

4.6 Normal Mapping

The trueSpace Player view supports the display of **normal maps**, which function similarly to the bump maps you may already be familiar with. Instead of using a greyscale bitmap with pixels encoding the relative “height” of the surface at a given point, normal maps use a full color image to encode the actual normal of the surface at that point. This results in a much improved method of increasing the apparent geometry of an object without adding more polygons.

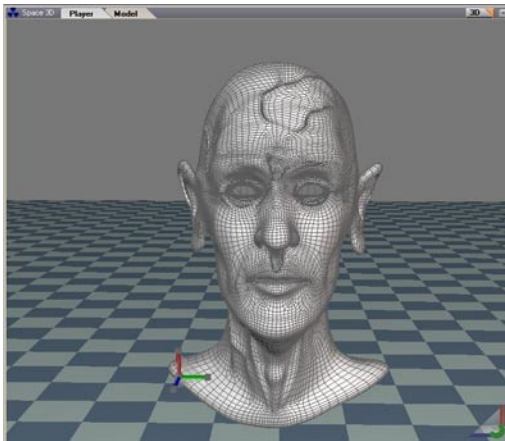
trueSpace provides **mesh simplifier** and **normal map generator** tools to help you turn detailed geometric objects into simple objects with normal maps that take up much less memory and processing power but look nearly identical in the real-time Player view.

4.6.1 Simplifying Meshes for Normal Mapped Objects

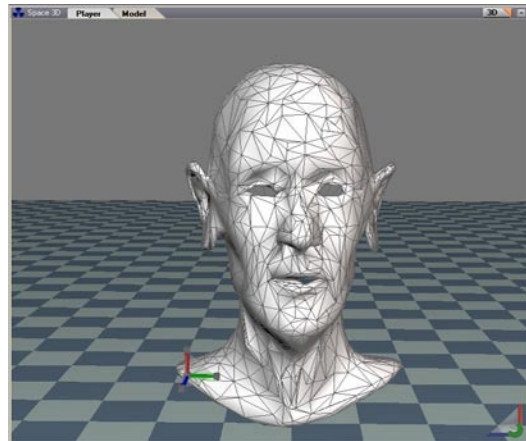


Simplify Mesh

The trueSpace mesh simplifier can be used to generate meshes that approximate high-polygon-count meshes, but with far fewer polygons. The resulting objects are perfect candidates for the application of normal maps (described later in this section). This simplification is achieved by removing vertices, edges, and faces from the high-poly mesh, but doing so in a way that leaves the resulting mesh looking very similar to the original.



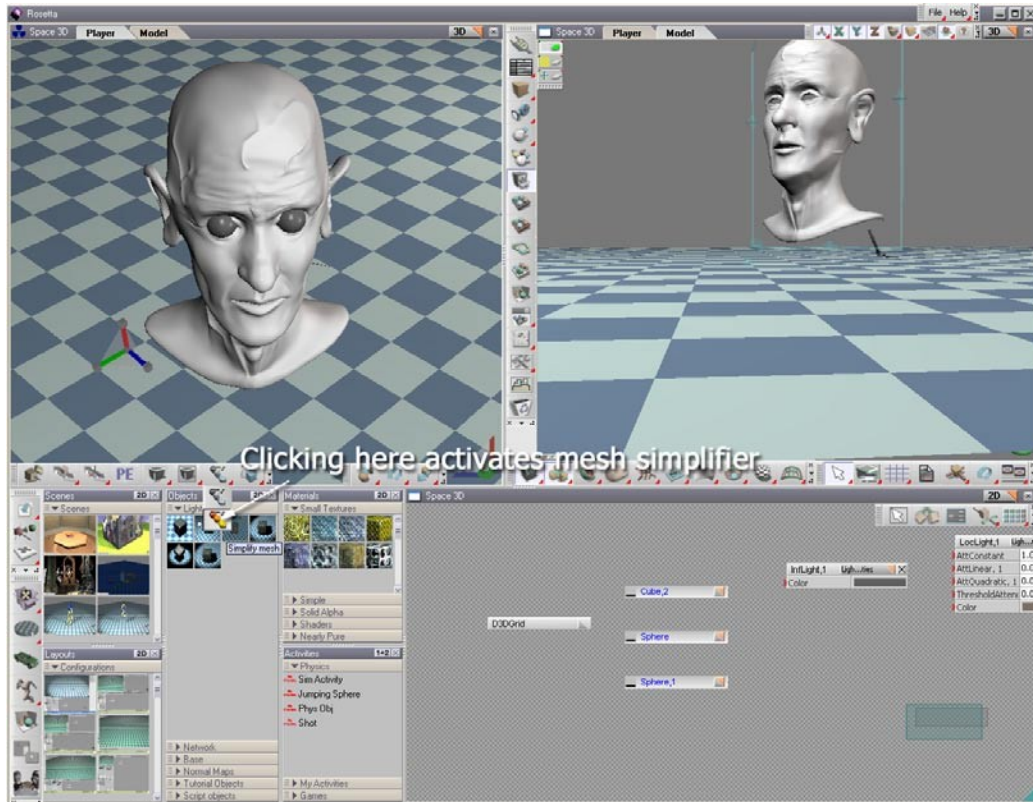
*Original head model, 28,164 triangles.
Model created in trueSpace by Kary Ohman.*



