TUTORIALS

TECHNIQUES / TIPS / TRADE SECRETS

RENDERMAN FOR MAYA

the art of realism

Virtual statue, real setting: in the first of this issue's photorealism-themed tutorials, harness the power of our cover software to shade and light the 3D model on the right to match its photographic backplate BY SCOTT EATON

The release of *RenderMan for Maya (RfM)* marks the first time this powerful, production-hardened rendering technology has been made accessible to the wider *Maya* user base. *RfM* couples the power, speed and stability of Pixar's production renderer with the familiar workflow of shading in *Maya's* Hypershade.

In this tutorial, *RenderMan for Maya* will be put through its paces in an attempt to shade, light and integrate a sculpture of the Greek Titan Prometheus into a background plate from the British Museum. During this process, we'll explore many of the advanced features that *RfM* offers: subsurface scattering, ambient occlusion, brickmaps, micropolygon displacements, and secondary outputs. An exclusive copy of the new *RenderMan for Maya Eval* is included on this issue's CD.

First, we'll develop a marble shader that approximates the main surface characteristics of our reference images. It will need to show small divots from the wear of time on the surface of the marble, discolouration from the effects of oxidation, and changes in specularity from polished to rough, unfinished areas. And, of course, no marble shader would be complete without subsurface scattering. Next, we'll analyse and match the lighting set-up in the British Museum. Without the benefit of a HDRI probe to light from directly, we'll have to dissect the lighting environment from reference photos, and a thorough analysis of how sculptures are lit in the museum itself.

Finally, we'll render out a number of secondary outputs (diffuse, specular, occlusion and so on) with *RfM*, and use them to build up a composite over a background plate from the museum. This step is where the magic and flexibility of secondary outputs pays off, as we layer and correct each output to match the museum plate. As the shading network builds up, refer to the scene files on the CD. Each important node will have notes on it to explain its function in the shading network. Also, it's a good idea to have the *RfM* documentation at the ready, so that some of the concepts touched on can be explored in greater depth.

