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Special Assignment
EECS 487

<center>CGI and Pixar</center>

In my opinion, one of the most fascinating applications of computer graphics

technology has been its implementation in film. The convincing effects of Computer

Generated Imagery (CGI) created some of my earliest movie memories. The flawless

integration of photo-realistic dinosaurs in Jurassic Park (1993), and Tom Hanks' amazing

ping-pong playing in Forest Gump (1994) made it clear the CGI would be a powerful

force in film for quite some time. So much so, that in 1995, Pixar produced Toy Story,

the first completely computer generated film.

Pixar is one of the leading innovators of CGI technology. Much of the

technology and techniques used by their studio are particularly related to the discussions

and projects we have experienced in EECS 487 so far this semester. I will proceed by

talking about 3 of the major areas of development that go into the production of a Pixar

film: modeling, animation, and rendering.

Modeling

Before any work can proceed, animators must first have 3-D models of the

characters they wish to manipulate. This is either done by constructing clay models and

that are then scanned, or purely digitally. Usually, areas that require the most detail (such

as faces) are scanned from clay models for the most accuracy. There is, however, a large

difference between the models that we use in class and Pixar's models. Our models

usually exist in a file with coordinates specifying the location of different polygons.

Because Pixar's models are to be used at any angle with any at any level of detail, the flat

edges of polygons are unacceptable. Instead, their models are stored as computer

programs! All of their models (except for simple background objects) are procedurally

generated using splines that interpolate coordinates to make a truly smooth surface.

Finally, these models have different "avars," or joints defined. Unlike the dozen or so we

have for our blobby man, Toy Story's "Woody" has over 700, 100 of which are in his

face.

Animation

Animation is not done like one would expect either. Instead of animating in the

conventional way, frame by frame, Pixar has developed sophisticated software to allow

them to do procedural animation. This is slightly more advanced than programming a

ball that bounces off of a cylinder. Animators define key frames by manipulating the

avars, and then use software to procedurally generate all of the in-between frames. They

then go back through and make changes as needed to individual frames. Progress starts

more generally with the basic movements, such as walking, and the more advance

animation is later added, such as facial expressions and talking. While this process saves

a lot of time and work, the bottleneck in production is still the animation, which takes even longer than the rendering time.

Rendering

Rendering is done using Pixar's renderer called RenderMan, which is available to the public for purchase and download of a free evaluation copy. This software also has a very powerful C-like shading language built in. This shading language is used to create procedural shaders that are used extremely heavily throughout the film. RenderMan is fully equipped, capable of rendering digital lights, bump mapping, motion blur, depth of field effects. RenderMan can even perform ray tracing. In general, however, ray tracing is not used much, thus shadows are "faked" and manipulated independent of light sources. This works without too many problems if you are attentive to detail. However, a close inspection has revealed a few negligible errors, such as highlights on Mr. Potato Head's ears when then should be in a shadow. Each frame is rendered using RenderMan in approximately 4 hours, but some can take as long as 13 hours to complete, depending upon its complexity.

As you can see, there is a large overlap between the techniques peformed at Pixar and those that we are learning in 487. Pixar continues to be a leader in the development of CGI technology, and a staple to the computer graphics community. They even used the model of the famous Utah Teapot in Toy Story for the scene with Buzz at Sid's

sister's tea party. All this to show that all of the hours we spend in the lab writing

animating men made of oblong spheres is not entirely in vain. These techniques are

actually very powerful, and can be used to create some very memorable and entertaining

films.
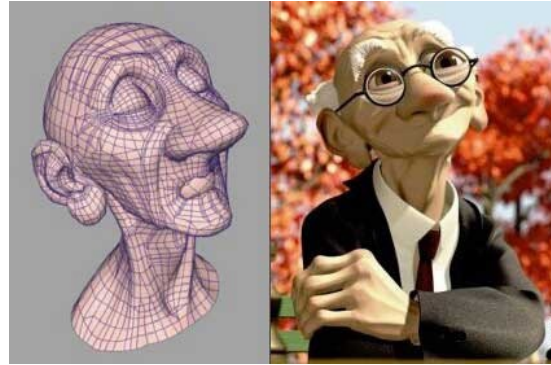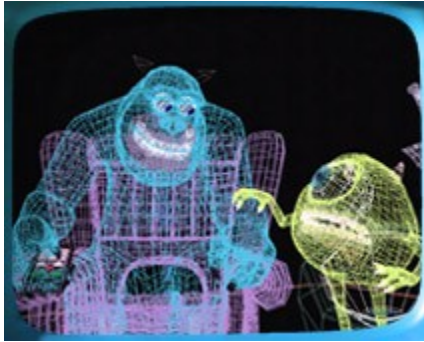
Wireframes of Monsters Inc., before
procedural spline modeling.

A progression – the middle layer is the model which is animated.
Afterwards, shaders are applied to produce lighting and other fancy
effects. such as fur.

An example of some of the powerful techniques Pixar's RenderMan can produce. Complicated backgrounds like this one are usually not modeled, but instead painted and just inserted as a background image.

References:

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http://en.wikipedia.org/wiki/Computer-generated_imagery
http://en.wikipedia.org/wiki/Toy_story