What is “Procedural Texturing”?
Creating surface textures has a variety of applications, from obvious aesthetic effects to increasing mechanical grip or decreasing aerodynamic drag. The required geometries can be difficult to draw manually and even more difficult to scale and conform around complex parts. This is where “procedural texturing” can be advantageous over the manual modeling of surface features. Another application is when a texture must look “natural”, in that there are no obvious repeating unit cells (e.g. leather as opposed to knurling).

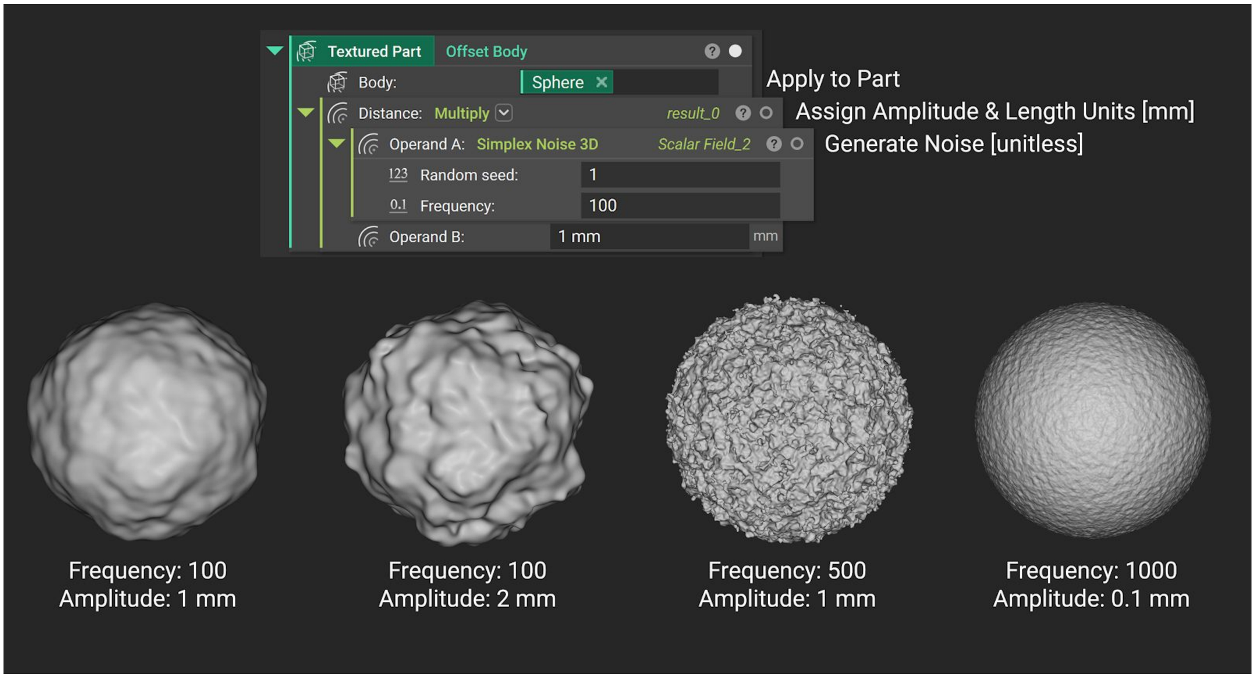
As the name suggests, this approach generates a surface texture using a mathematical procedure or algorithm. This allows for very high performance and scalability of a texturing workflow, and the ability to apply it to any new part. Creating a new texture (the topic of this article) can be non-intuitive at first, but once mastered can become the ultimate creativity tool in your arsenal.

Why is nTop good at it?
nTop’s implicit modeling engine is mathematically based, and natively compatible with procedural texturing recipes. Field-driven design allows users to control the size, shape, or strength of the texture however they desire.

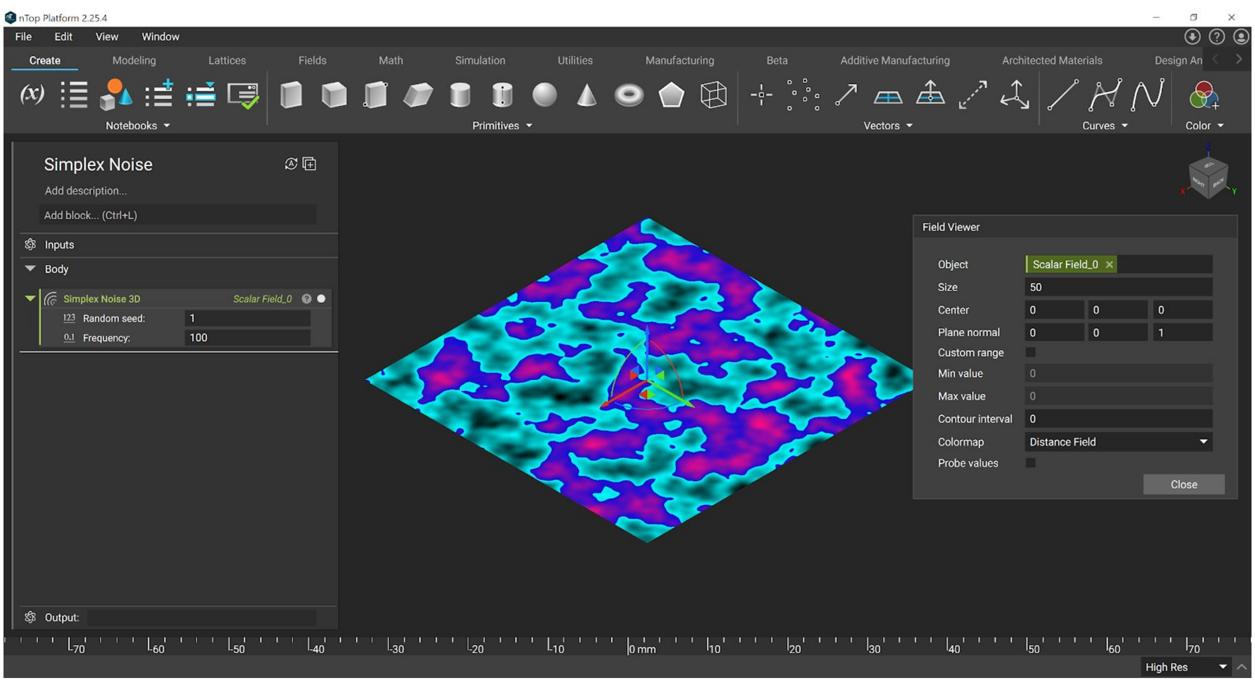
Note that other texturing methods are available in nTop as well, and can sometimes be easier for simple parts.

1. Roughness

Adding roughness is perhaps the simplest procedural texture, and a foundation for the more advanced ones below. It involves three easy steps: generating noise, scaling the noise, and applying it to a part.

