

# Developing Joy for *Inside Out*

Alexis Angelidis, Jake Merrell, Bob Moyer, and Angelique Reisch  
Pixar Animation Studios

The main character of Pixar Animation Studio's *Inside Out* is Joy, a personification of the human emotion. The art and technical departments were tasked with realizing a complete abstract into an animatable character. Moreover, since Joy was a main character, she would be used in over 750 shots in a wide range of poses, situations, and lighting setups. She needed to feel like a magical effect, but work and react as dependably as a more traditional character.

These requirements led to a wide variety of strategies and technologies, including volume, illumination, geometric procedurals, and pipeline innovations. These combined into a single look platform that could give a geometric character the appearance of a glowing hologram made of sparkles. The success with this approach led to the other emotions, Fear, Sadness, Disgust, and Anger, being developed on the same pipeline. Joy and the other emotions are the result of a two-year collaboration between art, characters, lighting, effects, animation, and global technology.



Figure 1: Developing Joy for *Inside Out*. ©Disney / Pixar. All rights reserved.

## 1 A Volumetric Approach

To convey the feeling that Joy is made of energy, three volume elements were created: a halo, an edge of energy, and a transparent body. For her halo, we will discuss the methods that were tried, including compositing, various methods for generating scalar fields, and phase functions. Joy's edge of energy is technically similar to her halo. Her semi-transparent body was achieved by computing lighting on a surface and using an extrapolation technique at render time using Renderman's caching mechanism. We were able to preserve the facial detail present in the modeled surface geometry for extreme closeups while keeping volume storage memory low. We will also discuss the various maps used to control her volume shader for thin cheeks, motion blur, and 3D coherence.

## 2 Shading, Illumination, and Procedural Geometry

As a character, Joy was supposed to be emissive. How do you shade a light bulb such that it can be lit? Because the traditional approach of adding an emissive component to the standard shading was difficult to control and balance, especially in different lighting setups, we demonstrate an emissive component we developed that turns itself off in areas receiving strong light, but remains on in the dark, which enabled lighting to better balance the emissive and lit sides. As a bonus, this approach allowed us to better match the color targets in the artwork.

Ultimately, the rationale behind Joy was that she was actually made up of many, many particles, many so small that in aggregate she looked like a volume. We'll demonstrate dynamic opacity masks on the hard surfaces in her head that prevented those objects from appearing to float inside the volume. We'll further examine procedural points grown off the mesh, intended to compliment her volume shading. We'll explain how they were controlled and animated and look at the pitfalls associated with those points. Joy required additional, more dynamic points which were handled in the effects department. These points are the subject of an additional submission. We'll also examine Joy's hair, where we replaced the curves with points to better match the points on her skin.

## 3 Lighting

Having a main character who is a light source presented several interesting lighting challenges on *Inside Out*. We will discuss techniques for Joy's direct illumination, including a special light rig that allowed us to shape her primarily with hue instead of value. We will also discuss techniques for creating Joy's emissive light, including Renderman's new geometric area light. This light allowed her animated geometry to become the source of illumination. It provided us with beautiful realism as she walked through a scene and interacted with objects. It was also an elegant solution that was easy for lighters to set up and use. Joy's geometric area light was used in every sequence of the film as her primary source of illumination onto the sets and characters. This was one of the first major production uses of this technology.

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