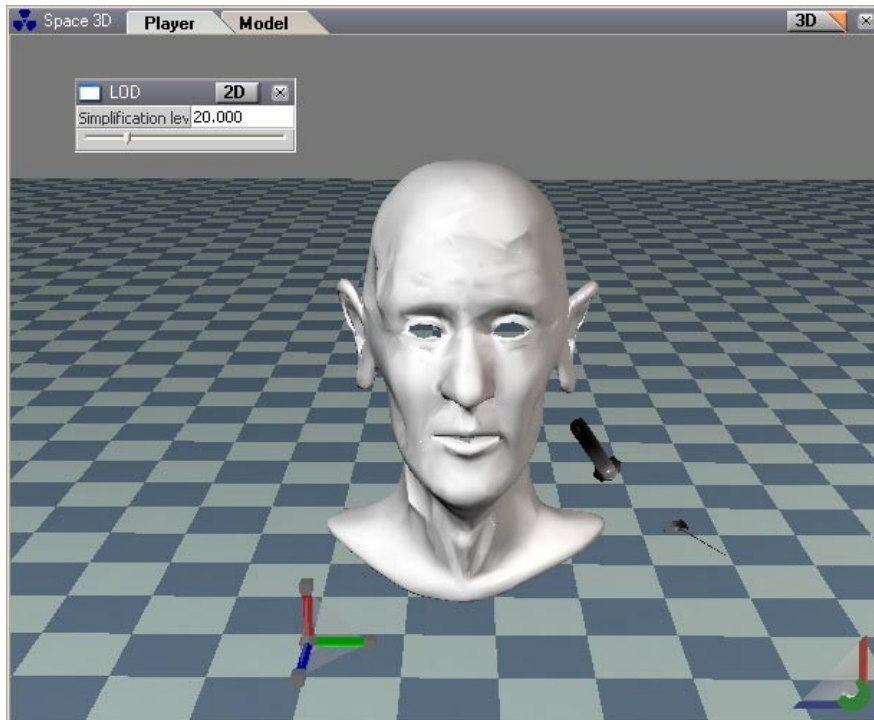
*Simplified head model, 1,971 triangles.
Total reduction of 93%.*

Building a Simplified Mesh

To create a lower resolution mesh from an existing high-poly mesh, select the object and click the **Simplify Mesh** tool.



The **Simplify Mesh** tool takes the original mesh and creates a simplified version of it. It opens a panel where you can set the desired simplification level.



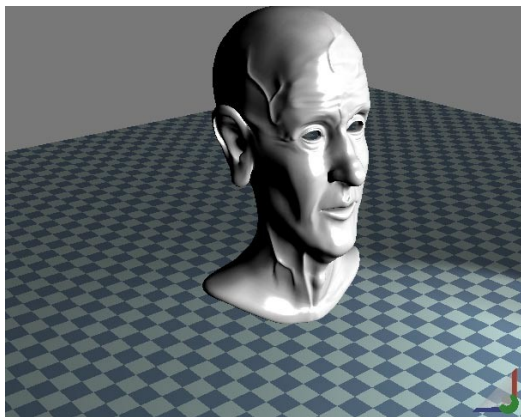
You can specify the desired simplification level either by entering a numeric value in the text box or by moving the slider left or right. You can also change settings such as welding distance (for correcting mesh topology errors) by examining the MeshSimplifier object in the newly created simplified mesh. The original mesh remains encapsulated inside of the newly created compound object and can be further modified if desired, with any changes propagating to the simplified mesh.