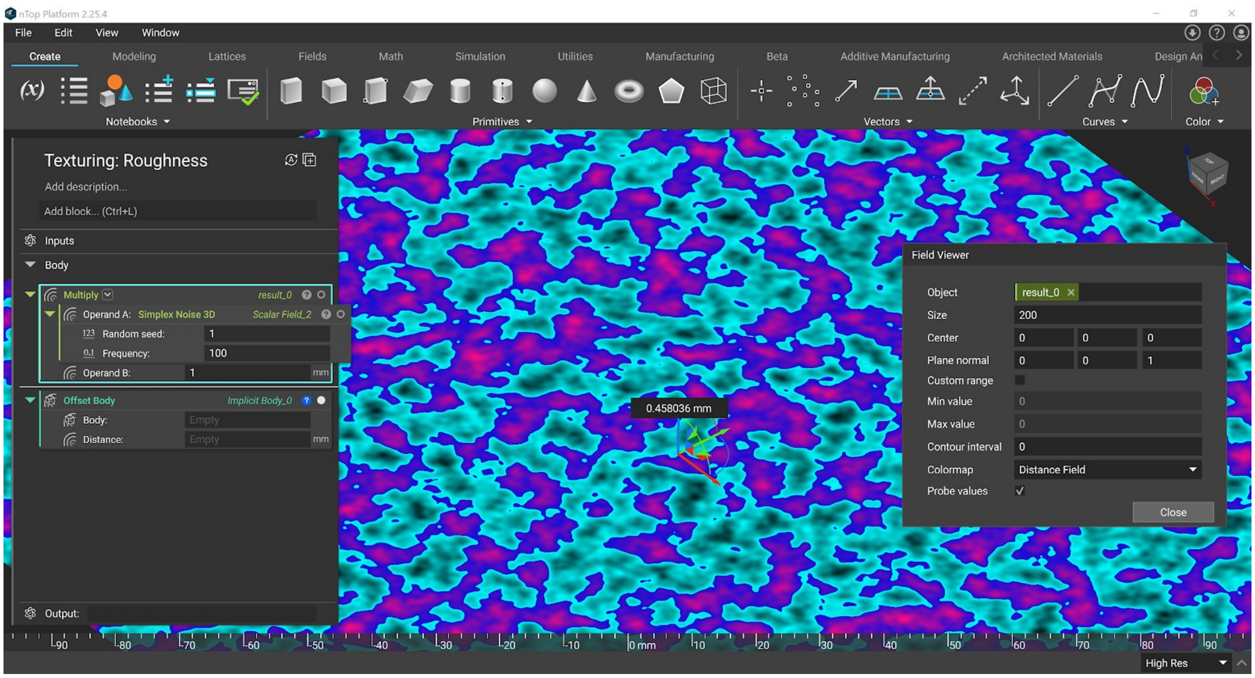


Roughness begins with a Simplex Noise 3D block.

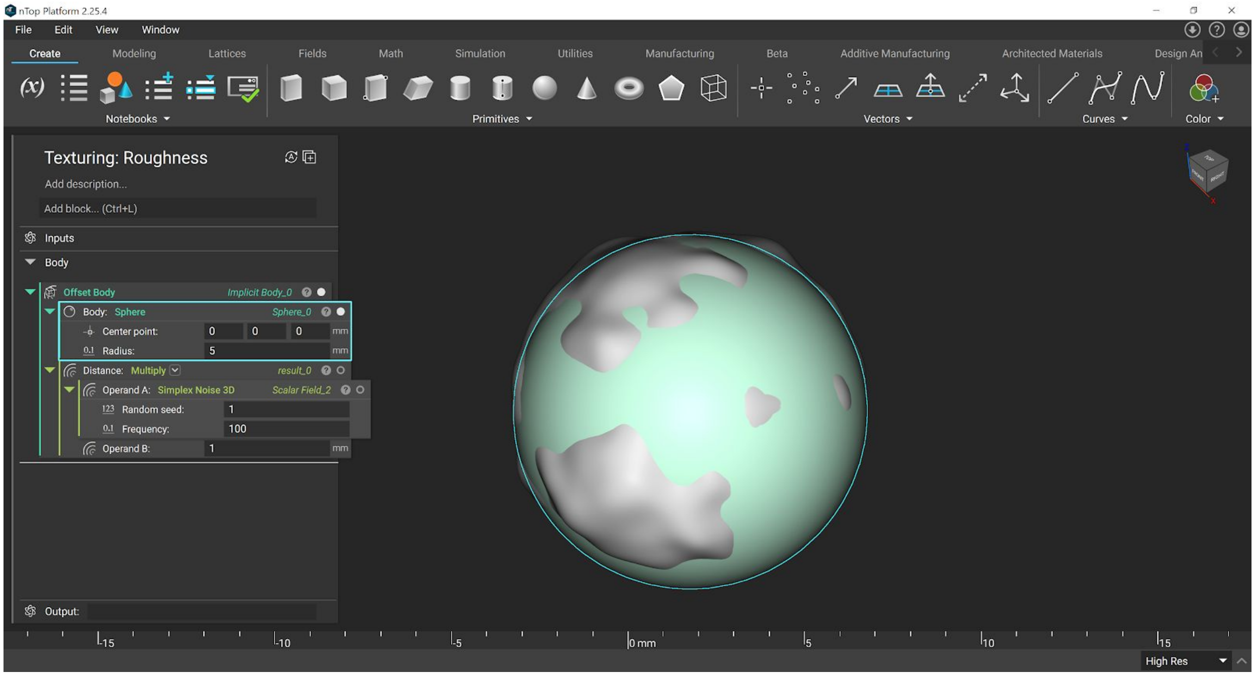


Using the field viewer (press F), you can see that the noise ranges from -1 to 1 (toggle "Probe Values" on the Field Viewer dialog, and hover over the field). The influence of the frequency input is best visualized by changing the value, and the random seed is useful if you want to layer multiple noise functions without them coinciding, or to randomize different parts' textures.

