Knobbly Man

How do I construct a figure whose surface is rougher than the usual 3D character's?
Theme: Modeling, Rendering
Techniques and tools used: Subdivision Surfaces, Split Polygon Tool, Extrude Faces, Displacement Shader

Most 3D objects have flawlessly smooth surfaces, which makes them too perfect for certain contexts. The usual procedure for giving a surface a little bit of roughness is to fake deformations using so-called Bump Maps. In fact, the Bump Map isn't a feature of the surface itself, it is a feature of the camera. Most of the time, Bump Mapping is sufficient and it's very economical in terms of rendering time. It fails, however, when you need very pronounced deformations and bulges that contrast sharply with the background.

Enter Displacement Mapping—a technique that doesn't fake the deformation for the camera but actually deforms the surface using the gray tones of a procedural texture or a picture. Unfortunately, we don't see these deformations in the modeling views. We have to render them.

This tutorial consists of two parts that fit together nicely. We start by using subdivision surfaces to model a tall, thin man with a small head. With a little bit of practice this task takes only a few minutes. (Before the era of subdivisions it was a matter of at least an hour.) If you don't have Maya Unlimited you can achieve similar results by using the same split and extrude tools and applying the Polygons > Smooth operation at the very end. If you want to skip the modeling part or keep it for later, just use any kind of primitive and continue with the displacement part of this tutorial.

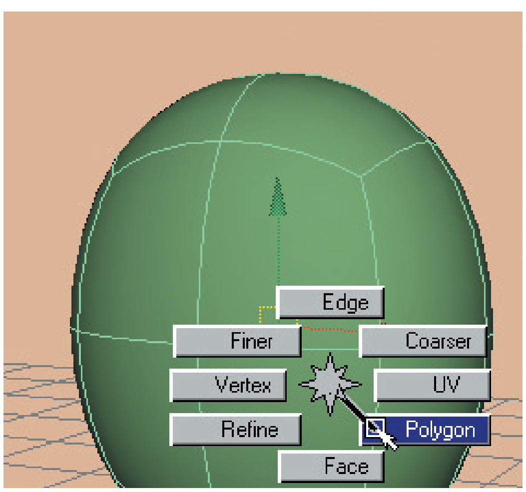


Figure 10.1 A polygon cube converted into a subdivision surface. Its context menu allows us to make the original polygon visible. ▲

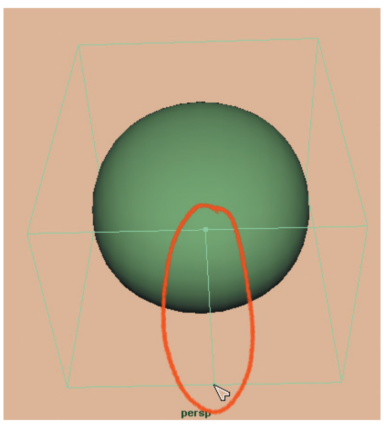
1 Create a polygon cube.
2 Choose Modify > Convert > Polygons to Subdiv to convert the cube into a subdivision surface.
3 Assign a new material to the subdivision cube.

If you inadvertently textured the cube (which is actually just the outer skin of the subdivision surface and not the surface itself) instead of the subdivision surface, undo the assignment. Select the actual subdivision surface *polyToSubdShape1* (for example, in the Hypergraph) before you assign the material again. For the following actions, right-click the subdivision object and use the context menu.

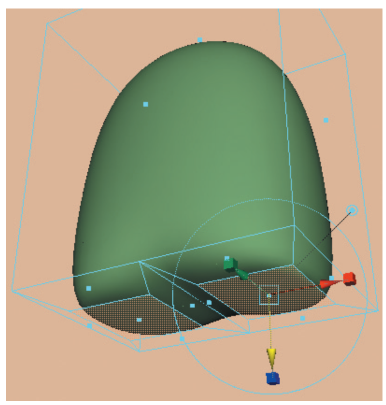
4 Switch to Polygon mode (see Figure 10.1).

You can model with subdivision surfaces in two general modes. One is using the polygon tools, the other is using tools from the world of Nurbs modeling. The classic polygon modeling tools are ideal for achieving higher geometric resolution (for example, in the area where the legs come out of the torso). That's why we'll perform most of the modeling for our guy in Polygon mode.

