Let There Be Hair

Thomas V. Thompson II
Walt Disney Animation Studios*

Sean Jenkins
Walt Disney Animation Studios

Chuck Tappan
Walt Disney Animation Studios

1 Introduction

The trademark look of Rapunzel in Disney's Tangled presented unique challenges in grooming, animation, rendering, and pipeline management. Her hair was highly art directed and seventy feet long. The length of the hair, the amount of screen space it occupied, and the role it played within the film necessitated advanced planning in order to treat it very much as if it were a character. This talk discusses the original hair roadmap and changes required during production.

2 Roadmap

On previous shows hair development was primarily focused on the look of the character with animation as a secondary concern. For this show, animation would take the lead.

The main concept was to have a hierarchy of curves that could drive the final hair. At the highest level, grooming curves would be uniformly distributed across the head. The simulation department would pick a subset of these curves to meet their needs. Animation could grab a subset of the simulation curves to hand animate if necessary.

The system would interpolate the curves from one level to produce the curves at the higher level. We would also allow simulation to layer on top of the animation results before interpolating. This would give us an extreme amount of flexibility and utilize a code base of interpolation with which we have had a lot of success.

Secondary to the hair growing from the characters head would be the use of prop hair. This would be hair grown from off stage that could be posed, dressed, and animated separately from the character. Chopping back the character's hair would improve iteration time as you work with the different portions in turn, rendering each separately and compositing results.

3 Off Road

Once production started it did not take long before problems with the roadmap surfaced. The first problem was that the art directors wanted very specific looks. For example, animation supervisor Glen Keane gave dozens of draw overs for the little swoop over Rapunzels forehead alone. This high level of art direction forced a shift in the grooming approach. It became obvious that we were better off parceling out the grooming curves where we needed them, strategically placing them in exact locations.

This didn't lend itself to stepping down to a lower density of curves for simulation and animation where a uniform distribution is still required. Further, we found that we really didn't need, or want, the flexibility of changing the number of simulation curves per shot. It was actually more advantageous to have a fixed set that permitted our artists to gain an intuition on expected results with a known simulation run-time. These two things allowed us to better plan out the time required for each shot based story boards.

*e-mail: [tom.thompson,sean.jenkins,chuck.tappan]@disney.com

Figure 1: *Rapunzel's groom in action with interaction.*

The disparity of curve distributions between grooming, simulation, and animation precluded using our original interpolation approach. Instead, we developed a motion mapper to drive the motion from one level up onto the next. This mapping would preserve the shape at the higher level but also spread the motion to neighboring curves. Given the high degree of art direction, this approach was vital as it preserved shape better without washing away any of the groom.

One major late addition was art directable breaking of the hair. Our grooming package, XGen, could add clumping, noise, and wave but the directors wanted the interpolation to break along the length during animation. Our simulation would track breaking distances on the curves and transfer it to the groom. The artists could paint directly on the simulation curves if necessary to match draw overs done by the directors or animators.

4 Cleanup

The interpolation of the guides had to be very precise within XGen for two reasons: groom and animation (Figure 1). The grooms were highly art directed but it was perhaps more important that the interpolation be exact for animation. The hair was held, brushed, dragged, and in general there was a lot more interaction than has been seen in previous films. To get things exactly right the artists could edit the curves at any level using a suite of tools. Ideally, they would edit the simulation curves since there were many fewer but one could edit the groom curves as well (173 vs 1006 for Rapunzel). Since the grooming curves lined up with higher level clumps, this was usually sufficient to reach the final look. If not, the artist could either cull problem hairs or add on a render-time collision module in XGen to resolve collision in the final hair.

5 Conclusions

Early on we decided not to ask for any story changes to cover for technological short coming. We would set the bar high and reach that height at all costs. Doing this inspired the teams and led to break-throughs in multiple areas. In addition, while planning up front was important and got us all on track, it was equally important to remain flexible to new ideas and approaches since the final solution changed with the shifting needs of production.

SIGGRAPH 2011, Vancouver, British Columbia, Canada, August 7 – 11, 2011.
ISBN 978-1-4503-0921-9/11/0008