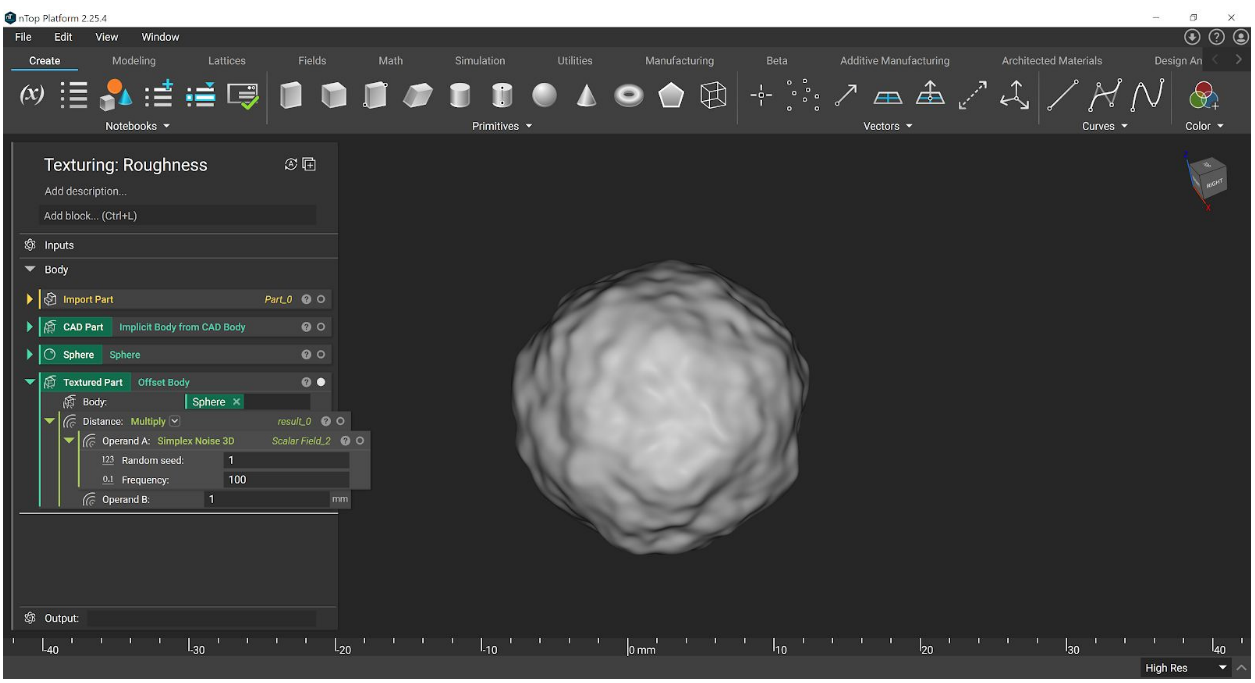
We need to assign length units in order for it to change the shape of a part. Using a multiply block assigns units of length, and also the strength or amplitude of the noise. Imagining this as a digital signal or 3D oscilloscope may help.



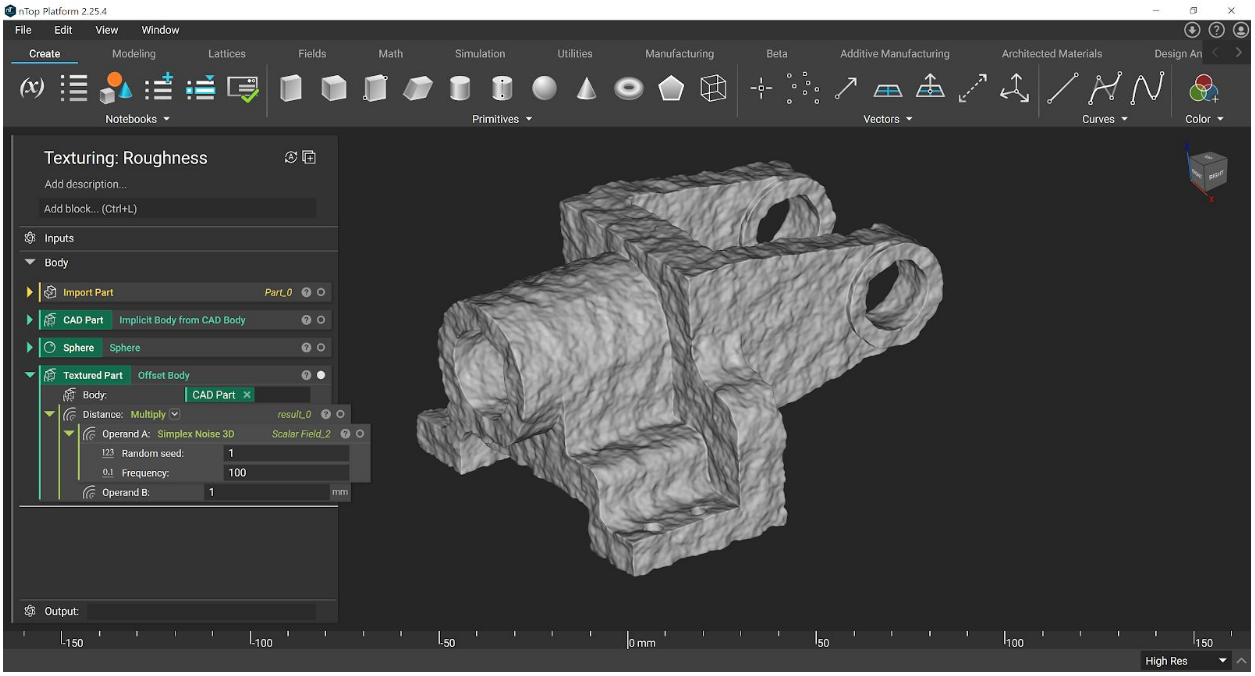
The resulting field now has units of length, and can be used in an Offset block to add and remove material (the original sphere is shown in green). The magnitude of this multiplying value controls the depth or strength of the texture, and can be varied spatially (as indicated by the curved field icon ).



Organizing the notebook, one can now swap in any part into this roughness texturing workflow, including imported CAD or mesh files (once converted to Implicit).

