ROCKET LAUNCH

Maya's particle system is a powerful and extensive collection of tools and features used to simulate a variety of effects such as dust, sand, fire, clouds, explosions, smoke, and liquids. Effects such as these are found in countless feature film and broadcast shots and have become part of the every day effects for many in the industry.

This tutorial explains how to set up and render a rocket launching. The focus is on setting up the smoke trail of the rocket using software particles.

In this tutorial:

A Taste of Maya

Before you start:

This tutorial requires Maya scene files. To download the tutorial files, please visit the Taste of Maya web site at www.aliaswavefront.com/tasteofmaya.

Starting Maya:

Double-click the **Maya 3.0 Evaluation** icon on the desktop, or from **Start > Programs > Maya 3.0 Evaluation > Maya**.

In Maya:

Once the tutorial files have been installed, set the current project to access the Maya scene files. To set the current project from within Maya:

• Select **File > Project > Set** and navigate to the directory where you installed the Maya scene files.

• Select the directory **Maya_tutorial_data** and press **OK**.

Rocket launch—Introduction

To create the smoke trail in the image, three different particle objects have slightly different motion and shading characteristics. All three particle objects are emitted from one emitter that is parented to the rocket.

Thick particles: Provides a base layer of particles resulting in a chunky display.

Softer particles: Provides a layer of wispiness.

Trail particles: Used to simulate the streaking effect in the smoke trail.

Once you tune the particles' motion and emission using fields and animation curves, you add lighting and shading and then render the scene.

Particle objects versus geometry

The differences between Maya's particles and geometry are:

• Particles are points in space. They require special handling when rendering since they do not contain surface information.

• Particles can be rendered using hardware or software rendering methods. You can choose a method using the **Render Type** attribute (see *Set the Particle Render Type and render attributes* for details).

The rocket example uses software render types only. Although software render types render slower, details such as shadows, detailed texturing, and reflections can be rendered.

• In Maya, individual particles belong to a common collection called the **particleShape** object. Just as CVs of a geometric object belong to their shape node, individual particles are like components to the particleShape node.

Adding a Thrust emitter

A particle emitter is like a cannon that fires particles into space. The following shows you how to add an emitter.

Open the scene file and play it back

1 Select **File > Open**.

2 Select **rocket_start.ma**.

This scene file contains a rocket on a launch pad. The rocket launch has already been keyframed. Playback to see the rocket launching.

Add a directional emitter

1 Press **F4** to access the Dynamics menu set.

2 In the **Outliner**, select **thrust** (within the rocket group).

3 Select **Particles > Emit from Object** ❏ and set the following in the window that displays:

| Set...	to...	
Emitter Name	thrustEmit	
Emitter Type	Directional	
Rate	45	The number of particles emitted per-second.
Max Distance Min Distance	5 1	Min and Max Distance determines a distance from the emitter in which emission can occur. The values used here keep the particles from overlapping with the tail of the rocket.
Spread	0.15	
Direction X, Y, Z	-1, 0, 0 respectively	
Speed	150	Controls how quickly the particles leave the emitter.

4 Press **Create**.

View and rename the particle object

1   Press play on the Time Slider to watch the particles emit.

Tip

Make sure **Playback Speed** is set to **Free** or the emitter may appear to sputter particles instead of provide a constant emission (**Window > Settings/ Preferences > Preferences > Timeline**).
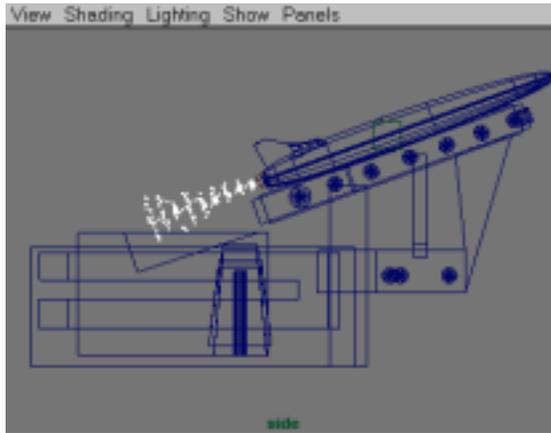
Particles trailing behind the rocket