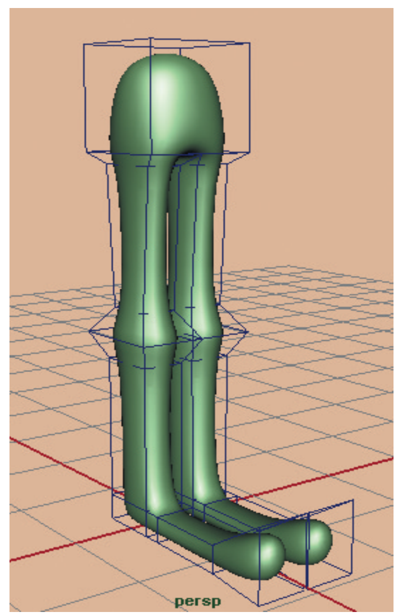
1 Choose Edit Polygons > Split Polygon Tool to break the cube's bottom face in two (see Figure 10.2). Just eye it, don't try to be too precise—our character isn't going to enter a beauty contest. Finish the Split command by pressing Enter.



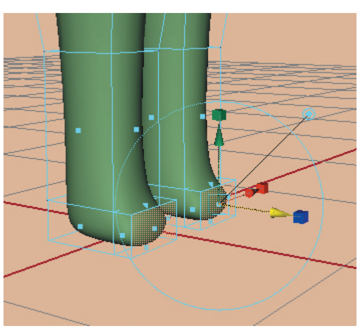
▲ ***Figure 10.2 Use the Split Polygon Tool to split the lower face of the cube into two parts.***



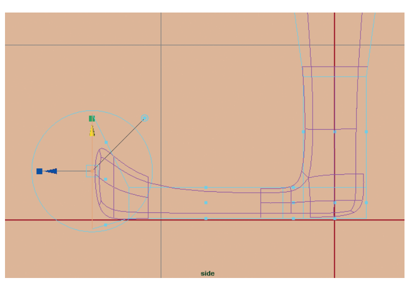
▲ ***Figure 10.3 The Extrude Tool creates a locally higher density of geometry. Here we use this density to start pulling out faces for modeling the legs.***



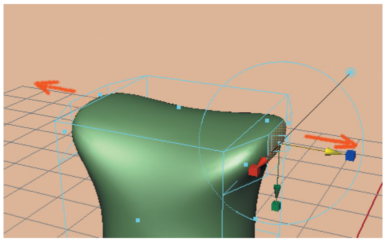
▲ ***Figure 10.6 The lower extremities are completed—with a little practice it takes only a couple of minutes.***



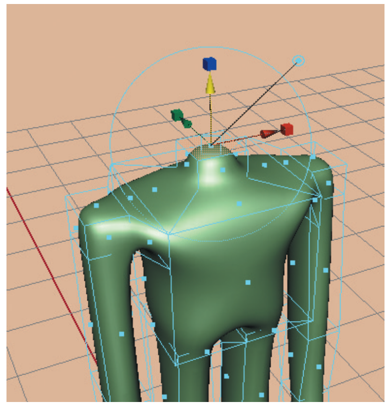
▲ ***Figure 10.4 A few extrudes later and the legs are finished—not at all perfect, but they're legs. The last extrudes (horizontal this time) will make the feet.***



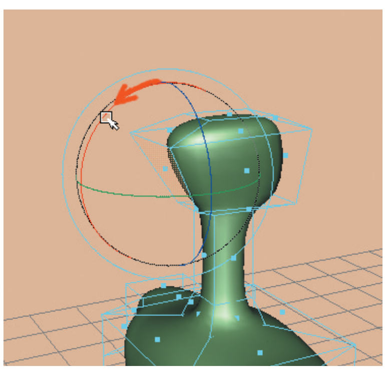
▲ ***Figure 10.5 View from the side for more precise modeling of the ends of the feet.***