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FACTFILE

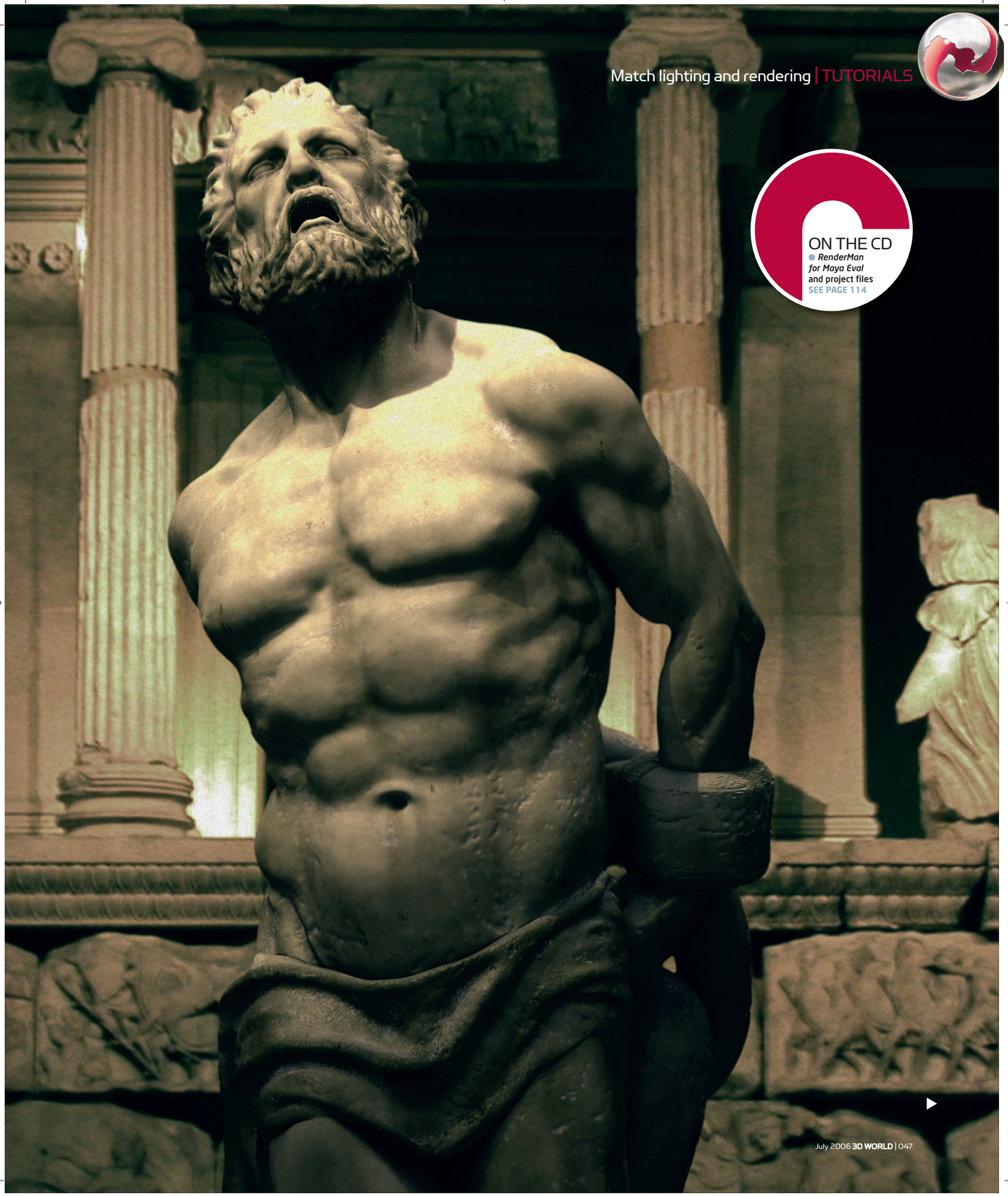
FOR
Maya and *RenderMan for Maya*

DIFFICULTY
Advanced

TIME TAKEN
Three hours

ON THE CD
- Full-size screenshots
- Source images
- Start and final scene files
- Final composite

ALSO REQUIRED
- *Photoshop*



ON THE CD
- *RenderMan for Maya Eval* and project files

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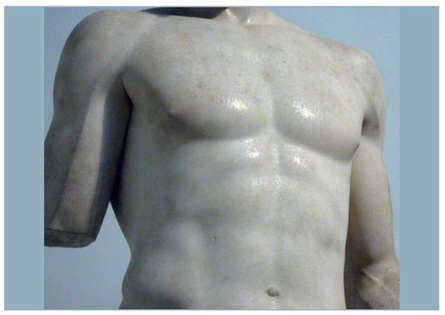
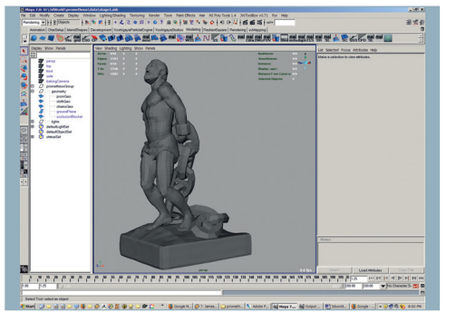
STAGE ONE | Analysing reference material



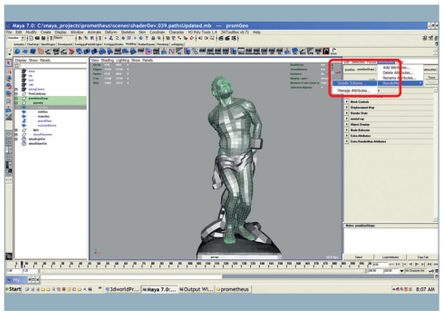
01 The surface we're attempting to mimic is aged, weathered marble. This isn't simply a 3D marble texture mapped onto a Blinn material. It's a layered combination of cloudy, grey base texture, yellowish surface discolouration, black specks from mineral contamination, faint rain streaks, and whitish marble dust build-up.

02 The lighting in the gallery is made up of direct and indirect light sources. Reference photos show that we can attribute a large amount of nondirectional diffuse light to the skylight above the gallery. In addition, each sculpture is individually lit with warm, coloured spotlights located near the ceiling.



03 Load 'stage1.mb' from the CD to get started on the tutorial. The initial scene has a simple light set-up, and our statue is in three parts: Prometheus, cloth and chains. Now, we'll see for ourselves how fast and powerful *RenderMan* displacements actually are.