4.6.2 Generating Normal Maps

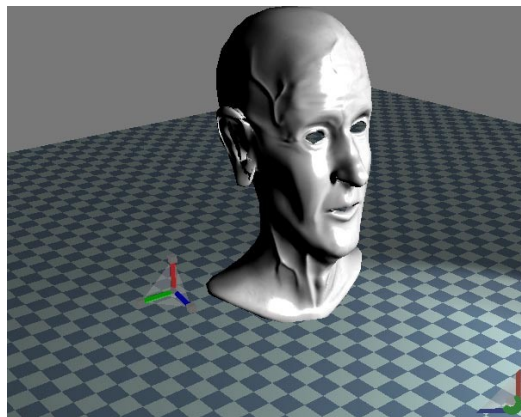


Create Normalmap

It is not possible to render geometry of unlimited detail in real-time. **Normal maps** can be used to add to the apparent detail of a mesh without adding to the actual geometry of that mesh. trueSpace includes a normal map generator to build normal maps from high-poly meshes that can be applied to low-poly meshes to give the appearance of more detail where there is none. The image below shows a high-poly mesh and a simplified mesh with a normal map applied. As you can see, the effect is quite similar.



*Original head model, 28,164 triangles.
Model created in trueSpace by Kary Ohman.*

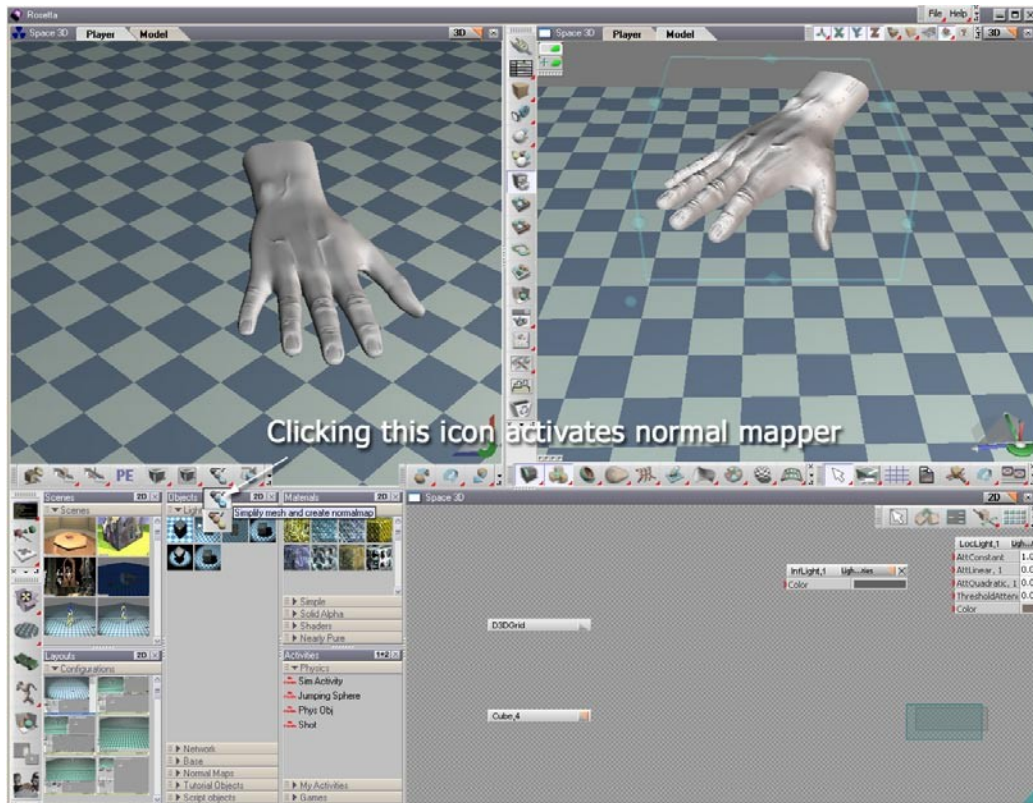


*Simplified head model, 1,389 triangles, rendered
using one 512x512 normal map.*

Building a Normal Map

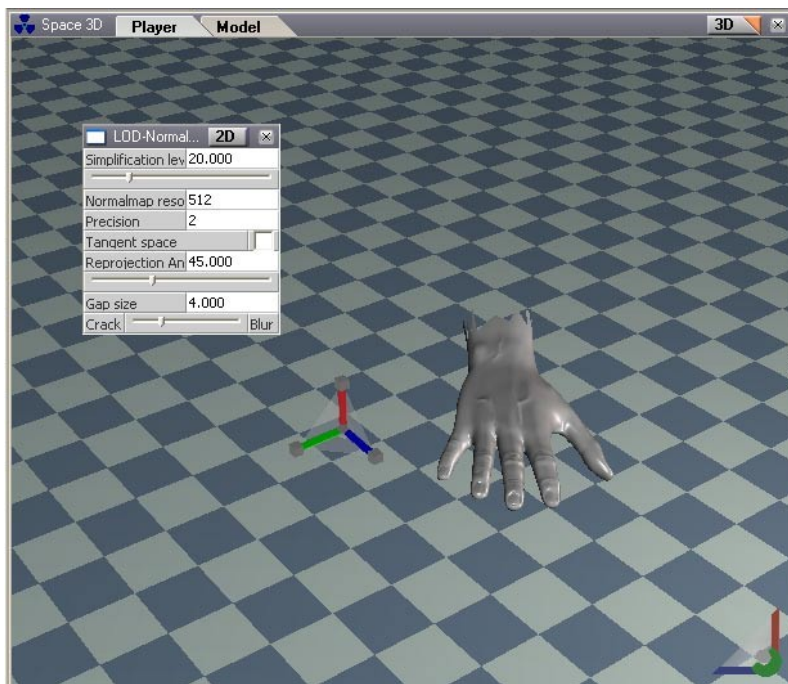
You can build a normal map in one of two ways. With the first method you take a high-polygon mesh and create both a simplified version of it and a corresponding normal map. With the second method you take both low- and high-polygon meshes and create a normal map that corresponds to the details of the high-poly mesh.