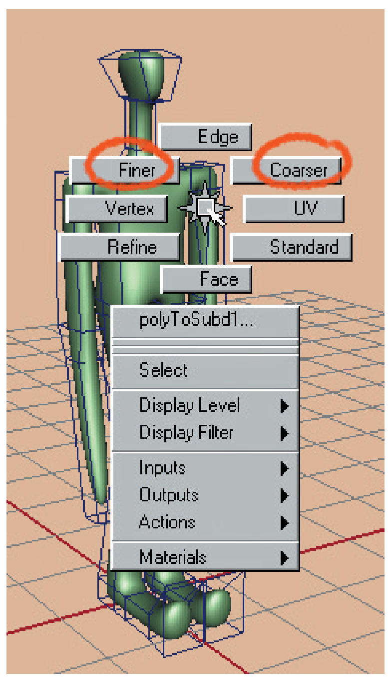
▲ *Figure 10.7 Working the upper body: Here are the first two extrudes for the arms.*



▲ *Figure 10.8 The first two extrudes for the neck and head.*



▲ *Figure 10.9 Aftermath: rotation of the back of the head.*



▲ *Figure 10.10 The context menu of the subdivision surface lets you switch between different levels of hierarchy. Finer levels let you work more locally.*

2 Use the context menu to make the Faces visible. Select the newly created two bottom faces of the cube. Choose Edit Polygons > Extrude Face to pull new geometry out of these faces (see Figure 10.3). Clicking on one of the scaling cubes of the tool puts the tool into scaling mode. Homogeneously scale down the extruded surfaces a little. Use the tool's arrow to translate them down a bit.

3 Don't lose your selection, press the G key to apply the extrude command again, this time to the freshly extruded faces. Pull the legs out of the torso by applying the command two or three more times. With the last extrude, create faces of a size that can be used to pull the feet out to the front (see Figure 10.4).

4 When extruding and scaling the feet, use the side and top views to work more precisely (see Figure 10.5).

1 Use the Split Polygon Tool on the sides of the torso and start extruding the arms (and, if you like, fingers). The extrude command works symmetrically, so you can extrude geometry simultaneously for the right and left arms (see Figure 10.7).

2 Extrude the top face of the subdivision polygon, scale down the cross-section of the neck and start pulling out the neck and head (see Figure 10.8).

3 Check the whole figure, adjusting faces to your taste. Keep in mind that you don't have to just translate and scale, you can also rotate faces (see Figure 10.9)!

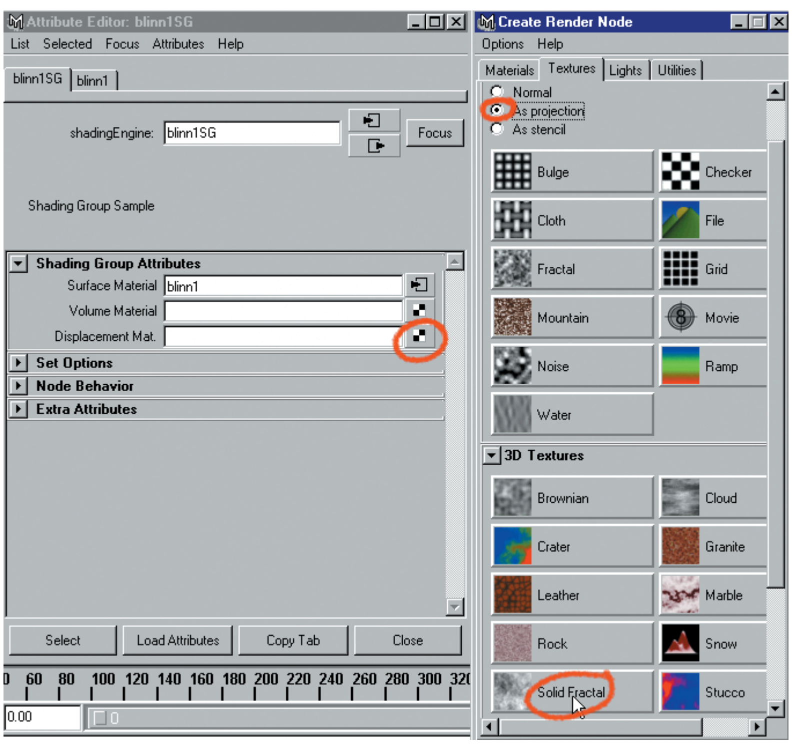
In the Channel Box, you can see that after all the extrudes you've done the surface's construction history contains a lot of information we don't need any more. Deleting history using the Edit > Delete by Type > History command also makes the scene a little lighter.

