Hairy Effects in *Trolls*

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Figure 1: Examples of the various unique and challenging hairy effects from the film *Trolls*.

ABSTRACT

Hair plays a feature role in the film *Trolls*. It is a crucial part of the overall character design of the *Trolls* themselves, typically composing over half the silhouette of the character. However, the use of hair on the show went well beyond the standard coif and bled into acting beats, traditional effects, environments, and set pieces. This talk presents the wide variety of unique and challenging hair effects in the film and the techniques used to create them.

CCS CONCEPTS

•Computing methodologies →Animation;

KEYWORDS

hair, effects, growth, shapes, interpolation

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1 INTRODUCTION

In the film *Trolls*, hair was an extension of the *Trolls* characters themselves. Story and animation dictated that their hair could extend at will, morph into any shape, split into various offshoots, work in unison, or even join together as one continuous strand. Additionally everything in the *Troll* world is composed of tangible, palpable materials, often times characterized as felt or woolly. Traditional effects such as fire and destruction were re-imagined with a 'hair' look to fit into such a world.

The technical and artistic challenges of a hair focused film were achieved by a flexible and extensible toolset centered around *DreamWorks Animation's* proprietary hair generation library *Willow*, primarily integrated in a third-party procedural software package. This allowed multiple departments, specifically *Character Effects* and *Effects*, to capitalize on a unified pipeline and toolset to efficiently produce unique effects.

2 ACTING HAIR

Throughout the film, *Trolls* will use their hair as an appendage, or as a whip, or as choreography elements to their music numbers. All of these required close collaboration between the *Animation* and *Character Effects* teams. *Character Effects* was responsible for all character hairstyles across the pipeline, from model creation, to rigging, to final motion. This approach allowed us to make efficient production decisions regarding the hair throughout the process. Robust hair rigs were built for *Animation* that allowed posing and shape control to achieve most acting beats prior to handoff to *Character Effects* for final posing, simulation, and style manipulation. For more complex shots, *Animation* would provide *Character Effects* with draw-overs for the acting beats and *Character Effects* would use a broader toolkit that includes screen space draw tools, procedural volumetric hair growth based on a modeled input surface, CV locking tools, and animated render time stylers, to achieve the desired effect.

The *Trolls* characters' hair rigs were built with a modified version of the spline IK system. These rigs are generally used for tails and ropes. For the characters that used their hair for a specific type of performance, the rig consisted of 3 primary IK controls and 10 secondary IK controls with translation and rotation functionality. They also had keyable attributes for the region of influence along the curve and the ability to specify their parametric location. In order to adjust the size of the cross-section of the hair, the rigs also had scale controls with a cage-based surface deformer for even more fine tuning of the silhouette. Since detailed control over the exact hair shapes was crucial, many effects also relied on the sharing of per-shot rigging techniques and keyframed animation.

For a shot such as the hair stairs, *Character Effects* was able to draw a per frame input curve over *Animation's* drawings while looking through the shot's camera. This input curve drove the overall hair deformation through a proprietary curve binding algorithm. As *Poppy's* hair is retracted back into its original shape, both the root and tip ends of the hair needed to be locked in place and a contraction mechanism was developed so that CV's in the middle of

the hair could be fed back towards the root without affecting the tip CV's. Finally, R&D added custom *Kink* styler controls to *Willow* in order to allow noise space manipulation so that the overall render time styling would be locked.

For choreographed shots where *Trolls* grow their hair into art-directed shapes, a hair shaping tool was built that can grow hair volumetrically through a convex NURBS tube. The guide curves' root points and the base CVs of the tube are projected onto a plane. A root point is then parametrically registered by casting a ray from the center of tube base to that root point until it hits the tube's circumference. A guide hair starting from the scalp root point is grown throughout the volume of the tube using this registration.

By centralizing both asset creation and final hair delivery in one department, we were able to make efficient decisions about the needs and toolset across multiple departments with the final motion in mind.

