Today

- Particle Systems.
- Dynamics.
- Soft Bodies.
Simulation-Based Animation

1. Initialize
2. Simulate
3. Render

Exit
Methods of Simulation

• Physics-Based Simulation:
  Forces and constraints described by differential equations.

• Procedural Simulation:
  Arbitrary rules implemented in computer programs.
Particle System

• Collection of objects whose motion is governed by a single simulation technique.

• Particle Object:
  – Represents whole collection of particles.
  – Attributes describe behavior of whole system.

• Particle:
  – Has some attributes of its own.
  – E.g., position, velocity, age.
Creation of Particles

• Particle Tool:
  – User clicks individual particles into position.
  – User sketches an arrangement of particles.
  – User specifies a grid of particles.

• Emitters:
  – Automatically generate particles over time.
  – Types: omni, directional, volume.
  – Emit from object: Place emitters on curve or surface.

  demos-08-particle-directional-emitter.mb
  demos-08-particle-curve-emitter.mb
Particle System Attributes

- Lifespan Mode and Lifespan: Determine how long a particle “lives” before disappearing from the scene.
- Conserve: Determines how much particle velocity is influenced by momentum versus force.
- Particle Render Type: The kind of geometry used to render each particle.
- …Many more …
Fields

• Define forces that influence motion of particles.

• Types of fields:
  – Volume Axis:
    • Forces aligned with coordinate axies.
    • E.g., spherical, cylindrical or toroidal coordinates.

demos-08-particle-newton-vortex-drag.mb

demos-08-particle-volume-axis.mb
Particle / Object Collisions

- Create a geometric object.
- Make the object into a “Passive Rigid Body”.
- Select particle system and geometric object.
- MakeCollide menu item tells Maya to implement collisions between particles and rigid body.
- Attributes Resilience and Friction of GeoConnector object determine details of the collision dynamics.

demos-08-particle-floor-collisions.mb
Rendering of Particles

• Select particle system shape node.
• Open in Attribute Editor.
• Go to Render Attributes tab.
• Render type determines geometry of each particle.
• Software rendering:
  – Uses main CPU to generate image.
  – Select “Maya Software” in Render Settings window to set up the final render.
• Hardware Rendering:
  – Uses hardware on your graphics card to generate image.
  – Windows-RenderingEditors-HardwareRenderBuffer to preview hardware rendering.
  – Select “Maya Hardware” in Render Settings window to set up the final render.
Goals

• Define one object as a goal toward which particles are attracted.
• Goal object may itself be a goal-seeking particle.

demos-08-particle-particle-goal.mb
demos-08-particle-particle-goal-goal.mb
demos-08-particles-sphere-goal.mb
Rigid Body Dynamics

- Create geometric object.
- Make the object into an “Active Rigid Body”.
- Apply a field to the object.
- Apply dynamics constraints to some objects.
- Motion is governed by field forces, constraints and collisions.

demos-08-dynamics-catapult.mb
demos-08-dynamics-ball-and-planks.mb
Rigid Body Constraint Examples

demos-08-dynamics-balls-on-strings.mb

demos-08-dynamics-balls-with-spring.mb

demos-08-dynamics-box-flipper-balls.mb

demos-08-dynamics-chain-links.mb

demos-08-dynamics-orient-constrained.mb

demos-08-particle-floor-collisions-rebound.mb

demos-08-dynamics-dominoes.mb
Soft Bodies

• CreateSoftBody defines a particle system in which the particles include:
  – CVs of a NURB surface.
  – Vertices of a polygon surface.

• Define fields, goals and collisions to control the particle system.

• Motion of particles will move and deform the geometric surface.

  demos-08-dynamics-cloth-falls-on-sphere.mb
  demos-08-dynamics-cloth-falls-on-plane.mb
Cloth Falling on Sphere

- Make two NURB spheres. Scale one down to 95% of the size of the other. Set the visibility of the larger one to OFF in the Channel Box.
- Make a polygon plane with 8 rows and 8 columns of faces. With the plane selected, go to the Dynamics menu set and invoke Soft/RigidBodies-CreateSoftBody. Move the plane to a point a little above the two spheres.
- Use the Outliner to find and select the particle system parented to the polygon plane. Invoke Fields-Gravity[], set the magnitude to about 0.1 and confirm.
- Select the polygon plane and then the larger (invisible) sphere and invoke Particles-MakeCollide[]. Set Resilience to 0.0 and Friction to 1.0 to make the cloth stick to the sphere.
- Play the animation.