To reduce a high-poly mesh and create a normal-mapped low-poly mesh from it, you must first select the object, and then select the **Create Normalmap** tool.



This detailed hand model was kindly provided by Kary Ohman.

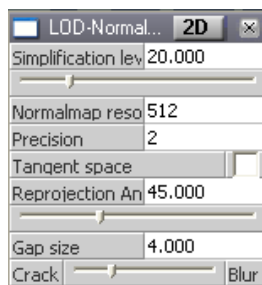
trueSpace responds by opening the Normal Mapper panel and simplifying the high-poly mesh according to the default settings of the tool. Then it generates a corresponding normal map for the newly created low-poly mesh. The result is shown in the following image.



The original mesh will be kept inside of the new, normal-mapped object, and any modifications you make to it will be automatically updated on the generated object.

LOD-Normal Map Panel Controls

You can change the settings on the LOD-Normal Map panel to affect the appearance of the generated object. Here you can alter the mesh simplification level, change normal map resolution, precision, and the method of normal map generation.



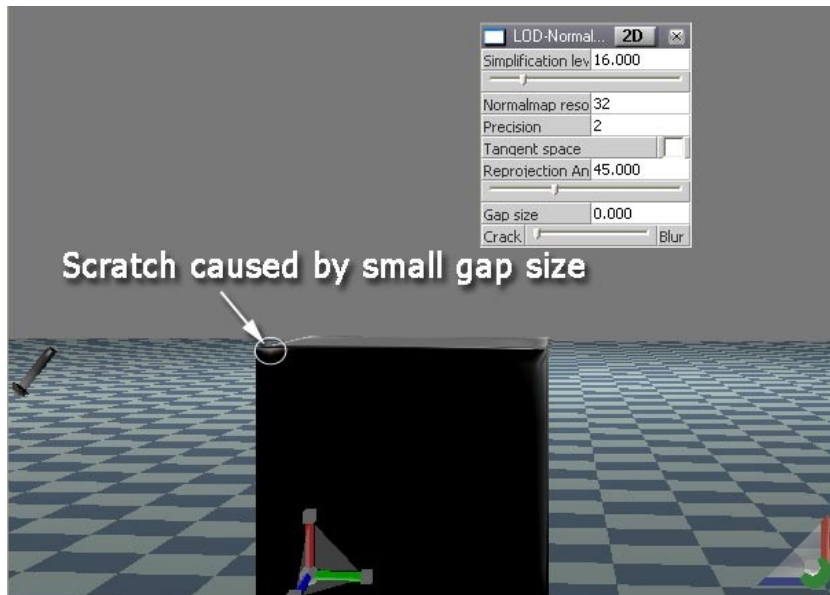
- **Simplification Level** determines how many triangles the generated mesh should have as a percent of those in the input mesh. For example, 20% means that output mesh will have 20% of the number of triangles found in the original mesh.
- **Normalmap Resolution** sets resolution of the generated normal map. A higher value means

