It’s not easy being green
Hans Rijpkema*  
Gregory Steele†  
Matt Derksen‡  
Rhythm and Hues Studios

1. Introduction
A tight integration between rigging, animation and lighting is one of the essential components in making the Hulk and Abomination characters come to life for the movie "The Incredible Hulk". When the characters are animated the rigs allow for automatic generation and manual control of many lighting properties.

2. Design
Interactive design sessions with the director were used to home in to the final look of the Hulk and Abomination. Using reference materials from body builders which showed all their muscles and veins flexing and pumping, the Hulk became a very fit and trim character with zero percent body fat. A special feature of Abomination are the bones that are protruding through the skin.

3. Muscles
The body deformations of the characters are almost entirely based upon a muscle system which allows for automated and manually controlled muscle flexing. The animator controls the muscle firing and fake dynamics methods are used to simulate skin and muscle jiggle.

The facial deformations are also fully muscle based and are crucial in creating the effect of skin sliding over the distinctive jaw (mandible) and cheek (zygomatic) bones. Motion capture was used to verify that the rigs are capable of the full range of motion (from subtle to extreme) of the two actors playing the creatures’ human counterpart. The facial rigs can both be driven by motion capture and keyframe animation using the same controls.

4. Animated lighting properties
The rig produces animated lighting properties in the form of point attributes on the skin geometry. These are, amongst others, based upon skin compression and stretching. A robust subsurface technique that allows for mapping of many of its parameters, like scatter distance, refraction index, and tissue color, then uses these point attributes to drive for example the blending of color maps. This can be used, for example, to simulate the whitening of the knuckles on a clenched fist, the accumulation of blood and the appearance of subsurface veins when an arm is flexed.

The displacement maps are separated into a number of layers to independently and locally control muscle striation, vein detail and skin wrinkles. These again are driven by the point attributes and by key framed curves created by either character animators or technical animators. On top of that, a pulsing vein system to simulate blood pumping through the body can be controlled by the lighter, using animated 3D mattes and noise filters provided by the rigger. Another good example of how rigging and lighting are interconnected is the method used to create the effect of skin sliding over fine detailed bone, muscle and tissue structure underneath it. This is done by generating animated displacement maps from independently moving skin geometries at render time.

5. Conclusion
The tight integration between stages of the character pipeline which are traditionally much more independent is crucial in order to create a smooth work flow for complex characters with a great amount of skin and muscle detail.