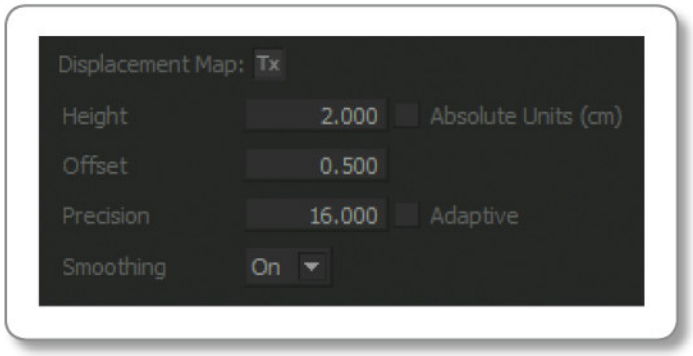
MAXWELL DISPLACEMENT:

Introduction

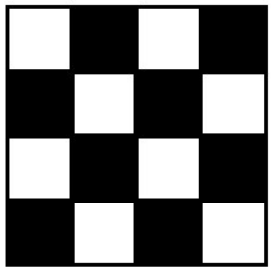
The displacement feature simulates real geometry at render time as if it was actually modelled. This feature is very useful for adding fine detail to a mesh which would otherwise be difficult or impossible to actually model. Displacement uses a texture to define the geometric detail. Unlike many other displacement solutions which pre-tessellate the geometry causing an increase in memory usage at render time, often of hundreds of megabytes for large detailed displacement, Maxwell's unique displacement method allows you to create virtually unlimited detail while using very little extra memory.

A displacement component can be added to the material (only one component per material is allowed) by right clicking in the Material Layers area of the Material editor, or from the Edit menu of the Material Editor.



The Parameters

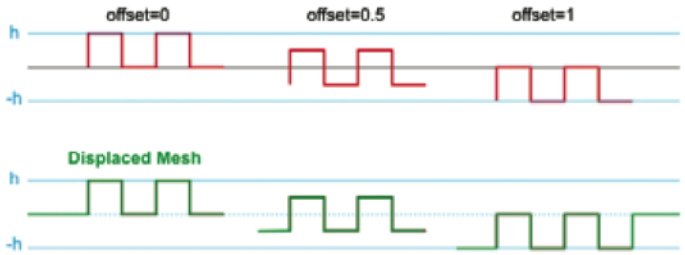
To use displacement, you need an object with UVs, and a displacement texture. The texture used is similar to a usual greyscale bump map – you have different shades of grey to describe elevation levels. For example, lighter greys will raise the geometry and darker greys will create cavities. The main displacement parameters control the surface precision and height of the displacement.



Displacement Map

Displacement Map

You must first load a displacement texture to access the displacement parameters. Maxwell Render can use 8, 16 or 32-bit greyscale displacement maps. It is recommended to use at least a 16-bit displacement image as 8-bit images may not contain enough grey levels (only 256) to make a smooth displacement. You may see a stair stepping effect if using 8-bit maps. 8-bit maps may be enough for displacements that don't require smooth transitions between grey levels, and additionally Maxwell's texture interpolation helps to render even 8-bit images smoothly.



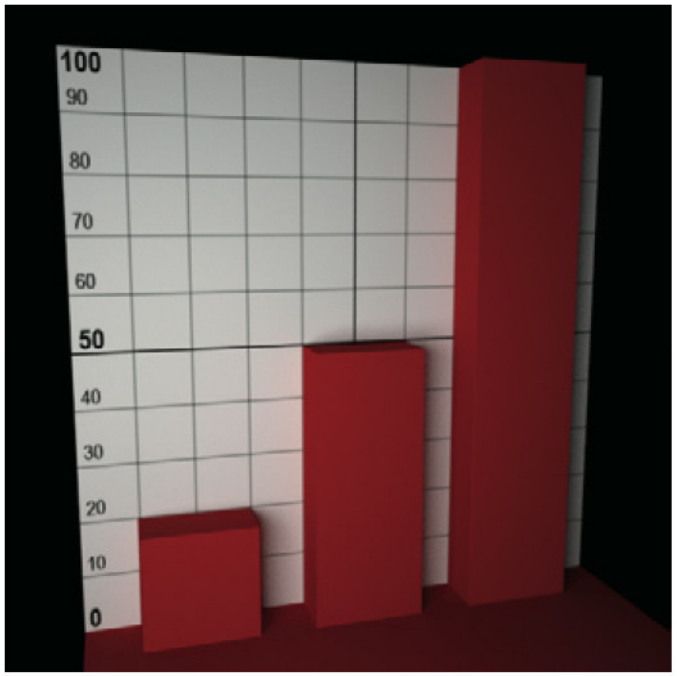
Base Mesh Surface

Offset

This parameter allows you to specify which grey level in the texture should represent zero displacement. It is important that you set this parameter correctly based on what type of displacement map you use. For example some displacement maps may use 50% grey to specify zero displacement (darker shades than 50% in the texture will create cavities, lighter than 50% will raise the geometry). In this case, you have to set the Offset parameter to 0.5 to get a proper displacement. If your displacement map uses black to represent zero displacement, set Offset to 0.