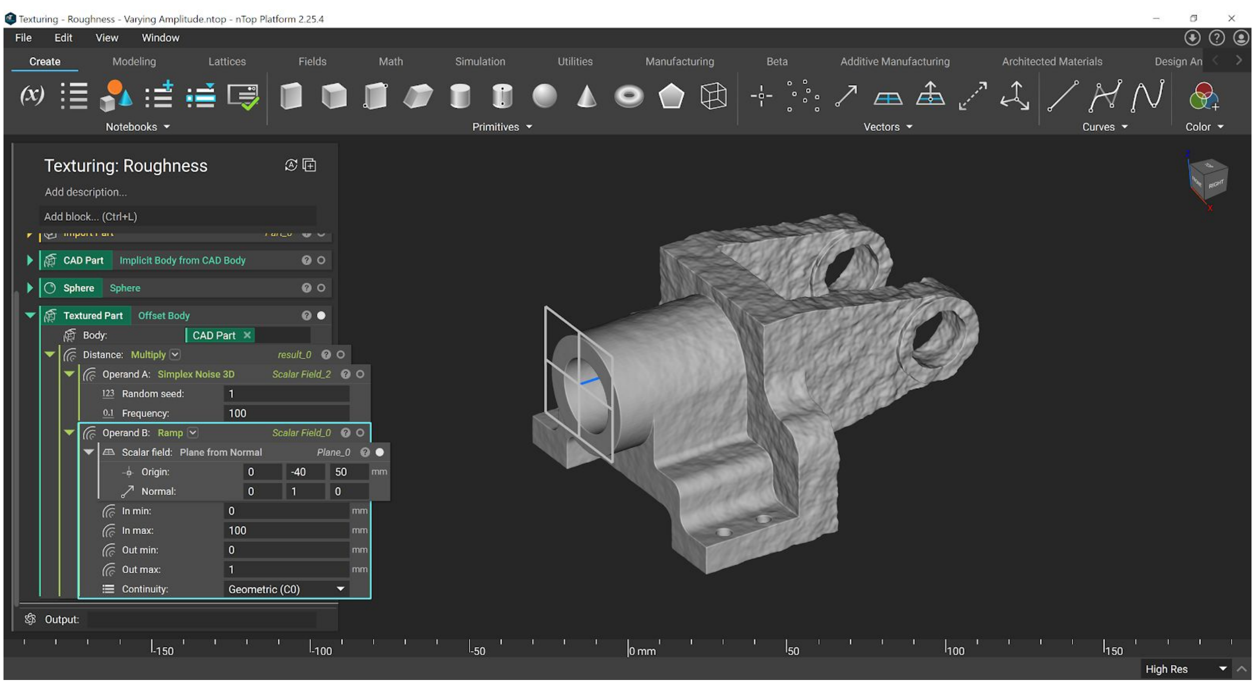


Shown on an imported CAD part:



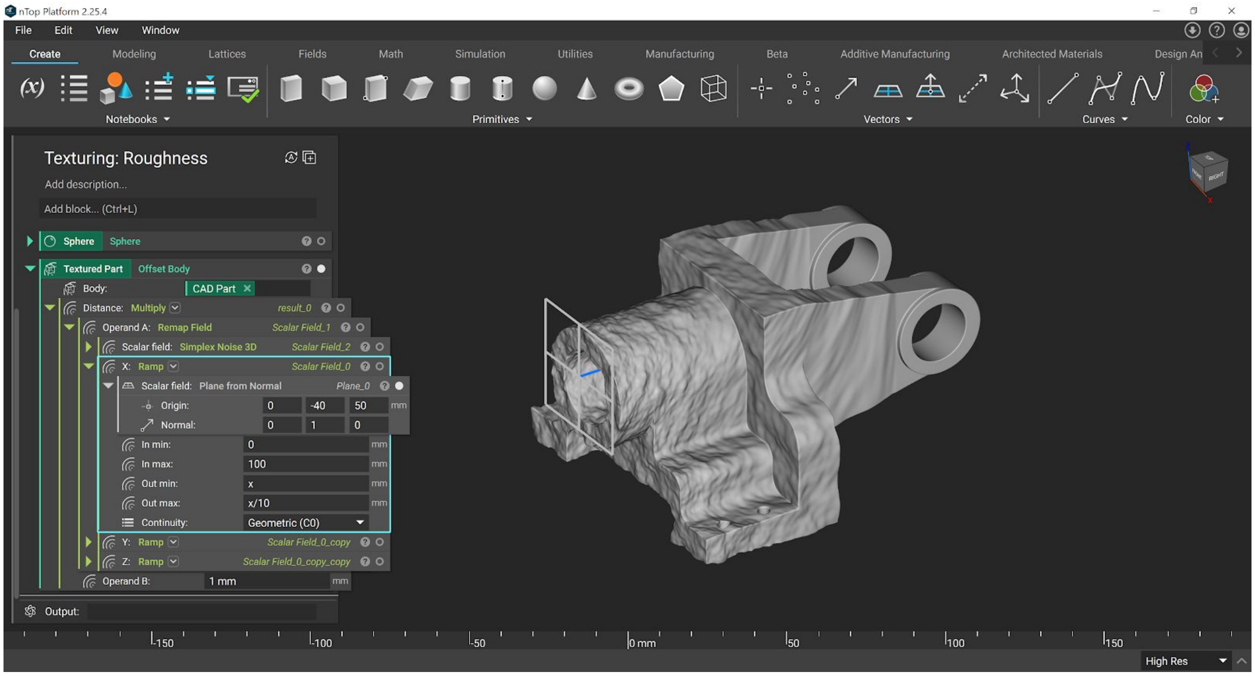
See example file: Texturing - Roughness.ntop

The texture depth can be controlled with a ramp block in the multiply input. Here we show fading from smooth (0 mm) to textured (1 mm) as we proceed away from the plane.



See example file: Texturing - Roughness - Varying Amplitude.ntop

The texture’s frequency can also be controlled by ramps, with a few more steps. Here we use a Remap Field block to warp the underlying noise field. A ramp block is used in each of the X, Y, Z inputs (recall the noise signal extends in 3D), each with their respective axis being divided by 10 as we move away from the plane.

