

Sprite animation

- A sprite is a bitmap image (or set of images) that is moved over a background
- Transparency
- Very fast, easy
- Fixed library of animation
- No dynamic lighting, depth, *etc.*

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Sprite animation

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Morphing

- Animation which shows the metamorphosis of one image (or model) into another
- Based on a deformation field and blending
- Can often provide realistic animation based only on two (or few) images with added feature correspondences
- Correspondences or matching points (usually) specified manually

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Morphing examples

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Théoden morphing scene

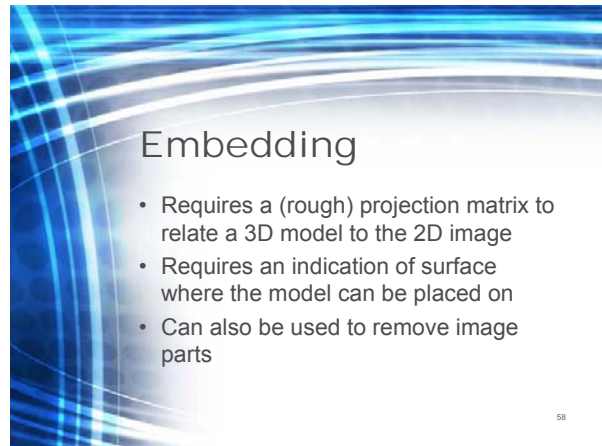
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Morphing