STAGE TWO | Shading – subdivision and displacement

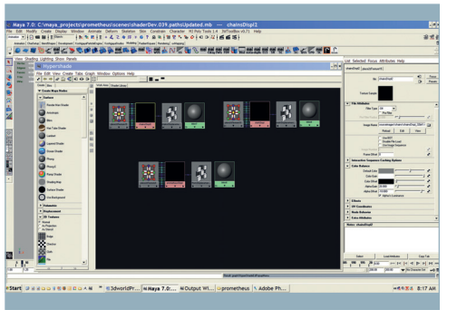


04 We'll begin with displacements to get the model looking correct. Originally created in *ZBrush*, the model must be rendered as a subdivision surface first. In *RfM*, this is as easy as adding a single attribute to the shape node. Select one piece at a time and, in the Attribute Editor, select Attributes > RenderMan > Subdiv Scheme. Do a test render and see a perfectly smooth subdivision surface.

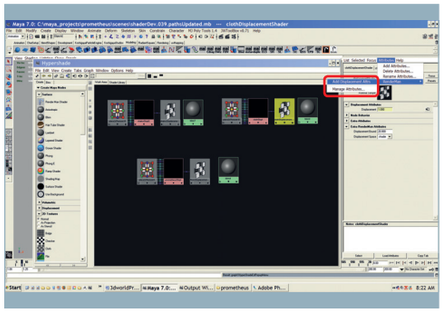
EXPERT TIP

Displacement mapping

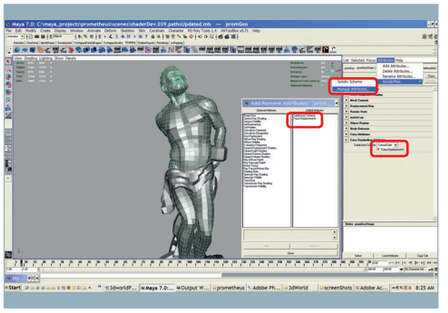
RenderMan for Maya brings *RenderMan's* extremely fast and accurate displacement mapping to *Maya* users. Getting used to having all this power takes time, and a shift in thinking about geometric detail. Because *RenderMan* renders displacement mapping nearly as quickly as bump mapping, there's no reason not to use it extensively in your scenes where geometric detail is required. Think, for example, tire treads on a large truck, which can be represented in your scene with lightweight models, yet displaced at render time for maximum detail.



05 Connect up three standard Blinns and assign a file texture to each one as a displacement map. Get the 32-bit displacement maps for each model from the 'sourceimages' directory on the CD. In each file, set the Alpha Gain to 20 and Alpha Offset to -10. This centres the displacement on zero. On file node, turn Filter Type to Off. This stops filtering on the map, which can reveal seams.



06 It's important to tell *RenderMan* how much we intend to displace the surface. This helps the renderer to efficiently process the geometry for rendering. Select the displacement nodes and go to Attributes > RenderMan > Add Displacement Attrs. To estimate the Displacement Bound (see screenshot), roughly use the Alpha Gain from the displacement map node.



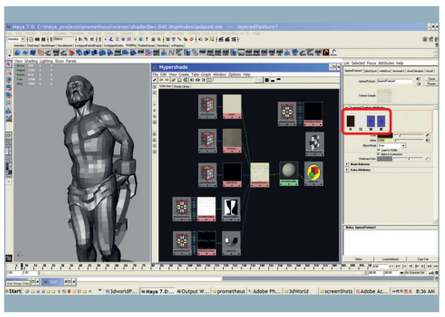
07 We must tell *RenderMan* that we want to use the displacement mapped version of this object for any raytracing that we're going to do (occlusion, blurred reflections, and so on). So we must add another *RenderMan* attribute to the shape node of our models. Individually select each shape node, go to Attributes > RenderMan > Manage Attributes, then select and add Trace Displacements.

EXPERT TIP

Quality control

A single parameter, Shading Rate, controls the quality of shading and displacement sampling in *RfM*. The control is located in the Render Settings > Quality tab. The value is expressed in pixels and equates to the pixel space between shading samples (in screen space) at render time, so the lower the number, the higher the quality. A value of one, for example, samples textures and procedural networks once for every pixel in the image. Consider raising the shading rate to 5-10 to speed your preview renders, but drop it to one or 0.5 for final renders.