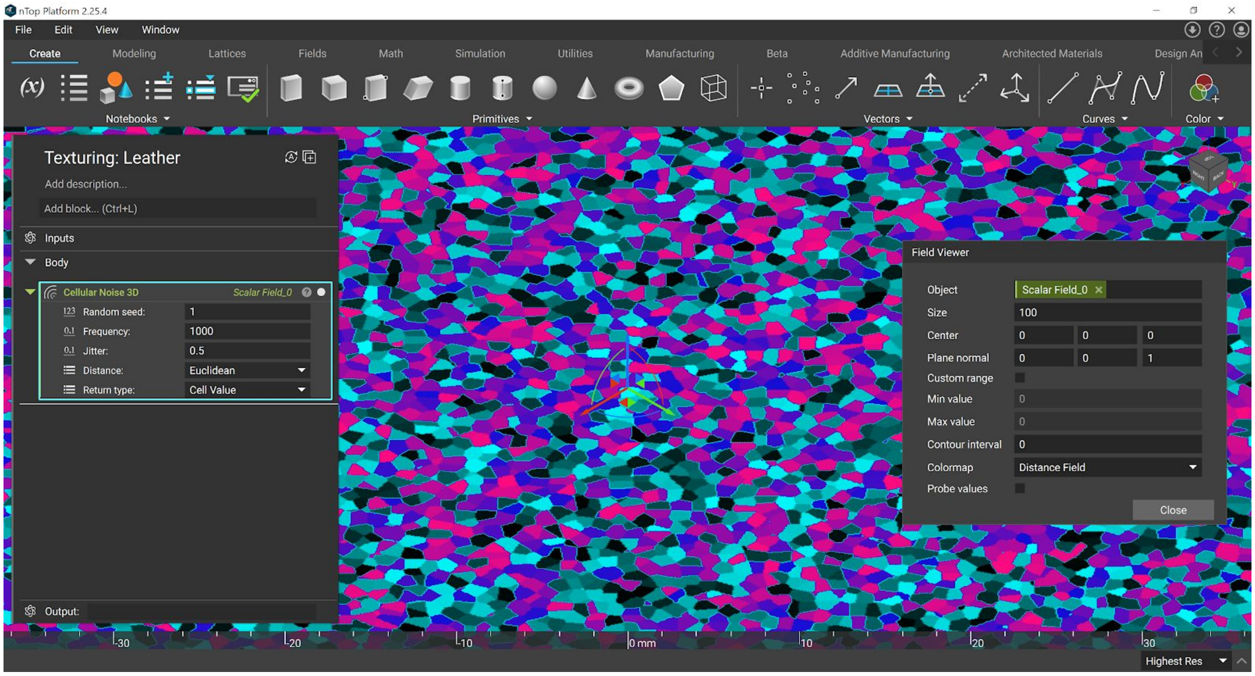


See example file: Texturing - Roughness - Varying Frequency.ntop

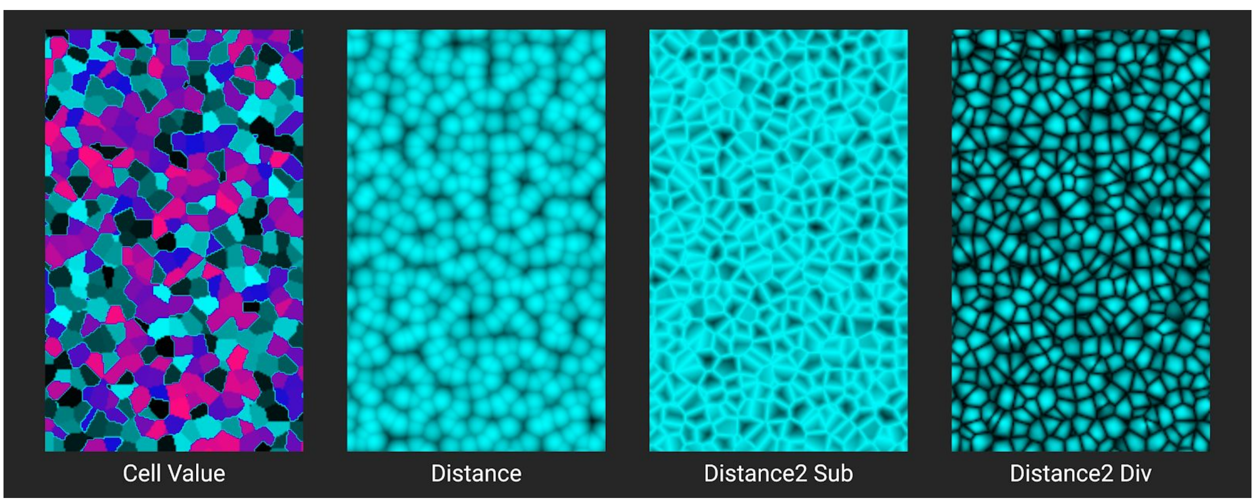
The two effects (ramping both frequency and amplitude) can also be combined.

2. Leather

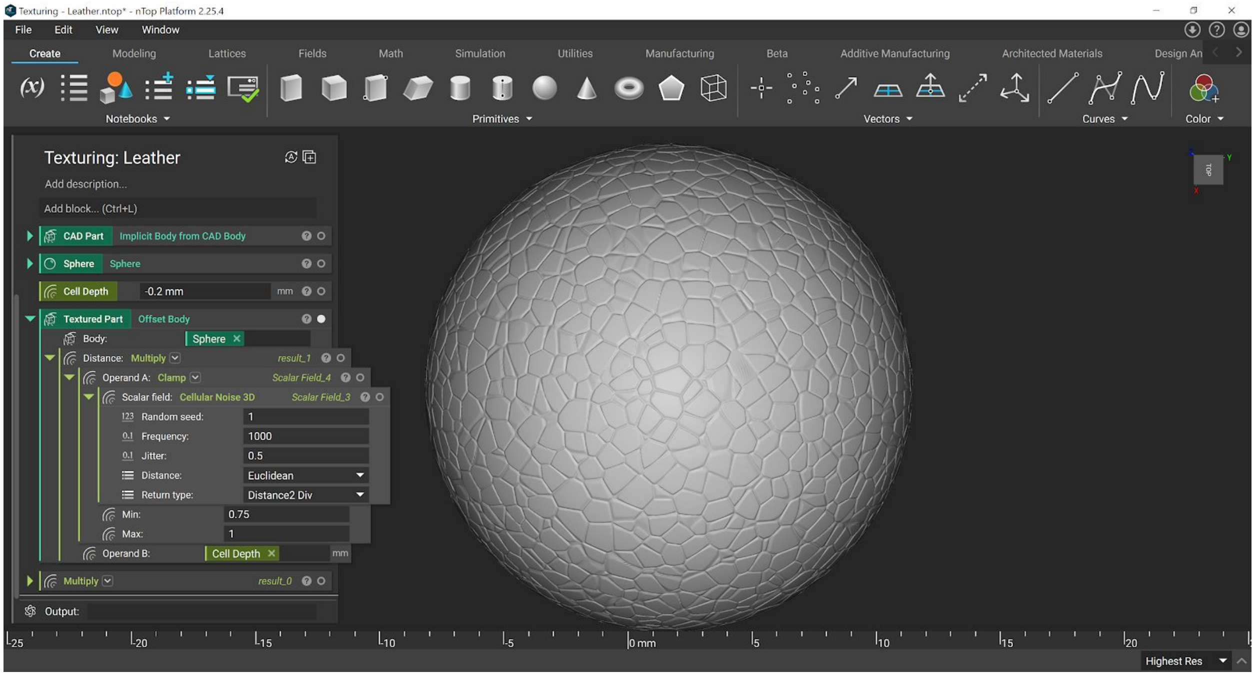
Cellular Noise is another block available and is useful for replicating natural textures such as leather.