2   Open the **Outliner** to see the new **particle1** particle object and the **thrustEmit** emitter.

3   Double-click **particle1** in the Outliner and rename it to **thick**.
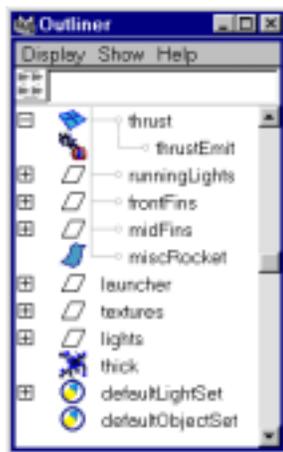
Outliner showing emitter and associated particle object

4   Select the **particle object** and set **Level of Detail** to **0.25** in the Channel Box.

To work with particles efficiently, use **Level of Detail** (LOD). Level of detail controls the percentage of particles displayed in the views and in the final render. Lowering this value lets you quickly evaluate motion while testing.

Remember to set this back to 1 when rendering.

Note

To create a stand-alone emitter that does not get placed within an object hierarchy, you can use **Particles > Create Emitter**. You can still parent this emitter to an object later if desired.

Adjusting particle attributes

Now that the emitter is in place, you can begin to make a few preliminary changes to the particles to make them more visible and behave like a realistic smoke trail.

Adjusting particle attributes in the Attribute Editor

You adjust most particle attributes in the Attribute Editor for the **thickShape** object. Changes made here affect every particle component belonging to the selected particle object.

Adjust attributes for thick particles

1   Continue from the last step, or open **rocket_thick.ma**.

2   Select **thick** in the Outliner.

3   Press **Ctrl-a** to open the Attribute Editor.

Set the Particle Render Type and render attributes

1   In the Render Attributes section of the Attribute Editor, set the **Particle Render Type** to **Cloud**.

2   Click the **Current Render Type** button. Attributes associated with the cloud render type display.

3   Change the following settings:

   • **Surface Shading** to **0.8**
   • **Threshold** to **8.250**

These settings control several rendering properties for the clouds (which will be more important later on). You will not see any change in the perspective view.
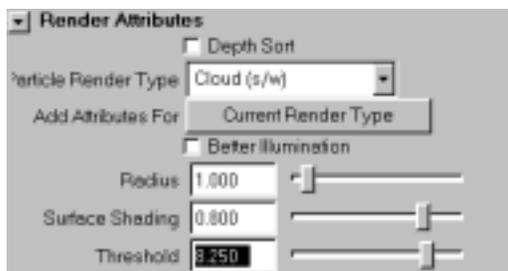
Setting thick particles to cloud and adjusting attributes

Add a per-object lifespan

Adding a lifespan attribute lets you control how many seconds each particle is displayed in the scene. To do this:

In the **Lifespan Attributes** section of the Attribute Editor, set **Lifespan Mode** to **Constant** and **Lifespan** to **5**.

Adding fields

Fields act like forces that move the particles around in different ways. At this point of the tutorial, you add gravity, turbulence, and radial fields and connect them using three different methods.

Method 1

Create gravity and connect it

The following shows you how to create a stand-alone field and connect it to the particles to make them look realistic when they fall.

1   Make sure nothing is selected.

2   Choose **Fields > Gravity**.

3   In the Outliner, select the **thick** particles, then **Ctrl-select** the **gravityField1**.

4   Select **Fields > Affect Selected Objects** to connect the gravity field to the particles.

If you switch to wireframe mode (press **4**) and select only **gravityField1**, the particles highlight in pink to indicate the connection.

Adjust the particle conserve attribute

Playback the scene. As you playback, notice how the particles quickly fall instead of float. To simulate ejecting and easing to a stop, you can adjust the amount of momentum the particles conserve at each frame.

1   Open the Attribute Editor for **thickShape**.

2   In the **Thrust Emit** section, set the **Speed** to **25**.

3   Adjust the **Conserve** attribute near the top of the Attribute Editor. A value of **0.5** works well.

This means that at each frame each particle keeps only 10 percent of the velocity it had in the previous frame. Try experimenting with other conserve values.