What you *don't* delete by deleting the surface's history is its identity as a subdivision surface. By using the context menu and the commands Coarser and Finer, you can switch from one level of hierarchy to the next in order to work more globally or locally, in polygon as well as in standard mode (see Figure 10.10).

You don't need to add too much detail to your fellow at this point, like a nose, shoulder blades, or toes. The Displacement Shader might wipe away features as small as a nose or shoulder blades anyway.

1 In the Attribute Editor of the surface's shading group (in the case of a Blinn shader, its name will be *blinn1SG*), click the checker icon next to Displacement Mat.

2 The Create Render Node window opens (see Figure 10.11). Chose a texture here that will deform the character according to its gray values, such as the Solid Fractal. For the mapping method, select "As projection." The projection will make sure that the texture is distributed evenly over the whole object.



◀ ***Figure 10.11** This is how to create a Displacement Map of a 3D texture by projection: Open the Attribute Editor of the Shading Group, click the checker icon next to Displacement Mat., and in the Create Render Node window choose "As projection" for the method and, for example, Solid Fractal as its structure.*

Figure 10.12 These two characters possess the same geometry and the same texture; the only difference is the way the texture was applied. The unevenness of the front figure comes from a Bump Map, whereas the back figure's texture is a Displacement Map. The edges of the front figure look smooth, but the Displacement Mapping on the other creates real bulges. Although no extra tuning was applied to the mapping procedure, the Displacement Map thickens the character drastically whereas the Bump figure basically shows the original size of the modeled geometry.

- Since you'll see no change in the modeling view, render the scene.

Rendering takes a while, maybe several minutes, depending on the geometry and material used and, of course, the speed of your computer. The results really clarify the difference between Displacement Mapping and Bump Mapping. In Figure 10.12, the character in the front was assigned the same Solid

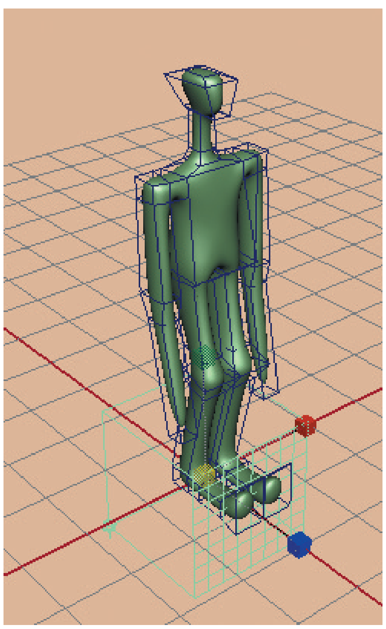


Figure 10.13 The wireframe cube at the character's feet determines the dimension of the Displacement Map. The smaller that cube, the more frequently the texture is repeated on the object.

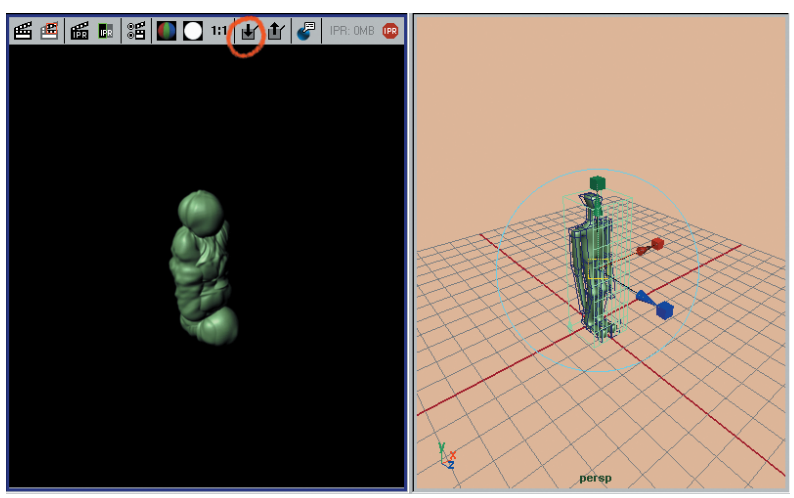


Figure 10.14 The 3D placement object now covers the whole character. To the left is the rendered scene. With the marked icon you can save rendered pictures to memory. They won't be deleted until you exit Maya (or until the program crashes).