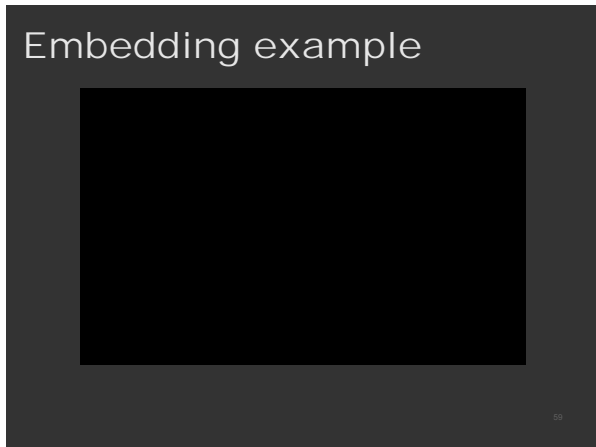
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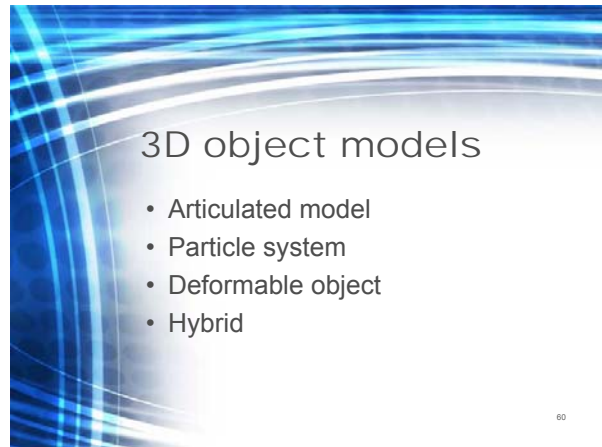
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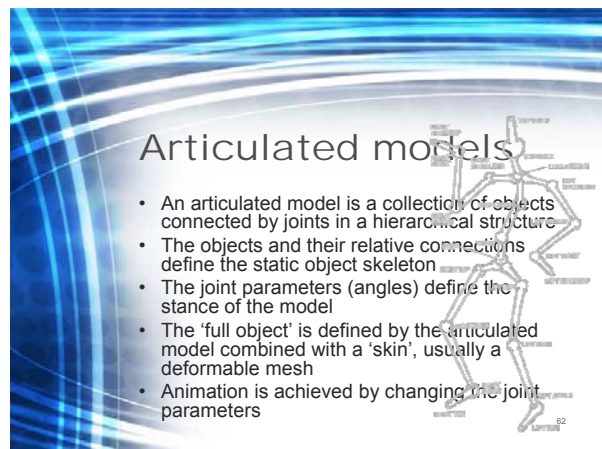
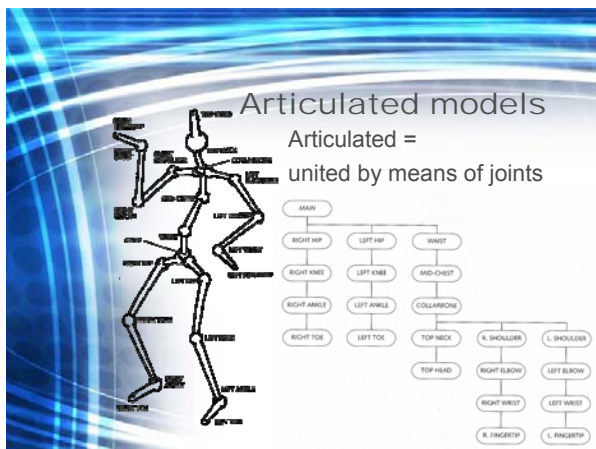
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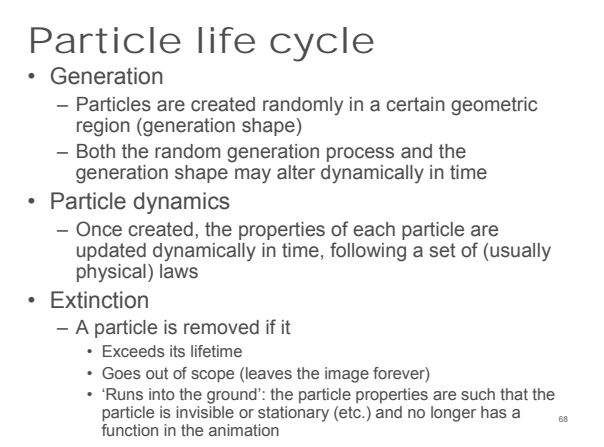
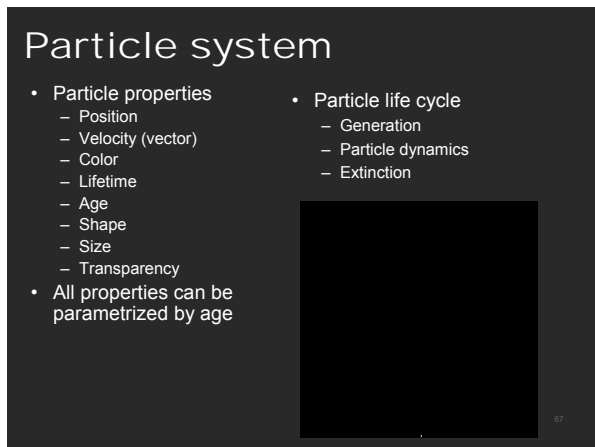
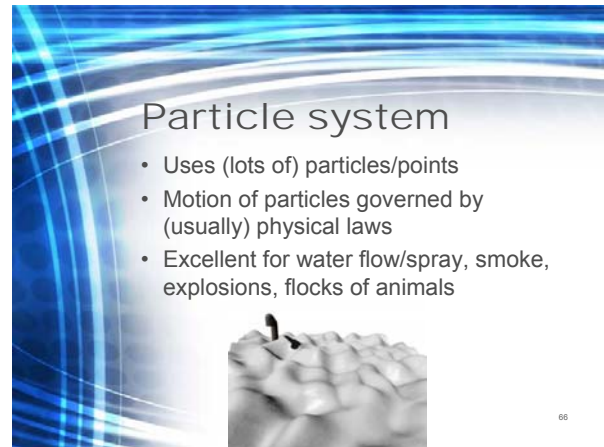
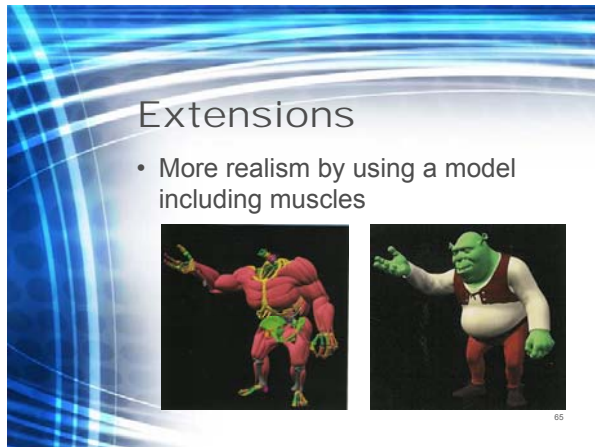
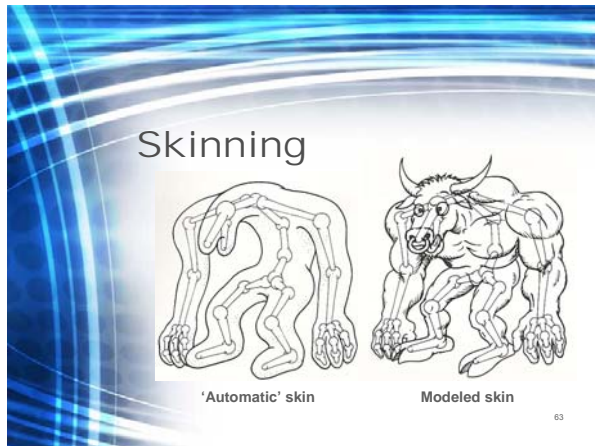