better quality, but more memory consumption.

- **Precision** controls number of samples used to create the normal map. A higher value means better quality, but it also significantly increases the time needed to generate the normal map. Lower values may result in dark dots appearing inside of the normal map. For testing, set this value low, then increase it after you are satisfied with the result. A precision level of between 3 and 4 should be sufficient for most final normal maps.

Reprojection Angle controls automatic mesh unwrapping. Higher values will cause smaller texel density for steeper polygons, but will generally create a lower number of patches, and thus will produce better normal map allocation for the rest of the mesh. Smaller values, on the other hand, will lower this reprojection distortion, but more unwrap patches will be generated. Because there is some space needed between patches, this will cause poorer normal map allocation. 45-60 degrees should suffice for most models.

- **Gap size** is the space in texels that should be allocated between normal map patches. Setting this value too low will cause scratches in the rendered image due to MIPMapping. With higher values, smaller parts of the normal map will be allocated for visible pixels, causing the normal map to be blurred.



Checking the **Tangent space** checkbox will result in building a tangent space normal map. Object space normal maps are more precise because there is no need to interpolate tangent space matrices during estimation of normals, but their reuse is somehow limited. On the other hand, tangent space normals can be more reusable, but because tangent space axes are shortened during linear interpolation in graphics hardware, tangent space normal maps cannot compensate for these differences between spherical and linear interpolation, resulting in some artifacts on meshes with high curvature.



Simplified mesh without normal map.

Normals in normal map would require being denormalized in order to compensate linear to spherical interpolation error. This causes boundary solver to diverge.

In this case, the correct solution provides only an object space normal map because it is not dependent on normal interpolation, and the boundary solver can compute the correct normal.

Other more advanced settings for tweaking the normal mapper can be modified directly in the Link Editor. These include the welding distance for vertex and edges welding during topology correction (found on the Mesh Simplifier object), coordinate set which is used for texture coordinate unwrapping, and object scale to manually control polygon surface to normal map mapping (both found on the Mesh Unwrapper object).

Extracting A Stand-alone Low Poly Mesh

The **Simplify Mesh** and **Simplify Mesh and Create Normal Map** tools are very powerful, particularly as they are dynamic – you can choose to change the level of simplification at any point, and your object will update accordingly. However, to do this the tools must keep a copy of the high resolution mesh in memory, and while this reduces the demand on the real-time rendering and in moving around in the scene, it increases the memory resources required overall.

If you are happy with the reduced version of the mesh and do not want to change the level of polygon reduction any further, it is possible to extract the reduced geometry and use that on its own. This will give you the benefit of the reduction of demand on the real-time engine, as well as the benefit of lower memory requirements for the object and scene.

This method for extracting a standalone mesh will give you the reduced polygon mesh plus texture maps for the colors, but not a normal map for simulating the removed detail (a more advanced set of steps is given in a later section which details how to extract a normal map that will work in the offline renderers as well as in the real-time renderer).

First, take your high poly object and choose either of the Simplify Mesh tools, and then use the File menu **Save As -> Object** option and in the file type drop down list select “trueSpace6.6 Object .cob” as the file

type. This will remove all active trueSpace behaviors and save only the geometry and the materials of the low polygon version.

If you have used any texture maps on your original model, then please note that at this point the saved object makes reference to some temporary textures that hold texture map information from the polygon simplification process (and the normal maps too if you used the Simplify Mesh and Create Normal Map tool). You want to get those textures saved permanently so that your object will load with the textures and normal maps later; otherwise when you close and re-open trueSpace, your temporary textures will be lost!