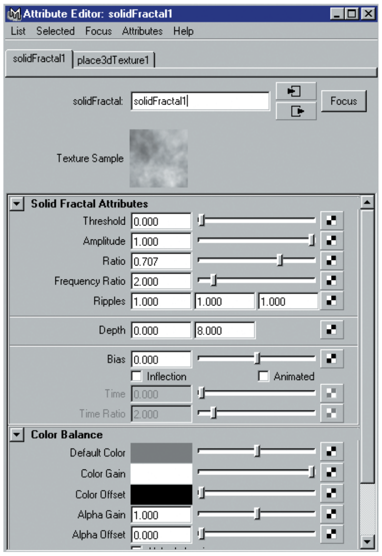


Figure 10.15 The texture's Attribute Editor. In the upper area are the parameters responsible for the structure of the fractal, lower down are the settings for gray, which are responsible for the amount of deformation. The main parameters when dealing with a Displacement Map are Color Gain and Alpha Gain. Higher values mean more white, which leads to an enlarged figure. When the Displacement Map finds only black it leaves the geometry untouched.

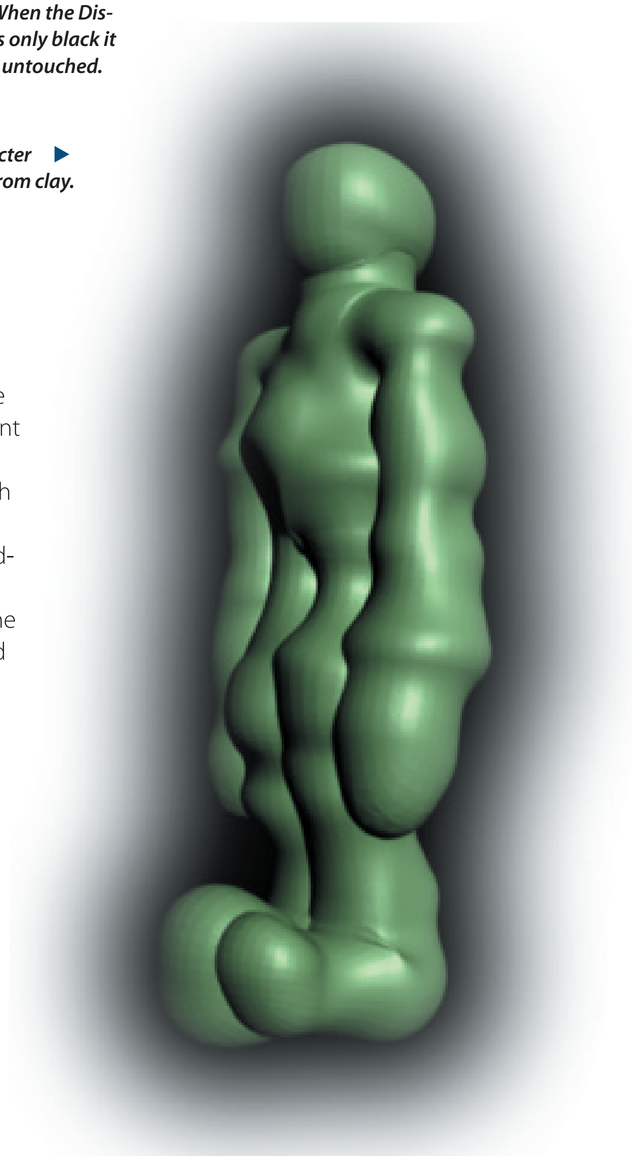


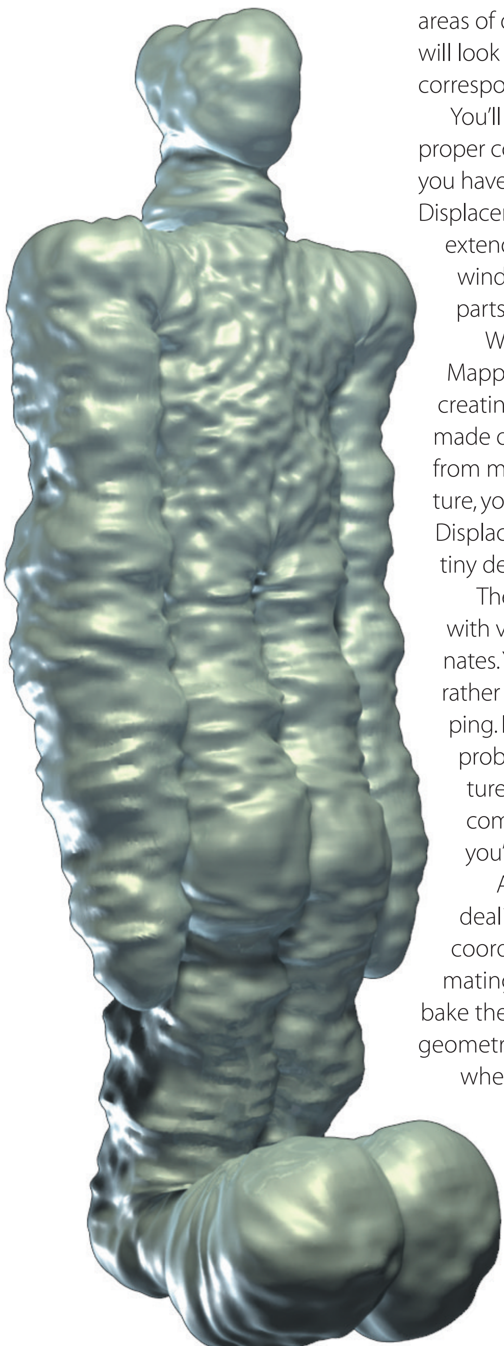
Figure 10.16 A character that looks sculpted from clay.

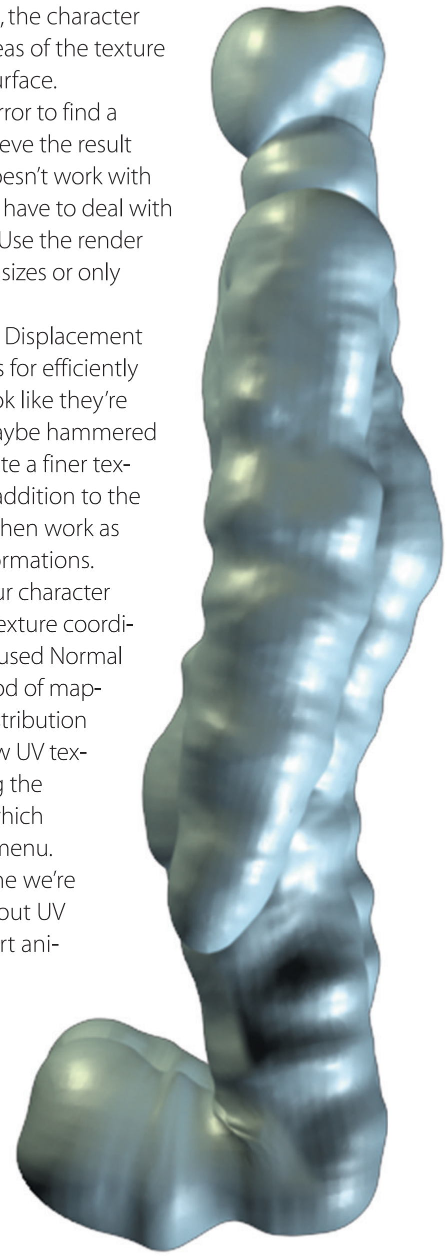
Fractal texture as the character in the back, but the texture was assigned as a Bump Map rather than as a Displacement Map (as for the character in the back). The surface of the front figure looks uneven, but its edges look totally smooth against the background.

Displacement Mapping has more or less effect, depending on how large you constructed your knobbly figure. There are two ways to adjust the strength of the effect. One is by changing the density at which the texture is mapped onto the geometry. In the modeling views you can see a wireframe cube named *place3dTexture1;* that's the tool that lets us make these changes (see Figure 10.13).

The second way to adjust the displacement texture is by using the texture's gray values. Displacement Mapping, like Bump Mapping, makes use of only the brightness (the alpha channel, not the color) of a texture in order to create geometric deformations. For most textures, such as the Solid Fractal, you'll find the grayscale entries under the Color Balance section in the Attribute Editor. First start with very dark, almost black values for the colors and a very low value for the Alpha Gain (see Figure 10.15).