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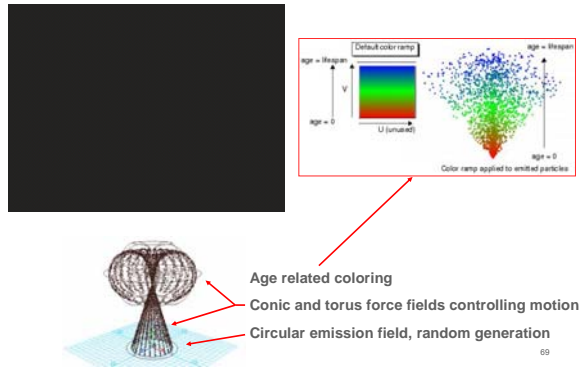


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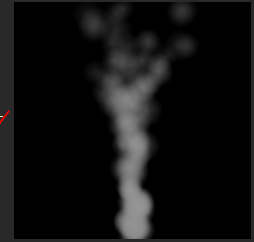


Particle system: MAYA example



Example: Smoke Particle System

- Small generation shape
- Constant upwards velocity
- Funnel-shaped force field with turbulence (spin)
- Particles rendered as partially transparent spheres that fade over time



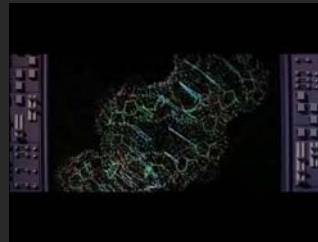
More examples



Example:

The wrath of Kahn (1982)

- Early use of particle system to model an explosion / raging fire



Example: water in *The Perfect Storm*

- Ocean created dynamically fluid dynamics



Flowing Water

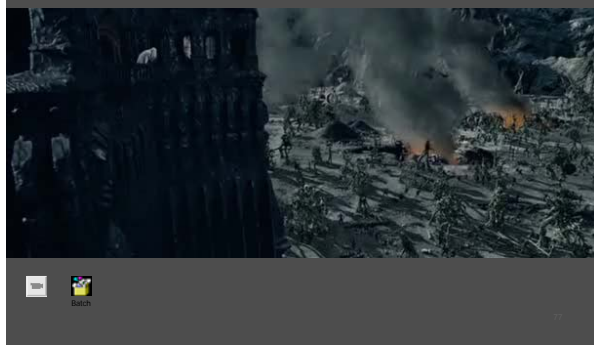
- Particle systems for
 - water flowing over boat
 - boat spray
 - impact spray



Composited result

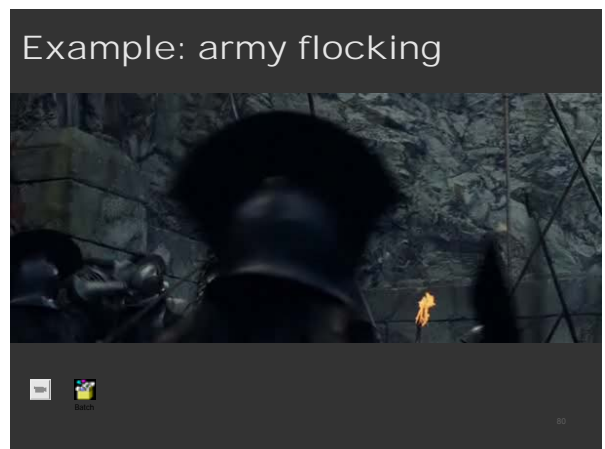
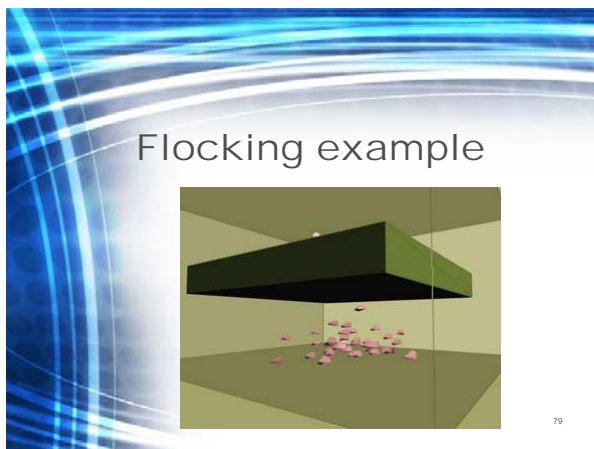
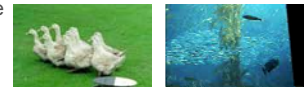