To save the textures permanently, when you save the object immediately load it back into your scene using the File menu **Load -> Object** option. Now delete the object created by the Simplify Mesh tool (the one that is still active and will change its level of detail in response to the slider) and then use the File menu **Archive** option, which will save a copy of the scene and all associated textures to a folder in your trueSpace installation directory.

Now you can load that scene at any time, and even store the object from the scene into a trueSpace library for use later.

Specifying Your Own Low Poly Mesh

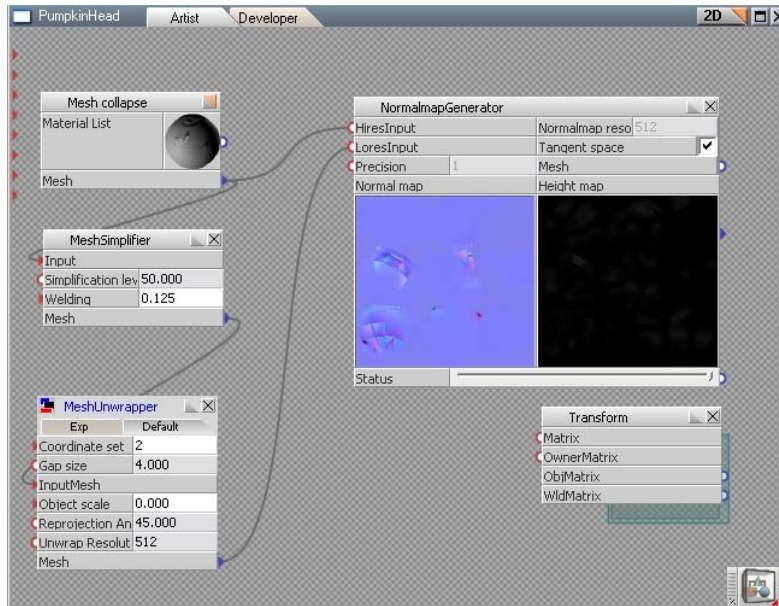
This is an advanced technique for when you might want to create a Normal Map from a high poly object and render it in the offline renderers such as Lightworks and V-Ray as well as in the real-time renderer, or if you want to use the normal map on a low poly mesh that you specify rather than the mesh created by the Simplify Mesh tool. This will require some minor work in the Link Editor, but is very useful once mastered!

The first method is used to render the normal map in the offline renderers. You can see if you render an object in Lightworks after using the Simplify Mesh and Produce Normal Maps tool, the result does not resemble the real-time view. Similarly, if you extract the material from the Simplify Mesh object using the trueSpace Material Editor you will see that it does not apply well to other objects, and indeed you may notice that the layout of the faces in the Normal Map image seems unusual.

These results are because the Simplify Mesh tool can use secondary UV streams for the Normal Map thanks to the real-time capabilities of your graphics card, while the other render engines such as Light - works do not have access to this processing.

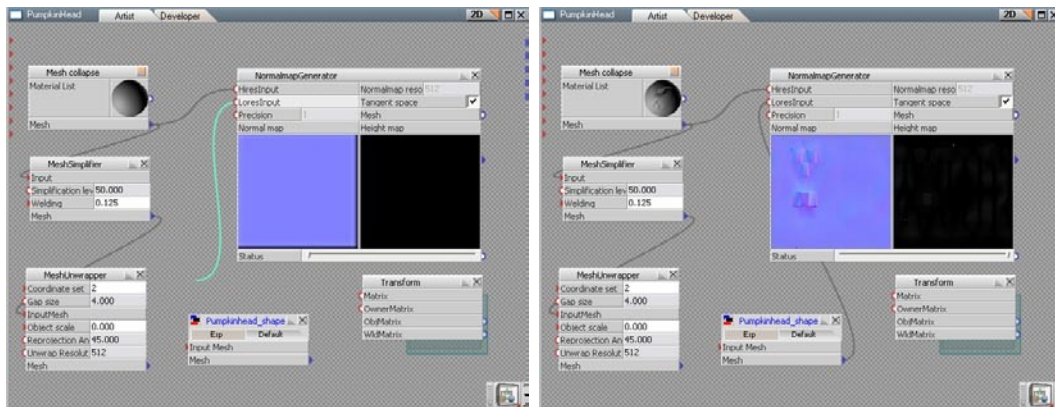
The solution is to ask the Simplify Mesh tool to use an object of your choosing internally in place of the simplified object that it generates – this means it will use the UV map from that object, and not the unwrapped UV map that it calculates by itself.

