Particle Systems – Technique for Modeling a Class of Fuzzy Objects
William T. Reeves, Lucasfilm Ltd.

SIGGRAPH Proceedings 1983
Fuzzy Objects

- Objects without well-defined surfaces
  - Clouds
  - Fire
  - Water
- Cannot estimate motion with affine transformations
Particle Systems

- Don't define these objects with polygons, use particles.
  - A group of points that defines an object's volume
  - Dynamic
  - Non-Deterministic
  - Procedurally Generated
How Do They Work?

- Generate new particles
- Assign attributes to new particles
- Extinguish old particles
- Transform existing particles
- Render the system
Particle Generation

- Determine the number of particles to be generated at each frame
  - Average + Rand() x Variance
- Alternatively, base the number on screen size
  - (Average + Rand() x Variance) x Size
Particle Attributes

- Generation shape
- Initial Velocity
- Lifetime
- Initial Color
Extinction / Transformation

- **Particle Extinction**
  - Kill particles have exhausted their lifetime
- **Particle Transformation**
  - Add a particle's velocity to its current position
Rendering

- Just as difficult as rendering polygons
  - Occlusion, lighting, intersection...
- Assumptions make it easier
  - Particles cannot intersect other objects
  - Render particles as light sources
Genesis Demo

- Part of Star Trek II: The Wrath of Khan
  - Transforming a dead, moon-like planet into a warm, Earth-like planet.
- Uses a wall of fire developed using this technique
Genesis Demo
Genesis Demo
Genesis Demo
Genesis Demo
Genesis Demo
Questions?