Isengard Flooding Scene



Particle system extension: Flocking

- Each particle represents an animal, e.g. a bird, hence the name *birdoid* or *boid*.
- A boid is a 'full object' not just a point or simple geometric shape, and has a local coordinate system (orientation), and can be fully rendered
- Fixed number of boids (no creation/extinction)
- Physical laws are replaced by behavioral rules:
 - Collision avoidance
 - Velocity matching
 - Flock centering
 - Etc.
- Smooth transition to AI-system (no well-defined boundaries)

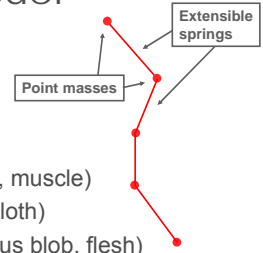


Deformable models

- Suitable for objects and materials that are non-rigid
- Several possible models
 - **Finite element approximation** of physically/analytically correct deformation considering material properties → infeasible
 - **Mass-spring model** → requires differential equation solving (expensive), but looks realistic
 - **B-spline/NURBS surface** with time-varying control points → need to specify the variation
 - **Free-form deformation** → needs deformation specification, but generally only a few control points are necessary
 - **Implicit surface deformation** (level set evolution) → poor feasibility

Mass-spring model

- Models an object as a series of point masses connected by springs
- Object can be
 - A curve mass (hair, rope, muscle)
 - A surface mass (water, cloth)
 - A volume mass (gelatinous blob, flesh)
- Rest length of springs may be a variable in animation

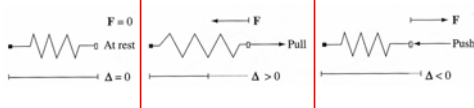


Mass-spring model dynamics

- Motion computed from external forces and Hooke's Law:

$$\mathbf{F} = -c\Delta\mathbf{U}$$

\mathbf{F} force exerted by the spring
 c constant of proportionality
 $\Delta\mathbf{U}$ deviation from rest length



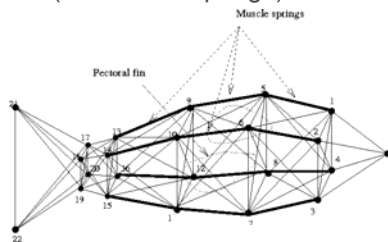
Example

Rope modelled as 1D mass-spring

The images show a yellow rope-like mass-spring model. The left image is labeled 'Gravity only' and shows a U-shaped curve. The right image is labeled 'Wind force from left' and shows the rope being pulled to the left, creating an asymmetrical curve.

Mass-spring model: 2D example

- Fish model
- Bold lines represent springs
- Dots represent masses
- Surface model (no internal springs)



Fish example



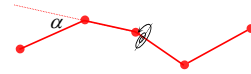
Fish stereo example



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Extensions (hair)

- Regular mass-spring (limp hair)
- Angular springs (bending, add 'body')
- Torsion (curling)



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Example: hair

- 'Nostalgia', SIGGRAPH 2001



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Hybrid models

- The different object models (articulated, particles, deformable, ...) are all best suited for a particular class of object and less (or not at all) for others → often systems that combine several types are necessary
- Allows to use the best appropriate model, but requires careful consideration of the interfacing of the models
- Example: diver (articulated model) diving in a pool (deformable model) creating water spray (particle system)

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Motion blur

- Rendering technique
- To reduce strobing and aliasing - high frequencies masquerading as low frequencies, e.g. a wheel appearing to move backwards
- Implemented by multiple renderings of a fast moving object in a single frame

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