Method 2

Create turbulence and connect it using dynamic relationships

The following shows you how to apply turbulence to scatter the particles a bit, and use the **Dynamic Relationships Editor** to connect the field. This editor can be used to manage many types of dynamics connections including fields, collisions, and emission.

1   Rewind to Frame **1** and make sure nothing is selected.

2   Select **Fields > Turbulence** ❏ to open the options window and set the following:

   • **Magnitude** to **100**
   • **Attenuation** to **1**

3   Press **Create**.

An **Attenuation** of **1** causes the field influence to diminish over distance, which means that particles further away from the field are less turbulent.

4   Press **w** to enter the **Move** tool.

5   Move the field's icon to roughly the same location as the **thrustEmit** object (near the back end of the rocket).

6   With the field still selected, **Ctrl-select** the thrust geometry object in the Outliner (not the emitter), then select **Edit > Parent** to make the field follow along with the rocket.
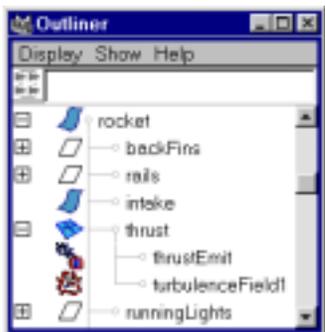
Parenting of turbulence field in Outliner

7   Select **Windows > Relationship Editors > Dynamic Relationships**.

8   Make sure the **Selection Mode** is set to **Fields**.

9   Select **thick** on the left side and **turbulenceField1** on the right. **gravityField1** is also highlighted on the right confirming that it is connected.
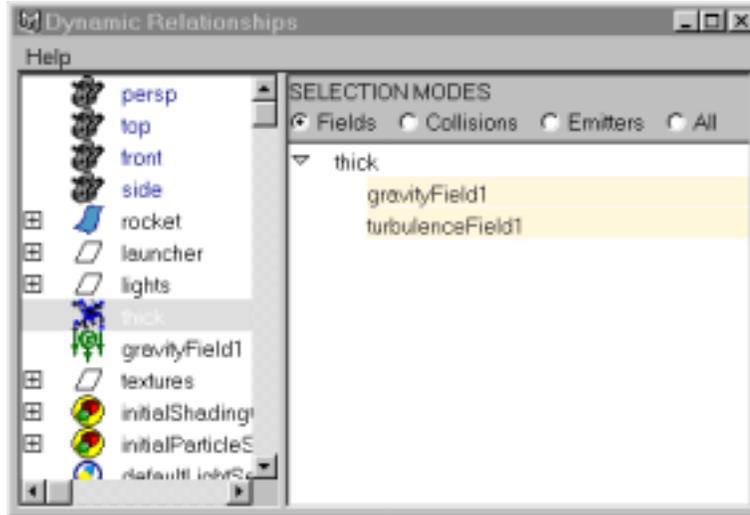
Gravity and turbulence connected in Dynamic Relationships Editor

Method 3

Add a radial field to push the particles outward

The following shows you how to slightly expand the particles after they leave the rocket by adding a radial field.

1 Select **thick** in the Outliner.

2 Open the Add Radial window (**Fields > Radial** ❒) and set the following:

| Set...	to...
Magnitude	0.8
Attenuation	0.5
Use Max Distance	On
Max Distance	8

3 Press **Create**.

4 Turn on **Apply Per Vertex** in the Channel Box.

Tip

You use **Add Radial** to automatically parent the field to the particles. Turning **Apply Per Vertex** on causes individual particles to behave as though independent radial fields are attached to it. This keeps all the particles pushing away from each other.

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5 To connect **thick** particles to **radialField1**, use the **Dynamic Relationships** window
(**Window > Relationship Editors > Dynamic Relationships**).