STAGE THREE | Shading – diffuse, specular and subsurface scattering

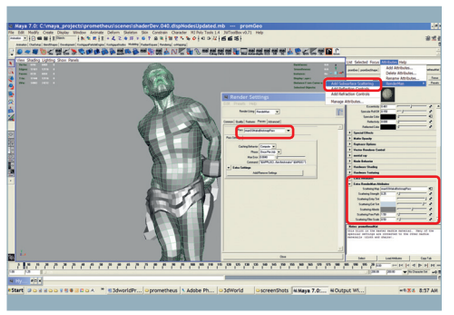


08 We can build up the surface detail with a combination of procedural textures, high-level control maps and texture maps. Open 'stage2.mb' and see how the marble shader is constructed. The diffuse, specular and bump layers are built up using layers, many of which are shared between shading components. We'll take this network as the starting point for adding *RenderMan*-specific features.

EXPERT TIP

Shading in layers

It's good practice to break your shading up into modular layers. If you're building up a diffuse colour (either procedurally or by painting maps), build it in components, starting from the largest 'low frequency' patterns, and work your way to the smallest 'high frequency' details. By separating these patterns into layers, it makes it easy to change or modify any one component independently. Some of these patterns will individually affect the specularity, reflectivity or bump of the material, and can be easily reused there.

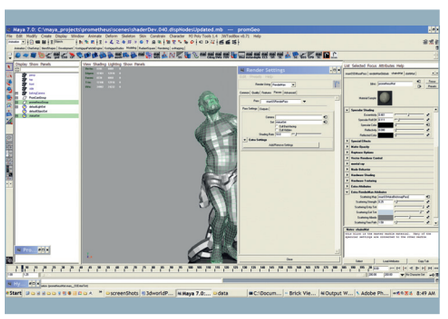


09 Let's add *RenderMan's* subsurface scattering attributes to our Blinn shaders. Select the material and go to Attributes > RenderMan > Add Subsurface Scattering (SSS). This adds a number of extra attributes to the shader, as well as an additional render pass for creating the SSS brickmap (see Expert Tip), which also shows up in the Render Settings > Passes tab.

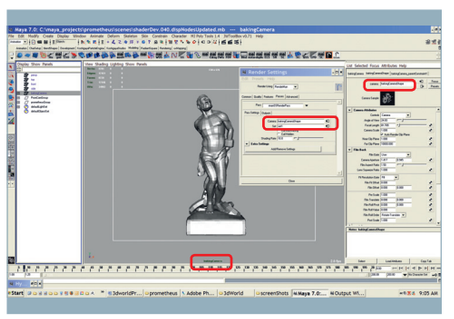
EXPERT TIP

Brickmaps

RenderMan uses an elegant baking system to capture computationally expensive effects into 3D disk caches, known in Pixar terminology as brickmaps. It's important to understand that baking is done as a separate render pass and is dependent on the camera being baked from. Because of how the renderer works internally, only the portion of the object visible to the baking camera gets written into the brickmap. By default, backfacing and hidden surfaces are not written, nor are parts of the object outside the view frustum.

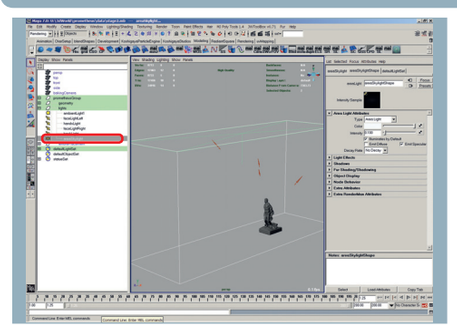


10 For the SSS pass, we want to include all the marble pieces into one pass and share the brickmap between the three Blinn shaders. In each Blinn, right-click over the Scattering Map field and select the first 'rmanSSMakeBrickmapPass' (the other SSS passes can be deleted from the Render Settings > Passes tab).

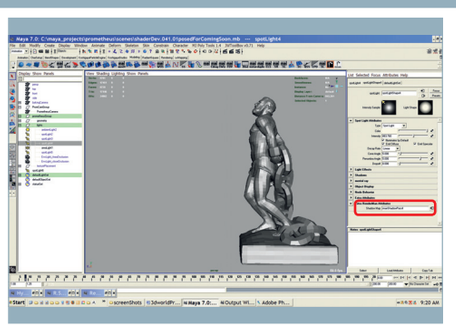


11 In Render Settings > Passes, select 'rmanSSRenderPass'. Right-click in the Camera field and select 'bakingCameraShape'. To tell the pass which objects to render in the SSS pass, right-click in the Sets field and choose 'statueSet'. Finally, turn off Cull Backfacing and Cull Hidden.