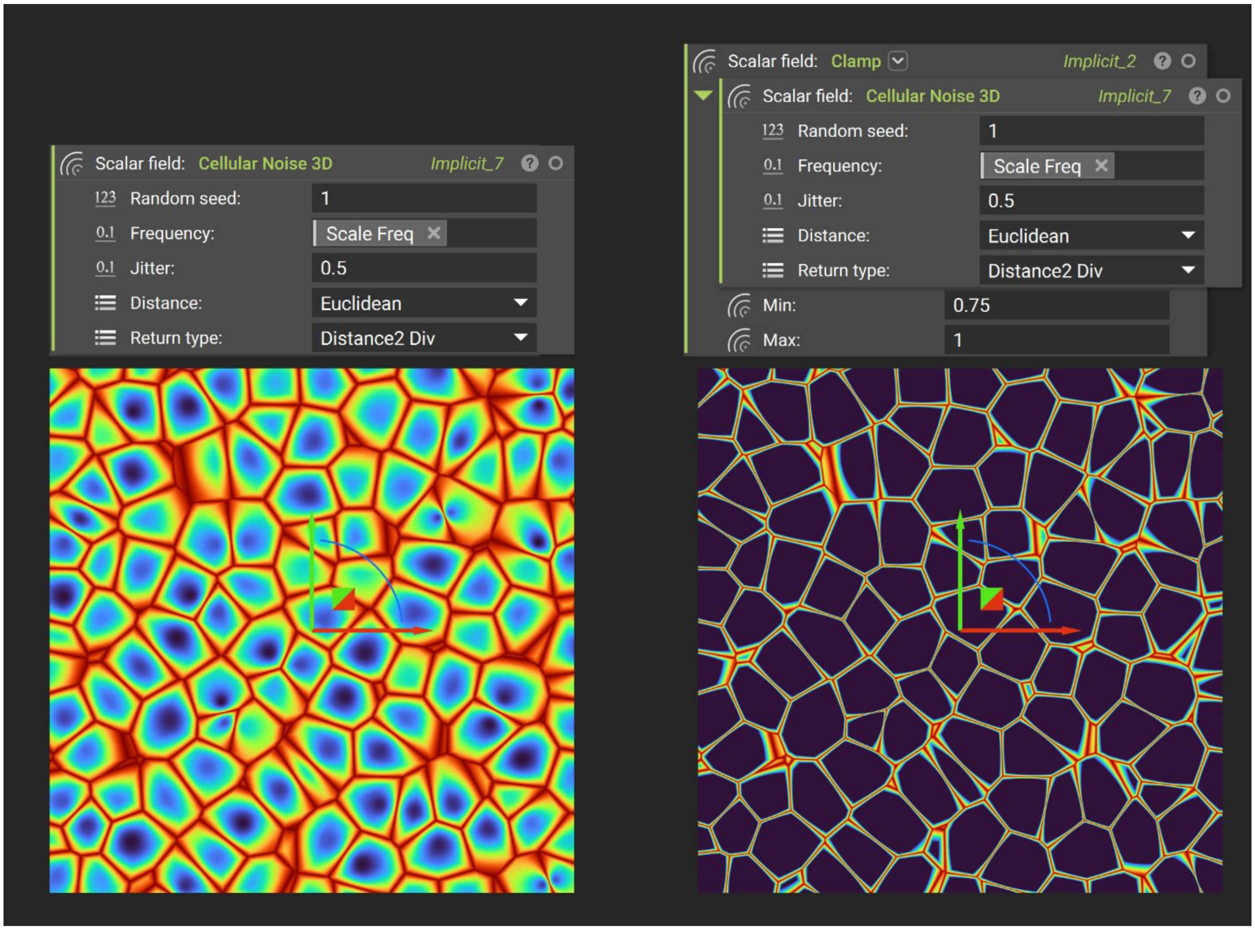
Effect of different Return Types in the Cellular Noise 3D block.



Applying this type of noise to our shape is very similar to the roughness texture shown earlier. For leather, we'll proceed with Distance2 Div, since it looks most similar to the effect we are aiming for.

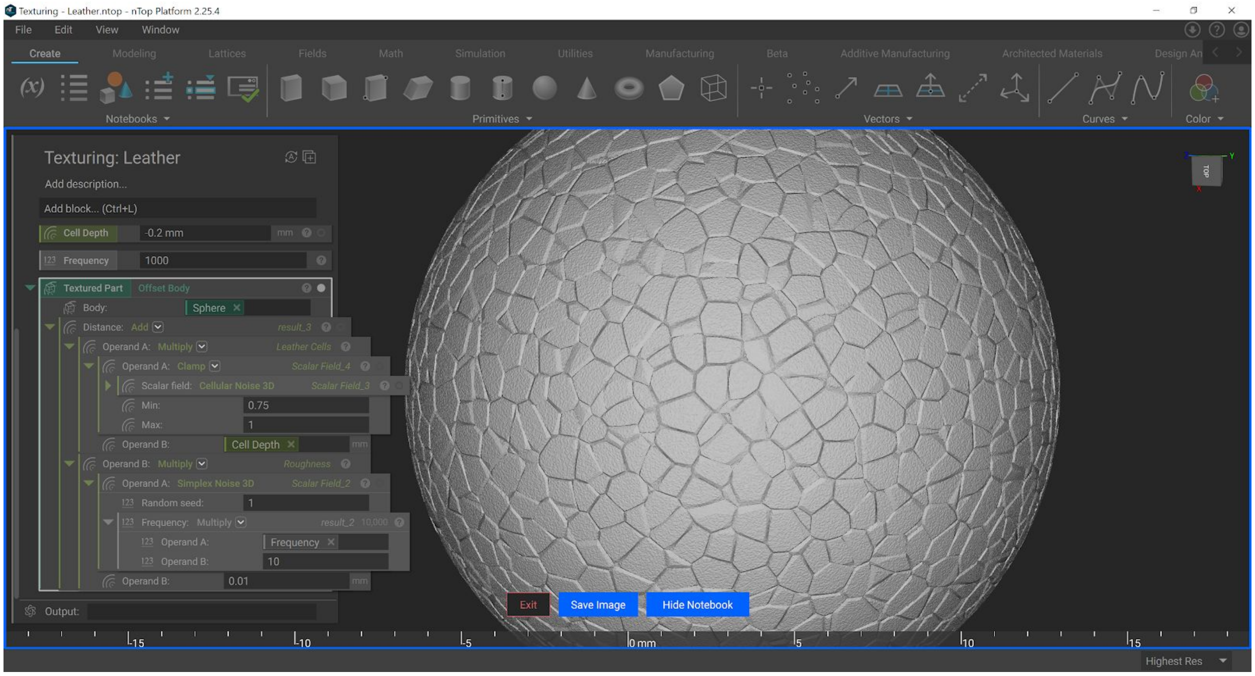


In between our Noise and Multiply block, we use a Clamp. This essentially thresholds the noise signal (which runs from 0 to 1) to be between 0.75 and 1 only. This will create flat spots in our leather cells, rather than mountains, and is easier to visualize with the Turbo option in the Field Viewer.



We want to etch this field into the part, so we use a negative value in the Multiply block. This offsets the creases (high spots in the field) inwards.