6 Playback to test the motion.

To see a completed version of the scene file up to this point, open **rocket_with_fields.ma**.
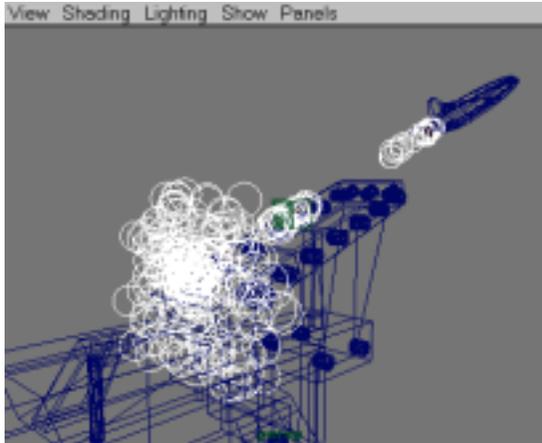
Particles pushed away from the center by a radial field

Changing each particle's radius over time

At this point, every particle in **thick** has the same radius (1.0). You can give each particle its own
radius value and change that value over the course of the particle's lifespan. This is done by
adding a per-particle radius attribute (**radiusPP**) which is controlled by a ramp. For example, the
particles can exit small, then grow, then get smaller again by the time they die, which is similar
to how puffs of smoke behave.

Add radiusPP to thick in the Attribute Editor

1 Select **thick** and open the Attribute Editor.

2 Click the **thickShape** tab at the top of the Attribute Editor.

3 Click the **General** button under **Add Dynamic Attributes**.

4 Click the **Particle** tab on the window that displays, select **radiusPP** and press **OK**.

Adding a radiusPP attribute
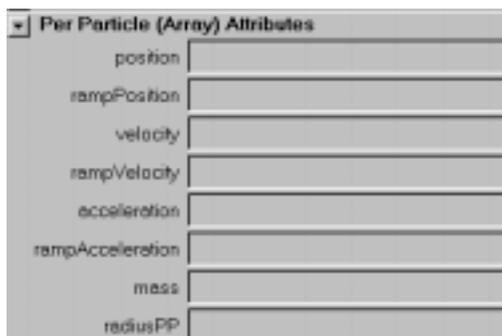
radiusPP shown in thick's Attribute Editor

Note

The particles disappear because radiusPP is set to 0. When both radius and radiusPP attributes exist, the radiusPP values override the radius attribute.

Assign a pre-made ramp to thick's radiusPP

Since radiusPP is currently 0, you have to assign a value so the particles can grow and shrink. A quick way to do this is to assign a pre-made ramp. (A ramp is just a gradation between values.)

1   In the Attribute Editor for **thick**, **RMB** in the field next to **radiusPP**, and select the box beside **Create Ramp** to open the Create Ramp options window.
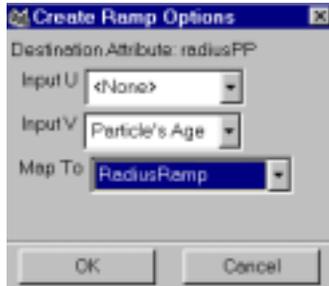
Selecting a pre-made ramp from the Create Ramp Options window

2   Select **RadiusRamp** from the **Map To** pull-down menu. This gradation of values has been set up for you so the radius grows and shrinks at the right times.

3   Leave **InputU** and **InputV** as they are and press **OK**.

4   Rewind and play back the scene. The **rocket_radiusPP.ma** file contains a setup version of the scene up to this point.
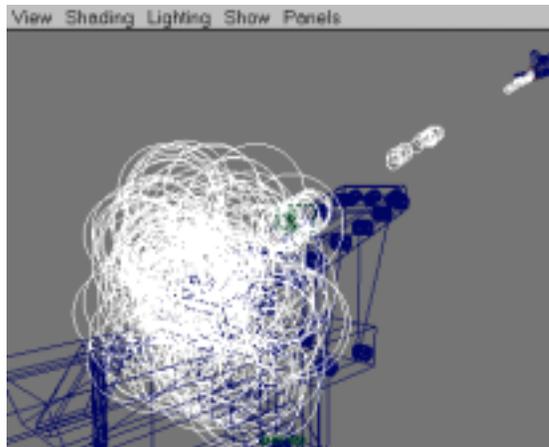
Particles with changing radius values

Animating the emission rate

A rocket exudes more smoke at initial take off. To simulate this, you have to animate the emission rate on the **thrustEmit** emitter.

Continue from the previous steps, or open **rocket_radiusPP.ma**, which can be used as a starting point.