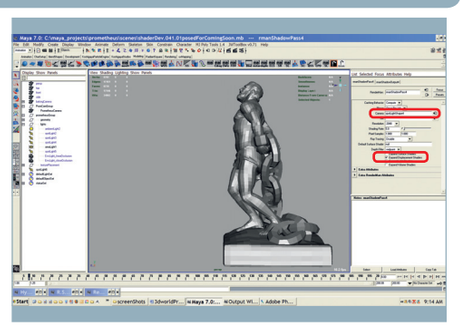
STAGE FOUR | Setting up the lighting



12 To approximate the gallery's skylight, we'll combine an area light for specular reflection and a custom occlusion pass (see Stage Five) for soft shadowing. The area light will be used only to cast accurate specular reflections, while the custom occlusion pass will allow us to bake expensive soft shadow calculations. Find areaSkylight in the scene, unhide it, and enable Emit Specular only.



13 There are four yellowish spotlights that light the sculpture from above. Add a *RenderMan* shadow pass to each spotlight with Attributes > RenderMan > Add Custom Shadow Map, then right-click in the Shadow Map field and select Create Shadow. This overrides *Maya's* shadowing parameters and gives us more *RenderMan*-specific control over shadow map generation and reuse.



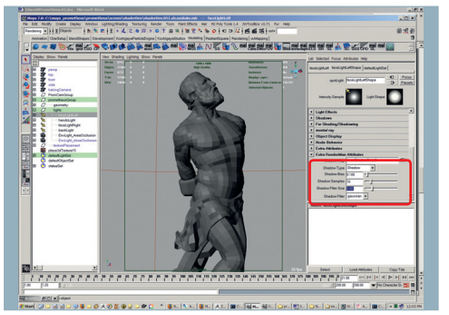
14 Follow the link from the Shadow Map field to the new pass. To specify the camera from which the shadow map will be rendered (we don't have to render from the lights' location), right-click in the Camera field and select the spotlight associated with this shadow pass. Render the scene once to generate all of the shadow maps, and then change the Caching Behavior setting to Reuse.

STAGE FOUR (Continued) | Setting up the lighting

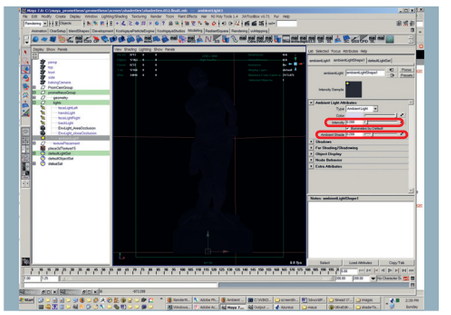
EXPERT TIP

Map reuse

RenderMan has a long history of reusing pre-computed maps to save on render time for large productions. Each time you create a new pass that needs to compute a map, you get a Phase option to create a disk cache in two ways: Once Per Job and Every Frame. For stationary geometry, as in this tutorial, Once Per Job is the option to select. For animation sequences where motion will change the map, use Every Frame and you'll get a cached map for each frame of the animation. After you've created the cache, switch the Caching Behavior from Compute to Reuse.

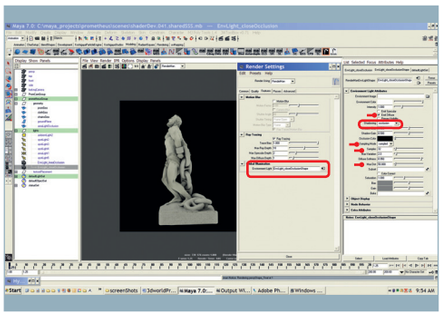


15 To give us control over the shadow filtering and samples once we have a shadow map baked, we need to add additional custom attributes to our light shape node. Select the light and go to Attributes > RenderMan > Extra RenderMan Attributes. This provides access to the shadow filtering and sampling attributes to blur the edges of our maps as required.