Height

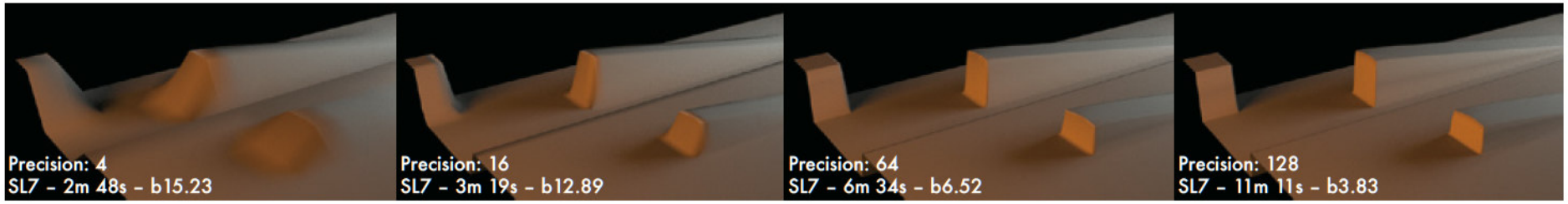
This parameter sets the maximum allowed displacement distance. It tells the engine how much real geometric height you want to displace on your base mesh. This value needs to be greater/less than zero for displacement to appear. The white of your texture will be raised to the height value you set. Displacement height can be set to use either relative or absolute height:
– By having the "Adaptive Units" option unchecked (allowing for relative height) the given value will represent the desired height as n% of the longest edge of the associated object's bounding box. For example, if you have a car of 300 x 150 x 110 cm and you set height as 1, this means the peak displacement will be 1% of 300 (the longest edge of the bounding box) which is 3 cm to be observed as real length in render output. Using relative height is useful when you wish to preserve the same displacement height if you scale the object.
– Checking "Absolute Units" allows you to set the height in centimeters and it will always displace to this given value regardless of object dimensions.



The image shows grey values 51 (20% grey), 127 (50% grey) and 255 (white) in order.

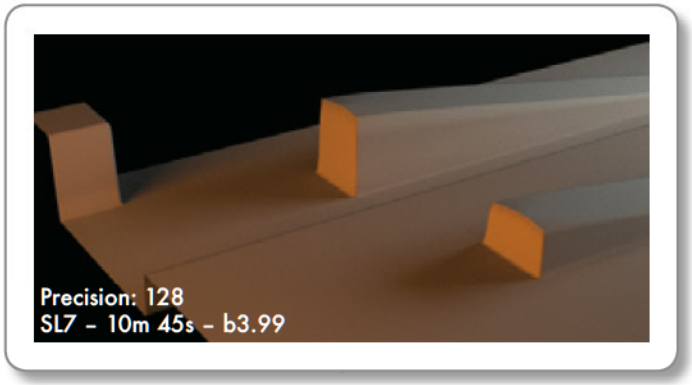
Precision

Precision defines surface accuracy, ability and response to detail independent of texture resolution. This means two things:
– Specifying a low precision value and using a high resolution texture (lots of detail), will not show more detail in the render than what is allowed by the precision value.
– Specifying a high precision value but using a low resolution texture will reach the limit of the pixel detail of the texture and will not result in a more detailed displacement. The displacement will have reached the detail level of the texture. This is important to understand because you can optimize the displacement by starting with a high resolution texture and lower precision value, and keep raising the precision value until the detail in the displacement is satisfactory. An example of how surface detail and render time are affected by increasing precision for the same texture can be found below:



Example of how surface detail and render time are affected by increasing precision for the same texture.

We can see in this case that going beyond precision 128 wouldn't add more detail but would increase the render time. So it's important to avoid unnecessarily excessive precision values.



In the example above, the same texture was used and adaptive mode turned on. We can see that the maximum detail this texture can provide has a similar render time of using a 128 precision value. But perhaps the user would have mistakenly set the precision value to 200–300, resulting in increased render time, not realizing the texture couldn't provide any more detail. So in cases where you want to get the most possible detail out of the texture, Adaptive mode can be useful. In most cases however it is recommended that you fine tune the precision value and leave Adaptive mode off as this allows you to optimize the render time while still having an acceptable level of detail.

Adaptive

The adaptive option locks the precision value to the given texture detail (at half pixel accuracy) which has the advantage of always creating the most detailed displacement that a given texture can provide. The user doesn't have to guess what the maximum precision value should be for that texture, or worry about exceeding it (which would increase render time but not increase the detail).

However this mode needs to be used with care, because using a very large resolution texture to represent a simple detail will result in unnecessarily long render times.

Smoothing

Similar to the objects smoothing angle setting, this parameter controls whether the displaced surface should render smoothly (continuous shading) or render facetted. It is generally suggested you leave this setting to On, unless you aim to render very sharp, detailed displacements. Please note that the objects smoothing angle will still override the smoothing used for the objects base mesh faces, so if the objects smoothing angle is set to Flat (making the object render facetted), and the Smoothing parameter is set to On in displacement parameters, a smooth displacement surface will be rendered over a facetted base mesh surface.

Important Tips Regarding Impact on Render Times

Render times can vary greatly and depend mainly on 3 factors:
– The base mesh vs. precision value (see below for details)
– The height of displacement (more height will increase render time)
– How many displaced surfaces and objects the rendered image contains. For example, a common usage of displacement may be a brick wall seen from far away which takes up 30-40% of the rendered image, in which case low height and precision values can be used, and render time impact will be minimal. On the other hand, a close up render of a displacement object taking up the whole image space and using high precision values will need more time to render clean.

Base Mesh vs. Precision

The more polygons you have in your base mesh, the less precision you will need to render the same amount of displacement detail. Using less precision will always render faster. For example, if you're planning to render displacement over a plane, model your initial plane using more than 2 triangles. A typical 4 x 4 subdivision will remarkably speed it up. Objects made of evenly distributed polygons are preferred for better quality.

Rendering Sharp Details

For rendering sharp details, consider turning off texture filtering. It will help you render high contrast areas in your texture sharper. If you're using a moderate precision value, displacement will tend to smooth the rendered detail. In this case, you should also turn off Smoothing under displacement options for rendering the details sharper. Keep in mind that turning off texture interpolation might reveal a stair stepping effect if using 8-bit maps with smooth gradients in them.