Keyframe thrustEmit rate

1   Select **Windows > Saved Layouts > Persp/Graph/Outliner**.

2   Select **thrustEmit** and open the Channel Box.

3   Go to frame **18** on the **Time Slider**.

4   Set **rate** to **0** in the Channel Box.

5   **RMB** click on **rate** in the Channel Box and choose **Key Selected** to keyframe the rate to **0** at frame **18**.

6   Set four more keyframes using the following values:

   •   frame **22**: rate = **10**

   •   frame **26**: rate = **6**

   •   frame **39**: rate = **40**

   •   frame **70**: rate = **0**

The goal is to create an animation curve in the Graph Editor resembling the following:
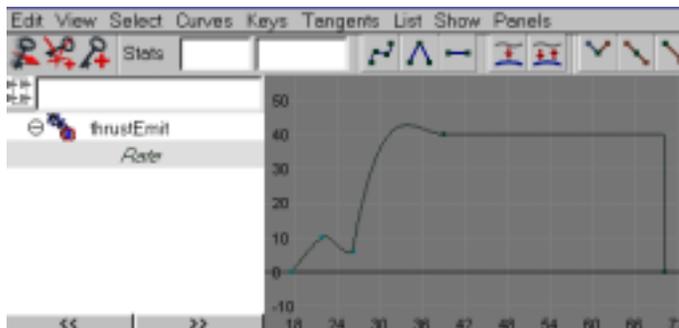

Emission rate controlled by animation curve in the Graph Editor

Note

The last two keyframes in the image use *stepped tangents.* For more information about adjusting keyframe tangents and weights in the Graph Editor, see the on-line documentation.

Tip

If there are too many particles to see what is happening, or if the playback is too slow, you can temporarily lower the emission rate in the Graph Editor, or lower the **Level Of Detail** attribute on the particle object. Temporarily setting the **Render Type** to **Points** can also help.
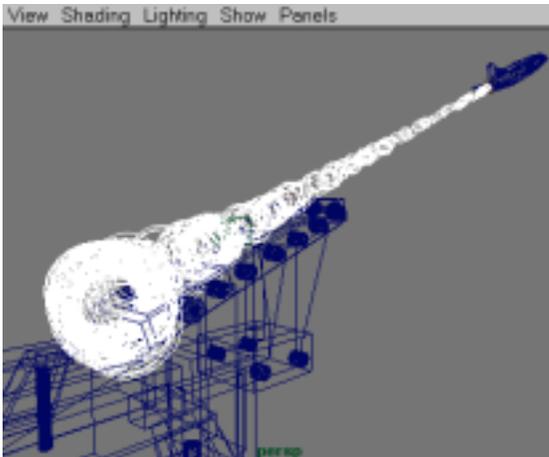
Keyframed emission rate result

Rendering the scene

This part of the tutorial shows you how to render the particles to resemble smoke. The scene file provided contains additional particle objects and lighting. Your task is to assign the appropriate shaders to the particles.

File contents

Select **File > Open Scene** and open the **rocket_render.ma** file. This file contains additional particle objects, display layers, and two volumetric particle cloud shaders. See the following descriptions.

Additional particle objects

Emit from the same emitter as the thick particles.

- **softer**: These particles are slightly larger than the **thick** particles.
- **trail**: The length of these **Tube** render type particles are determined by how fast they move. These particles create trailing streaks behind the rocket.

Display layers

Provided for each particle object. Use these display layers to turn the visibility of the particles on and off. This helps you manage the number of particles displayed on the screen and speeds up the test renders.

Volumetric particle cloud shaders

- **thickCloud**: Provides a chunky-edge appearance to the **thickParticles**.
- **softCloud**: Assigned to **softer** and **trail** particles. More transparent than thickCloud, this provides a softer boundary overlaying the thickCloud and tones down the brighter highlights.

Tip—Render speed considerations

While performing test renders, render speed is greatly affected by the number of particles and the percentage of screen space those particles occupy. It is recommended that you frame the scene for test renders, and don't forget to use the **Level of Detail** attribute and the display layers to help manage rendering speed.

Assigning Shaders for the Particles in Hypershade

You use Maya's Hypershade to build and assign materials (sometimes called *shaders*) to the particles.