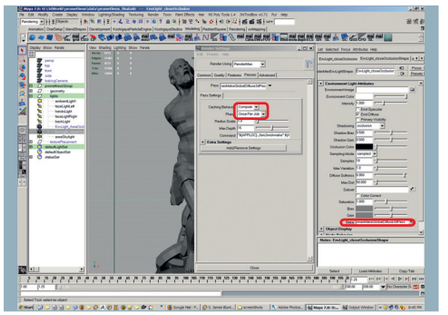


16 There is reflected light in the room as a result of the overhead skylights. We'll include an ambient light in our scene, which we'll later attenuate with our ambient occlusion pass. Set the Intensity low and tune Ambient Shade to 0.2 to give a little direction to the light to simulate reflection from the ground. The amount of ambience can be tuned later in compositing.

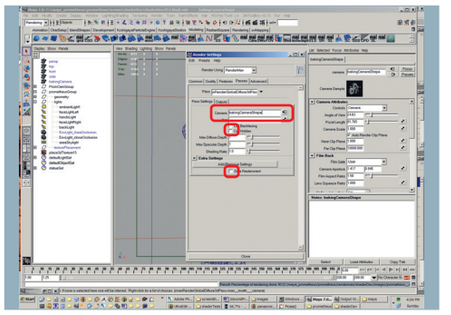
STAGE FIVE | Occlusion and secondary outputs



17 To enable global illumination effects, such as ambient occlusion and colour bleeding, create a *RenderMan* Environment Light from the Render Settings > Features tab. Enable Ray Tracing and create an Environment Light - this is where we access our settings for occlusion. Tune the settings as shown in the screenshot above, hide the other lights and then render.



18 To save recalculating this expensive raytracing effect every frame, we're going to bake the calculation into a brickmap. Create a new 'rmanMake GlobalDiffuse3dPass' in the Bake field of the Environment Light. This will create a new pass in the Render Settings > Passes tab where we can tune the Caching Behavior and Phase for the pass. We'll use Compute and Once Per Job.

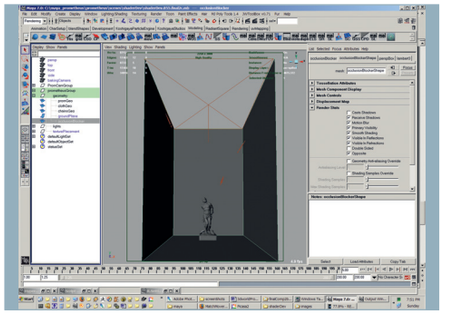


19 The other tab created with the new 'rmanMake GlobalDiffuse3dPass' is the 'rmanRenderGlobal Diffuse3dPass', found just underneath the former in Render Settings. Similar to the SSS set-up, this tab is where we set up a camera for final baking. Specify the same bakingCameraShape and disable Cull Backfacing and Cull Hidden. Render to bake, then set Caching Behavior to Reuse.

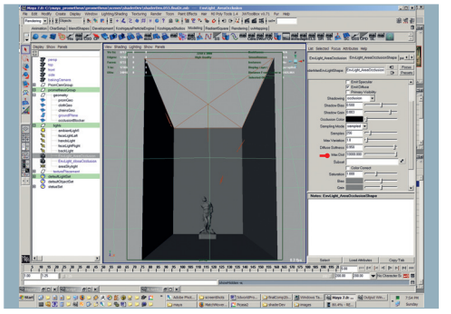
EXPERT TIP

Tuning GI effects

The Environment Light has a number of parameters for tuning the type, quality and speed of the global illumination effects. Shadowing can be set to either Occlusion or Color Bleeding. Of the two, Occlusion is considerably faster, as it shadows an object based solely on the presence of blocking geometry around the point being shaded. Color Bleeding shadows based on the average colour of blocking geometry and is much slower. Sampling gives the best results, and increasing samples gives higher quality and reduces noise if you don't bake.

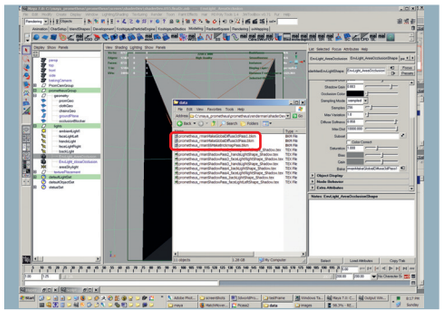


20 Now we'll fake an area light using occlusion for soft shadows. Hide the first Environment Light, and 'unhide' the occlusionBlocker mesh in the geometry group. This missing face at the top will act as the skylight, letting the occlusion pass see white. Next, create a new Environment Light from the Render Settings > Features tab.