Basically you let the character grow in size by applying a bright texture. A Displacement Mapping that finds only black will leave the figure unchanged. If the texture shows





areas of distinct changes in brightness, the character will look very bulgy, with the bright areas of the texture corresponding to the bulges on the surface.

You'll have to use a lot of trial and error to find a proper combination of settings to achieve the result you have in mind. Unfortunately, IPR doesn't work with Displacement Maps, which means you have to deal with extended periods of test rendering. Use the render window's option to render smaller sizes or only parts of pictures.

With subdivision modeling and Displacement Mapping you have two strong tools for efficiently creating complex characters that look like they're made of clay (see Figure 10.16) or maybe hammered from metal (see Figure 10.17). To create a finer texture, you might add a Bump Map in addition to the Displacement Map. The bumps can then work as tiny deformations on the larger deformations.

The modeling process leaves your character with very unevenly distributed UV texture coordinates. You would see this if you had used Normal rather than Projection as your method of mapping. In order to fix these texture distribution problems you need to create a new UV texture map, for example by applying the command Automatic Mapping, which you'll find in the Subdiv Surfaces menu.

A projected texture like the one we're dealing with here doesn't care about UV coordinates. But as soon as you start animating the character, you'll have to bake the projected texture onto the geometry. Otherwise it will look as if when the character moves it's swimming through the texture. You find the command for baking textures in the Hypershader: Choose Edit > Convert to File Texture. If you want to use the sophisticated tools for polygon texture mapping, save your scene and then convert the subdivision creature into a polygon creature (choose Modify > Convert > Subdiv to Polygons).

Figure 10.17 ▲
Hammered-metal knobbly guys.

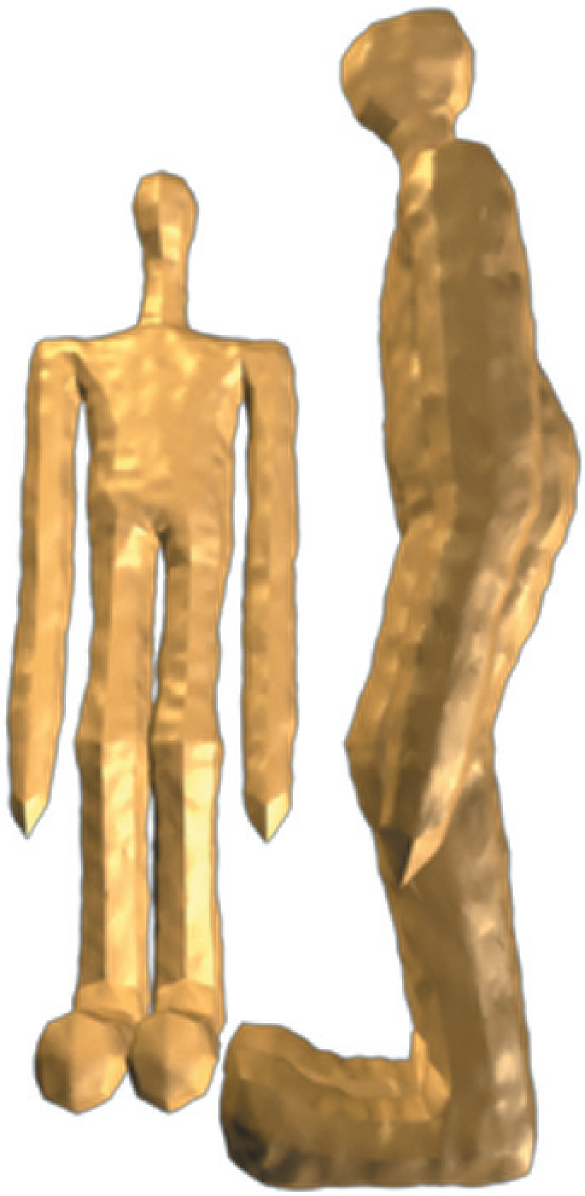


Figure 10.18 Knobbly guys hammered out of gold.

And now for something completely different: Pressed the A or F key recently?