1 Open **Windows > Outliner** and select **thick**.

2 **Shift-select** the **thickClouds** material icon in Hypershade (**Window > Hypershade**).

3 **RMB** on the **thickCloud** icon's text label and select **Assign Material to Selection** from the pop-up menu that displays.

4 Repeat the process for **softer** and **trail** except assign the **softCloud** material to both of them.
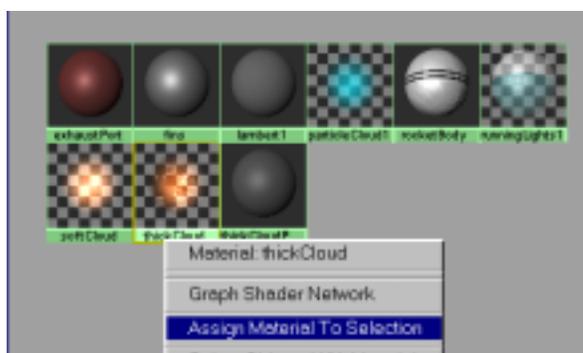
RMB menu for assigning shaders in Hypershade

Test rendering individual layers

To get an idea of what each material and particle object is contributing to the image, use the display layers to display only one particle object at a time, then render a frame.

Tip

When adjusting materials, try to focus on one particle object at a time. This keeps rendering times lower and helps you see what is going on.

Test render layers

1 Make sure the layer bar is displayed (**Display > UI Elements > Layer Bar**).

2 From the Time Slider, play up to frame **40**.

3 To hide **softer** and **trail** from the layer bar, **RMB** in the Layer Bar and turn off visibility for **softerLayer** and **trailLayer**.

4 In the **Render View** (**Window > Rendering Editors > Render View**), choose **Render > Render > Current (persp)**.

5 Repeat the process (two particle layers hidden, one visible) to render one still image of each particle object.

6 Test render a frame with all three particle objects visible so you can see how they display when combined. See the following examples.
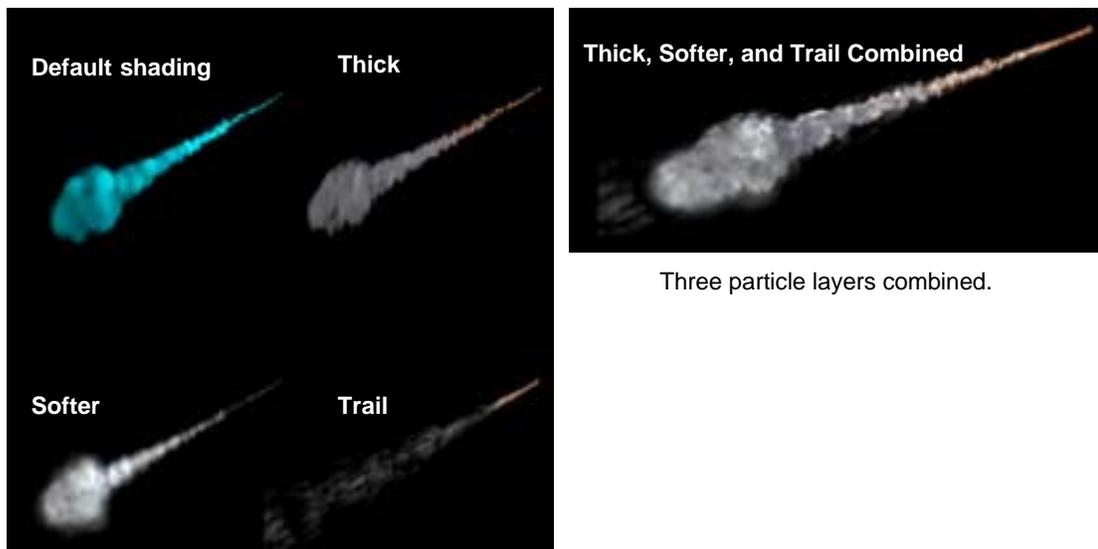
Three particle layers combined.

The default particle material and each particle object rendered.

Tip

Press the **1:1** button in the Render View to view the Render at the accurate aspect ratio.

Lighting and global settings

Other options are important to consider when rendering this type of shot in Maya, such as lighting, and setting Render Global attributes.