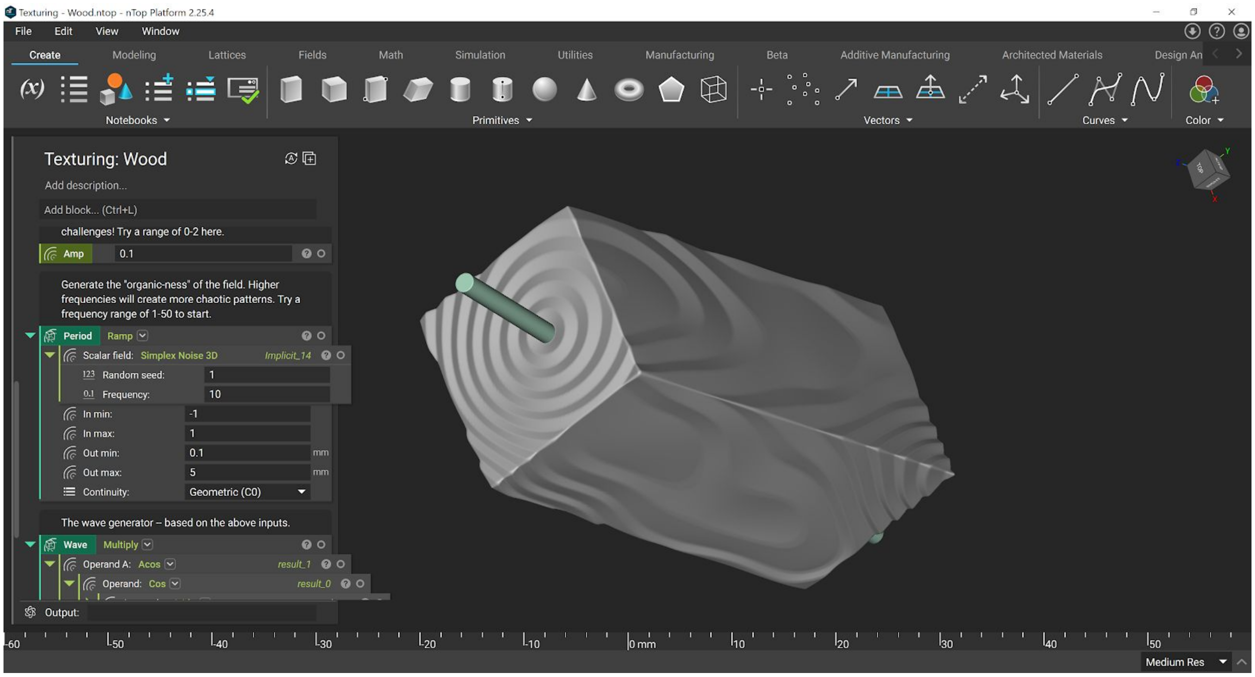
To make it more realistic, we can add a fine layer of roughness to the leather. Here we used variables to keep the frequencies proportional to one another (the roughness being 10x the frequency of the Cellular Noise). Be sure to only use a small amplitude here. You may need to do the high-res Ctrl+H render to see the effect.



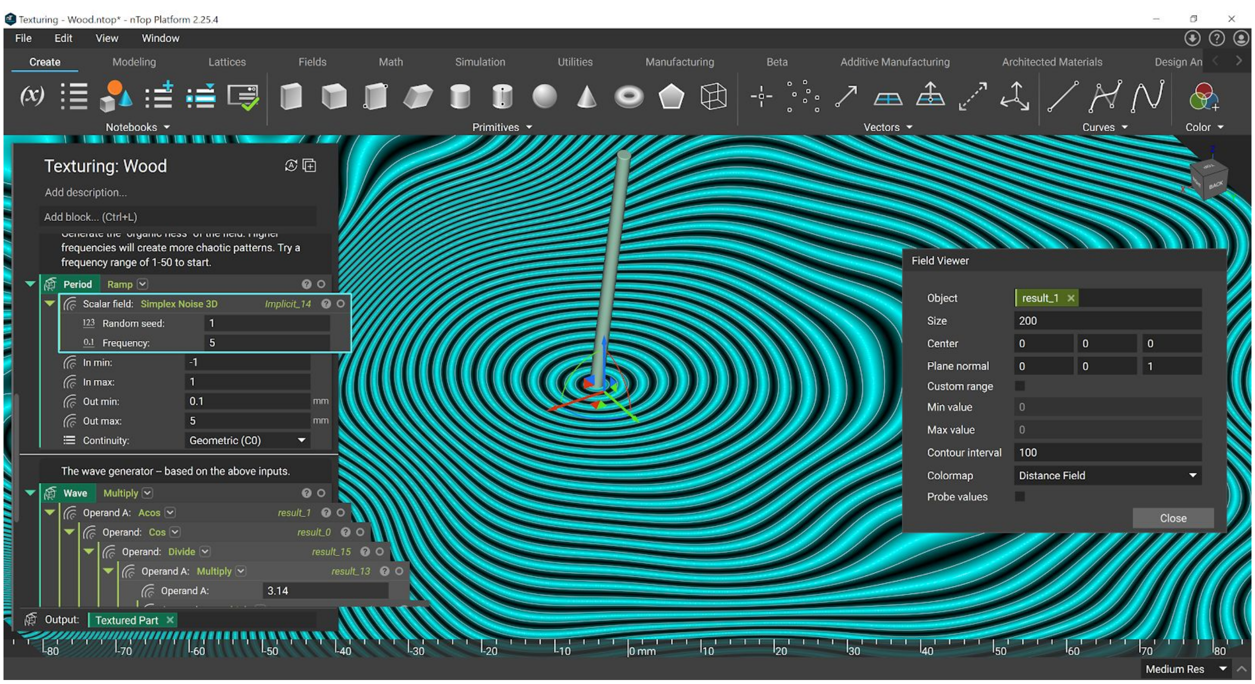
See example file: Texturing - Leather.ntop