Start by loading the high resolution object, and then apply the **Simplify Mesh and Create Normal Map** tool. Now follow the steps described in the previous section “Extracting A Stand-Alone Low Poly Mesh” up to the point of saving the simplified mesh as a trueSpace6.6 format object. Now load that object back into your scene. If you compare the two objects in the Player window, you will find that the object you have just loaded appears distorted as the Normal Map is not correctly mapped on it.



The internals of the object with the Simplify Mesh and Create Normal Map tool applied

Fortunately there is only one simple part of this that you need to know about, and that is the link from the Mesh parameter in the MeshUnwrapper object which connects to the LoresInput parameter on the NormalMapGenerator. The UV Map is fed into the NormalMapGenerator at this point, and we want to replace that input with our own object, which is the Shape object saved in the library. Drop this object into the LE by using Click and drag to move a copy from the library. Then ensure you select the Default aspect of the Shape object. Now click on the middle of the link and drag it to the Mesh parameter on your Shape object.

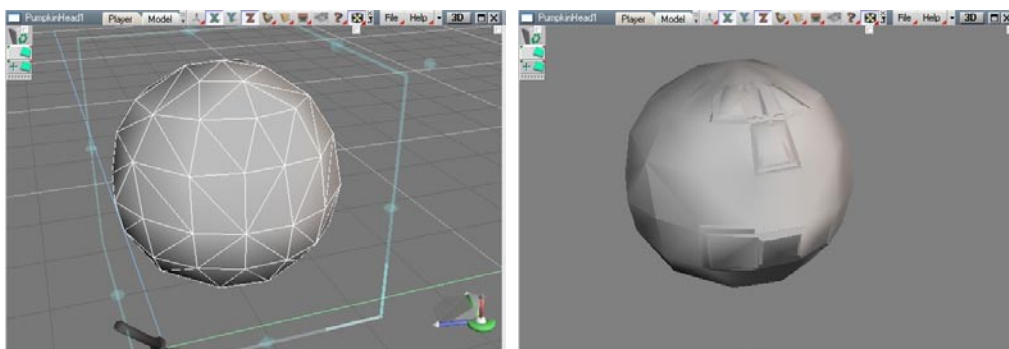


Reconnecting the LoresInput so that the NormalMapGenerator uses the UV Map of our Shape object

When you connect up the Shape object, the NormalMapGenerator recalculates the map. You will see that the new Normal Map looks more familiar in its layout. At this point, leave the object and wait for the Normal Map to recalculate.

Now in the Model window, use the **Material Editor** tool to Inspect the object, which will pick up the texture with the Normal Map in it. It is a good idea to save this texture to the trueSpace texture library. You can now paint this texture onto the permanently simplified mesh that you saved out in trueSpace6.6 format, and this Normal Map will now render under Lightworks and V-Ray, giving you the full benefit of lower polygon counts while retaining the appearance of higher detail!

The final step is to use Archive to save the normal map image permanently, then you can save the final object to the Object Library for use whenever you choose.



Modeler screen grab on the left shows the flat faces with no sign of the detail; the render in Lightworks on the right shows the detail from the Normal Map simulating the geometry

One thing to note is that the above procedure used the geometry produced by the Simplify Object tool, but you can in fact use the Shape component of any object. For the “pumpkin head” example above, for instance, you could take the Shape component from a Sphere, which would produce a Normal Map that you can paint onto a sphere. Similarly, if you were creating a jacket, you could create the basic shape, save it, then add detail such as pockets and seams using geometry. You could then use the Shape component from the basic jacket object that you saved prior to adding the detail, and this would create a Normal Map for that object but containing the detail from the detailed version.

4.6.3 Limitations

Please note that both the **Mesh Simplifier** and **Normal Map Generator** tools handle DX (Player-originated) materials perfectly, but can simplify complex LW (Modeler-originated) materials for the final object. E.g., when you apply the mesh simplifier tool to the Bowl object (can be found in Modeler’s objects library), the original procedural wood material will be replaced by plain texture.