

A Completely Procedural Approach to Materials (sketches_0143)

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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 pure 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 are 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 and decided to ignore long render times and embrace the advantages of procedural texturing.

Noise-based texturing provides resolution-independent layers of detail. At any time in the rendering pipeline, subtle or sweeping changes to the look can be easily dialed in. Using 3D noises also liberates the texture from geometric UV space, eliminating the need for custom adjustments to the texture space of a model. 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 reapplied to a huge variety of geometry, and allow for automatic or carefully articulated variation. An entire family of animals can use one material, but still feature a huge variety of skin texture and color. Every mechanical component of a robot, or a robotic city, can have a completely different color and age. This frees the materials artist from repetition.

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 could be used intuitively by an artist, allowing us 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. Typically in computer graphics, this involves an understanding of the C++ language, in addition to any programming eccentricities involved in writing code for a renderer. To overcome this, the R & D group at Blue Sky heavily modified the Hypershade interface in Alias' Maya, for use with all of CGIStudio's proprietary noises and algorithms. This gave the Materials Artists simple and visual access to a complicated set of

possibilities; even the act of compiling the proprietary code was streamlined to a single button. Procedures created in the system could then be 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 rooftop of every building in a city, we developed a set of directional projection vectors that allows for "spraying" layers of texture, from single point or parallel sources. This technique reacts to the surface normals of geometry, and can be as ethereal as an airbrush. Inspired by the natural phenomenon of edge wear and crevice accumulation, and taking advantage of complex SubD geometry, we developed a set of controls to guide textures based on the changes in the contours of a surface. Chipping paint off the corners of a mailbox or adding wrinkles to the armpit of a pachyderm becomes almost automatic. As often as the process benefits from detail in a model, it also creates undesired artifacts, but these can be blended away with other 3D brushes. These patterns are then used to layer materials, one on top of the other. The resulting textures can be dozens of layers deep, but render efficiency is maintained by evaluating only the layers visible per pixel. 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 these techniques have proven efficient and flexible, the most rewarding aspect of pursuing a completely procedural approach to texturing has been the visual result. There's rarely a temptation to go back to map painting.



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