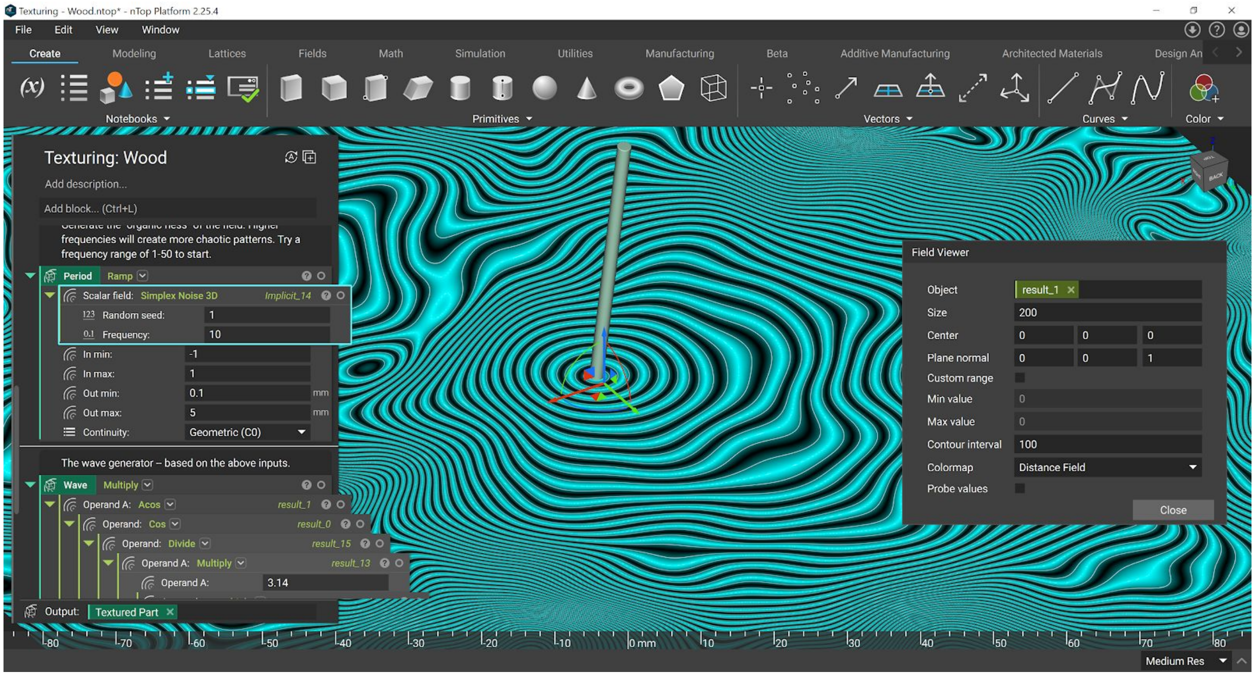
3. Wood

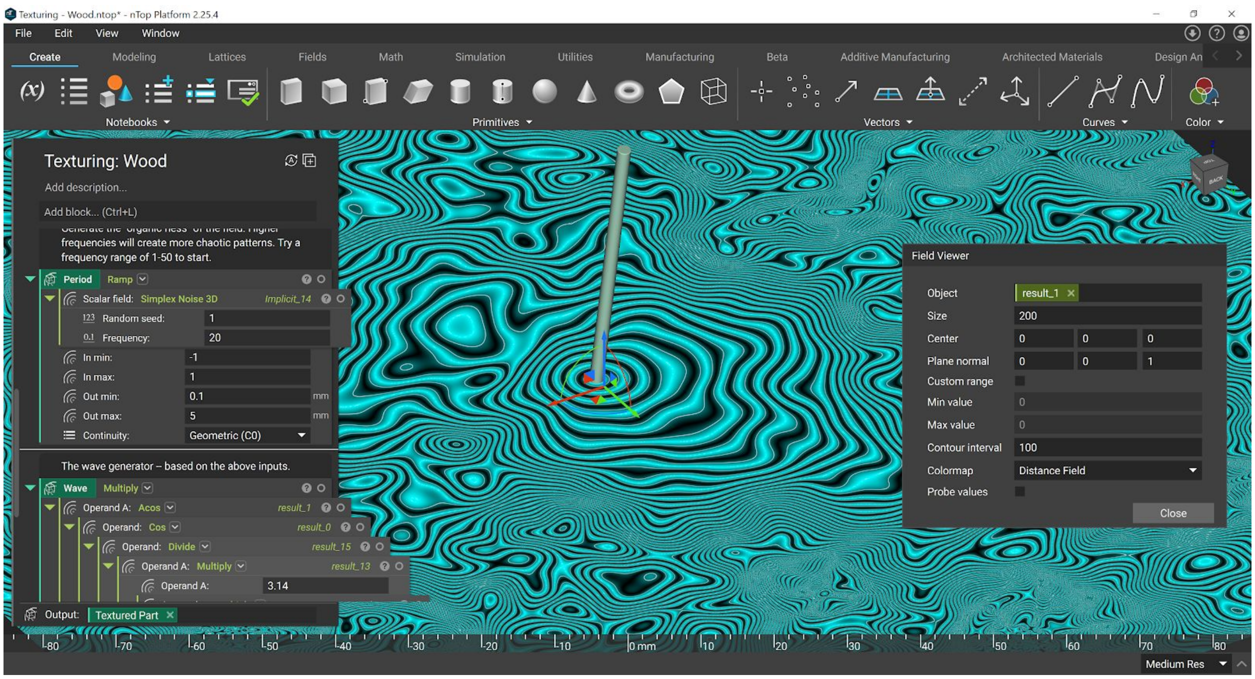
Generating a wood texture in nTop adds another series of blocks into our file: trigonometry functions. We can use these to create waves which resemble the rings in wood.



The period of the waves can be linked to noise functions, allowing control over how chaotic the rings look. With a high frequency value, the texture may begin to resemble some sort of magnetic material instead.



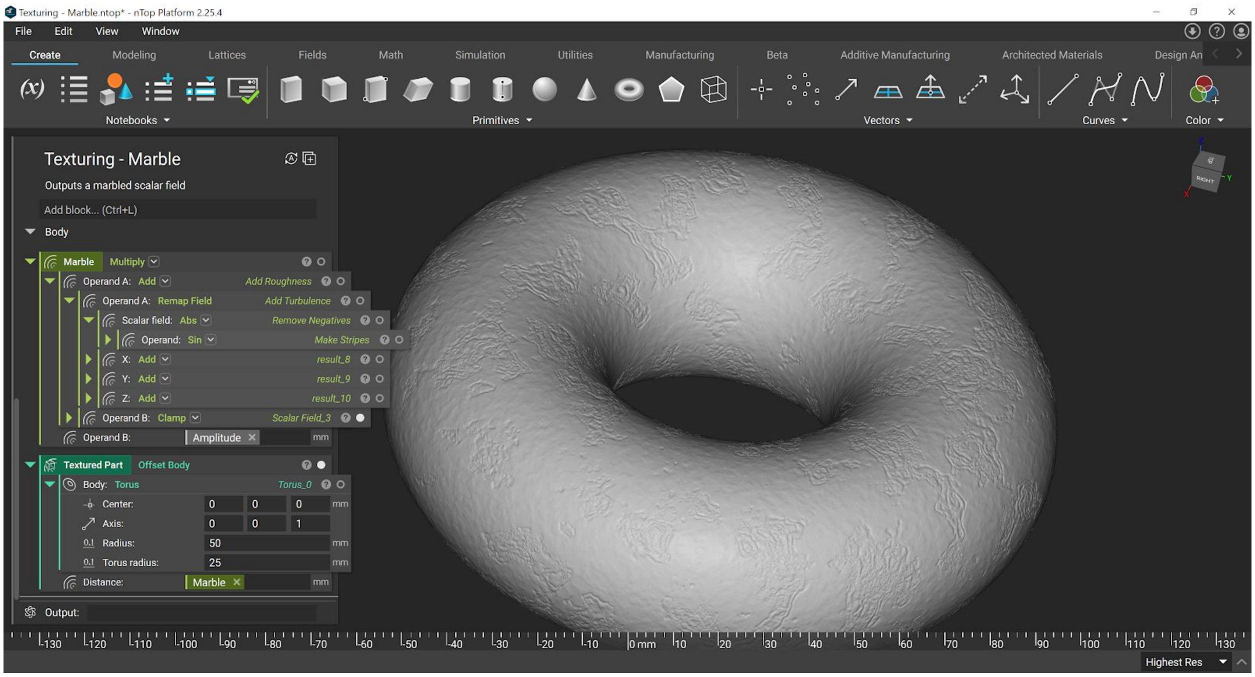




See example file: Texturing - Wood.ntop

4. Marble

As a final bonus texture, here is an example file for a Marble texture. This one combines everything we have learned above: noise functions, remaps, clamps, and trigonometric functions. It is best stepped through carefully with the field viewer.



See example file: Texturing - Marble.ntop