Lighting the scene

The particles are lit independent of other objects in this scene. Two **directional lights** illuminate the rocket, and a **spotlight** illuminates the particles. A colored **point light** parented to the back of the rocket is also included. See the following.

Creating and placing lights in the scene

Create lights

1 Select **Create > Lights**.

2 Select the light you want from the menu that displays and click in a view.

3 Adjust the attributes in the light's Attribute Editor.

A **spotlight** with linear decay, a slight color tint, wide cone, and high intensity, work well for this shot.

4 Select **Create > Lights > Spotlight**.

5 Set the **Linear Decay** to **Linear**.

6 Click the swatch beside **Color** and select a color to add to the light from the **Color Chooser**.

7 Set the **Cone** size to **70**.

8 Set the **Intensity** to **5**.

Tip

To display Maya's special light manipulators, select the light in the view then press **t**.

Light linking

Setting **Illuminates by Default** off lets you set light linking relationships so certain lights only shine on certain objects.

1   Select **Window > Relationship Editors > Light Linking > Light-centric** or,
    Lighting/Shading > Light Linking > Light-Centric.

2   Select the **particleKey** light on the left and the objects you want it to illuminate on the right.
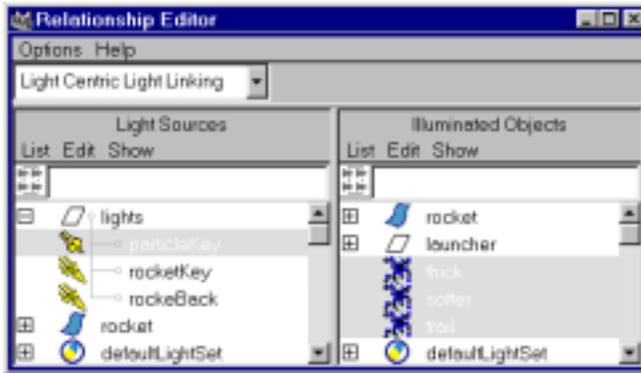
Setting up light linking

Another benefit is that you can use Depth Map shadowing (which renders faster) on lights linked to geometry in the scene.

Experiment with placing lights in the scene, or try creating some of your own to see how they affect the rendered image.

Using Raytraced Shadows

The scene must be raytraced with raytraced shadows on the lights to apply self-shadowing to the particles. To enable raytraced shadows, select the light and turn **Raytraced Shadows** on in the **Shadows** section of the light's Attribute Editor.

Render Globals settings

Many important rendering controls are set in Render Globals (**Windows > Render Globals**).

The **rocket_final.ma** scene file contains the Render Global settings for a final quality render. When test rendering, you can turn some of these options off to increase the render speed.

Open the Render Globals window to see where to find the following settings and experiment with them to see the results they produce.

• **Raytracing**: Required to invoke particle self-shadowing (found under **Raytracing Quality**). Since Raytracing a scene slows things down considerably (more computation is necessary), leave Raytracing OFF until you tune the particle shadows for the final render.

Lit from above and rendered without raytracing.

Raytraced with raytraced shadows.
Also contains shadows within the smoke volume.

- **Motion Blur**: 2D motion blur adds realism to the rocket motion. The particles do not get motion blurred. Set **motion blur** off when test rendering.
- **Anti-Aliasing Quality**: Set to **3D Motion Blur Production** when rendering the final shot. Use **Preview Quality** when test rendering.
- **Shadows obey light linking**: Located in the **Render Options** section, this option must be on so shadows from particles do not cast onto the rocket (the rocket is lit by different lights).
- **Better Illumination**: The Better Illumination check box is located just below the **Render Type** setting in the particle object 's Attribute Editor. Turn this option on when performing *final renders only.* (This option is only for cloud particles. It increases the quality of the lighting on the particles while helping to prevent artifacts and shadow popping.)

CONCLUSION

To recap, this tutorial showed you how to:

- Create particles and emitters
- Parent an emitter to animated geometry
- Adjust particle attributes
- Add fields to affect particle motion
- Keyframe the emission rate in the Graph Editor
- Change the particle radius with respect to particle age
- Assign materials to particles
- Set Render Global options