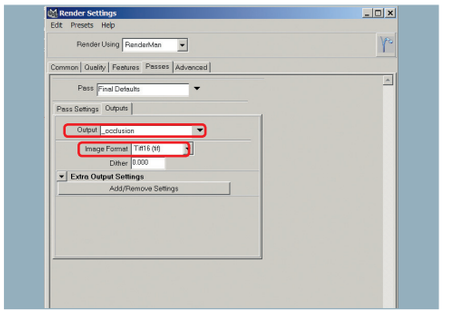


21 We'll make this Environment Light act like an area light by setting the Max Dist attribute to a value larger than the maximum dimension of our blocking geometry. Here, a value of 10000 is used. The other settings are the same as the last Environment Light.

STAGE FIVE (Continued) | Occlusion and secondary outputs



22 Use similar bake settings for this pass. Remember to turn off Cull Backfacing and Cull Hidden and specify the bakingCamera. Render the scene to bake the occlusion brickmap. We should see this brickmap file, along with the other brickmaps, PTC files and shadow maps in the '/renderman/${SCENE}/data' folder in the current project.



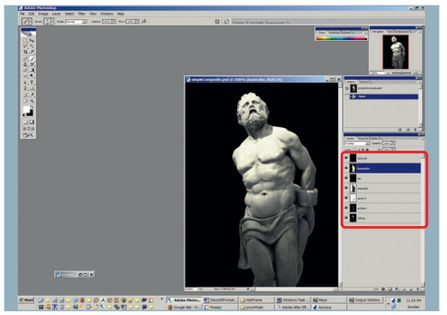
23 To prepare output passes, go to Render Settings > Passes and add these secondary outputs to the Final Defaults pass: ambient, diffuse, occlusion, specular, subsurface, surfacecolor (use format Tiff16). Render once and look at the outputs. Unhide the first EnvLight and hide the skylight EnvLight. Render with only occlusion as a secondary output, saving the new pass as 'nearOcclusion'.

EXPERT TIP

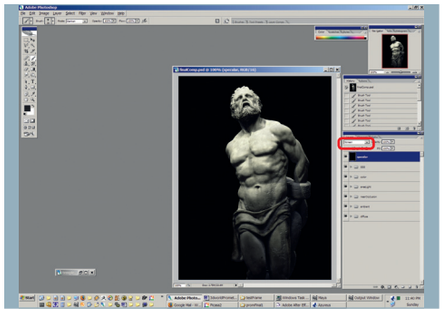
Secondary outputs

Passes are known as secondary outputs in *RenderMan*. Rendering your scene in separate passes gives you maximum flexibility in compositing, and greatly reduces the amount of time spent tuning renders in 3D. A good renderer should efficiently provide all the passes needed to rebuild a final render in compositing. When you break your output down into its component parts: diffuse, reflectivity, occlusion, shadow and so on, you have greater flexibility in colour correcting individual layers to more precisely match background plates.

STAGE SIX | Compositing



24 The advantage of rendering with secondary outputs is that it provides incredible control when tuning the look of the plate in 2D. We'll use *Photoshop* to demonstrate the basic steps used to composite our secondary outputs. Open all of the secondary outputs and layer them in one image (as shown above).



25 We need to set the blending modes between layers. Diffuse is the lowest layer: above it, Screen on the ambient layer. Multiply by nearOcclusion, then either Multiply by areaLight (the occlusion pass) to take light out of the image, or Screen to add light. Next, Overlay the color pass. Screen both the SSS (subsurface) and specular passes. Use Layer > New Adjustment Layer > Levels to tune the image.

26 Finally, we need to colour correct our plates to match the background. The challenge of colour correction is in not only matching the colour temperature in the highlights, midtones and shadows, but also matching the rate of transition from light to dark.

In this instance, the background plate is a warm red/orange in the mids and highs, while the shadows have more cyan. There are a number of tools that let us manipulate the colour in different value ranges, so use whichever are most familiar. Curves are powerful, and give us precise control over the red, green and blue channels, and they're also great for targeting specific value ranges for colour correction. The file 'finalComposite.psd' on the CD uses a number of techniques to achieve our final colour-corrected result.