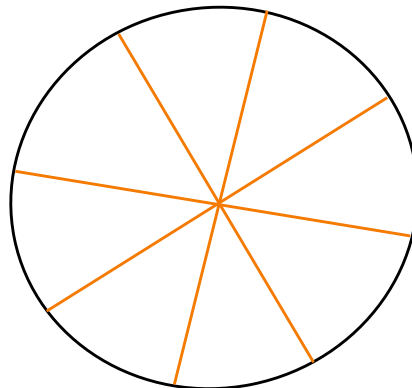
- Artifacts due to limited temporal resolution
 - Strobing
 - Flickering



Temporal Aliasing



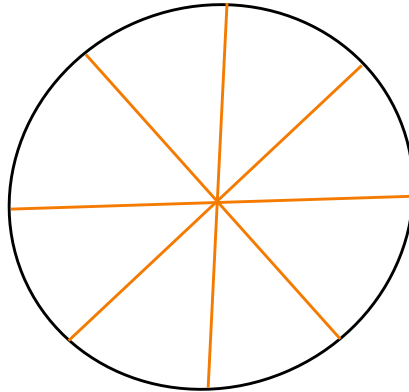
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Temporal Aliasing



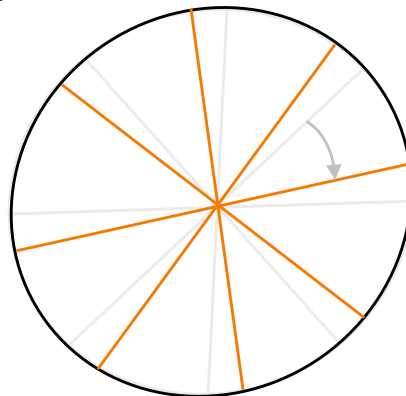
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Temporal Aliasing



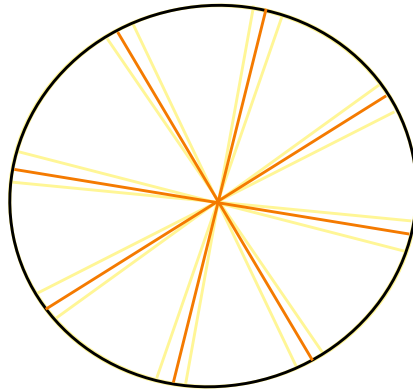
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Motion Blur



- Composite weighted images of adjacent frames
 - Remove parts of signal under-sampled in time



Summary



- Animation requires ...
 - Modeling
 - Scripting
 - Inbetweening
 - Lighting, shading
 - Rendering
 - Image processing



Pixar