A Completely Procedural Approach to Materials

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Blue Sky has developed a completely procedural approach to texturing for CG feature films. Through a suite of tools for our proprietary renderer CGIStudio, traditional texture mapping has been virtually eliminated from our materials process. From robots made of hundreds of parts to wet furry animals, skyscrapers to mountain-scapes, no painted maps are used. Instead, the Materials Artists at Blue Sky use a variety of flexible techniques to layer and sculpt 3D noises achieving a high level of detail and artistic control.

Procedural Texturing Advantages

CGIStudio is a raytracer. Complex materials such as water and diffuse reflective metals are easy to create and are rendered with a physically accurate reaction to light. Elaborate geometry such as Sub-Divided surfaces is rendered directly to implicit Bezier patches. All this can lead to long render times, but the prevailing philosophy at Blue Sky is that an artist's time is far more valuable than a machine's time. We extend this philosophy into our materials process by ignoring long render times and embracing the advantages of procedural texturing.

Procedural texturing is, by nature, resolution independent. At any point in the rendering pipeline, subtle or sweeping changes to the look can be easily dialed in. 3D noises liberate the texture from geometric UV space, eliminating the need for custom adjustments to the model's texture space. At Blue Sky, this allows modelers to build freely with Sub Divided surfaces, and alter models at any time in the process without affecting the materials. One of the biggest advantages to using procedural textures in feature film production is ease of reuse. A well designed texture can be applied to a variety of models -- automatically vary patterns based on the model shape -- and still leave room for an artist to tweak in carefully articulated differences. For instance, entire families of animals using the same material feature a huge variety of skin texture; every mechanical component of a robot, or robotic city, has a different color and age. This can free the materials artist from repetition, while giving them control of variation.

New Procedural Texturing Tools

The biggest challenge with procedural texturing is that it can be an abstract and highly technical process. Early on, it became obvious that we needed a set of tools that an artist could use intuitively, allowing them to concentrate on the look and feel of a material, instead of the underlying code.

The first step was to simplify the process of generating procedural textures. This typically involves an understanding of the C++ language, in addition to any programming eccentricities specific to a renderer. To sidestep this hurdle, the R&D group at Blue Sky modified the Hypershade interface in Autodesk Maya to use all of CGIStudio's proprietary noises and algorithms. This gave Materials Artists a simple visual interface through which they could create complex shader networks. Even the act of compiling the proprietary code was streamlined to a single button. Procedures created in the system could then used as a plug-in for CGIStudio.

Replacing the act of painting a texture, however, led us to create a suite of procedural textures for CGIStudio that could be described as "3D brushes". The primary implements are volumetric regions of influence. By using various shapes like spheres and cubes, 3D noises can be convoluted into any pattern desired, vague or detailed. Noises can be pushed and dodged into wrinkles, pores or oil streaks. For tricky spots, like the inside of a creature's mouth or the rooftops of buildings in a city, we developed a set of directional projection vectors that "spray" layers of texture from a single point or parallel sources. This technique reacts to the surface normals of geometry, and creates brush strokes with the ethereal quality of an airbrush. More tools were inspired by the natural phenomenon of edge wear and the accumulation of dirt in crevices; we developed a set of controls to guide textures along the surface contours of complex SubD geometry. Chipping paint off the corners of a mailbox or adding wrinkles to the armpit of a pachyderm is almost automatic. Unfortunately, as often as a texture benefits from detail in a model, it also creates undesired artifacts. But these can be blended away with other 3D brushes.

Finally, the patterns generated via these methods are used to layer materials, one on top of the other. The resulting texture can be dozens of layers deep, but render efficiently because only the layers visible per pixel are evaluated. Most recently, these techniques were ported to our proprietary voxel-based fur system. Not only were they used to set material properties for the fur, but an extension of the system was also used to grow and groom the fur itself.

The Result

Although our procedural texturing techniques have proven efficient and flexible, the biggest reward is the visual result. There's rarely a temptation to return to map painting.

An example of the procedural textures used by Blue Sky in the CG feature films Robots *and* Ice Age: The Meltdown.