3 HAIR HIDEOUTS

An ongoing gag is the *Trollbaby*, *Keith*, hiding inside other *Trolls'* hair. Effects such as these require heavy manipulation of not only the guide curves, but more importantly the render hairs themselves, to ensure these hairs interpolate correctly for a clean opening and are free of interpenetrations with collision geometry. This required a solution that handled not only collisions with secondary geometry, but also art-directed splitting regardless of collision.

Our hair pipeline allowed us to efficiently process data from our guide curves to pass to *Willow*, where a customized *Collision* styler [Somasundaram 2015] that provided multiple artist controls for driving render time interpolation breaking was applied. These included external breaking control, render time distance based control, and render time collision based control. Coupled with our real-time preview, artists art-direct the character interaction with the fully styled hair, including collision clean-up, all without expensive renders.

4 HAIR TRANSITIONS

At two unique moments, we see multiple *Trolls* combine their hair to form *Bridget's* rainbow wig. Amplifying the challenge was the fact that these transitions were in frame with a nearly locked camera.

For the transition from rainbow wig to *Troll* hair, we divided the rainbow wig (by default, an asset that is part of the *Bridget* character in our pipeline) and split it into eight partitions, one for each *Troll*. Because *Willow* encapsulates the full hair asset in a single cache file, we were able to seamlessly break the asset pieces that could be transferred to each Troll, all while maintaining the style and shape of the full asset. Because we could create and manage assets at the shot level so easily with *Willow*, we were able to focus more on the artistic challenges of how *Bridget's* wig should contract and transition to reveal the underlying *Trolls*.

In the reverse transition, nicknamed the *Hairnado*, the challenge was to seamlessly animate from 8 individual hairstyles to *Bridget's* rainbow wig while forming a tornado in the process. We used the final rainbow wig as the base of our animation and layered procedural animation on top. Because the original stylers were untouched, the wig hairstyle would re-appear automatically as the guide curves were animated back to their default. In practice, we worked with a couple thousand guide curves and then baked the full hair (≈220k curves). The 8 troll hairstyles were then reconstructed for each frame based on the fully baked hair.

Hair camouflage is another recurrent type of transition: a pony-tail morphs into a torch, hair transforms into a leaf, etc. Because we had full access to all components of a hairstyle within the simulation software, we could initiate the transition by simply ramping down the original stylers while blending in target hair shapes. Target hair shapes such as a leaf or rock were generated using procedural techniques that slid guide curves down the UV space of the original leaf or rock models. Finally, R&D added render-time UV look-up to *Willow*. This allowed us to transfer texture maps from a proxy model to the camouflage hair. This feature was also used to texture the *Painter Troll's* hair.

5 HAIR EXTENSIONS

To blend in with the tactile feel of the production design of the film, traditional effects such as fire or destruction were intentionally stylized with 'hair' and other 'fibrous' elements.

Fire appears in a variety of forms in the film: from a camp fire to a plant that turns itself into a flamethrower. While the animation style varies between these, we consistently rendered them as hair. This artistic choice helped anchor the effect in the tactile environment while giving it a unique yet easily recognizable style. Shots were animated using a mix of procedural techniques and simulations. In the most active cases, the hair curves were generated through a gas simulation while sampling the temperature channel for shading purposes. We found the cross product of the gradient and curl of the density field to be stable and used it to trace our hair strands. Finally, embers took the form of little burnt hairs.

Most destruction in the film is shot at the height of the *Trolls*. At that scale, the felt on surfaces is clearly visible. After some experimentation we chose to model dust with fiber puffs, mimicking fibers being scraped off the surface of objects when impacted.

In one sequence, parts of an underground tunnel collapse when the *Bergens* start digging with picks and shovels. Again, we had to rethink the visual elements to create an effect that fits our world. Instead of collapsing and breaking, the tunnel surface bends and tears like a sack (*FEM* solver), maintaining the fabric quality of the environment. Similarly, chunks of dirt become hair balls (*Bullet RBD* solver) that pour out of the tears in the walls and ceiling. The effect is ultimately rendered using a procedural shader to add the hair look at render-time.

6 CONCLUSION

Hair is a prominent element throughout *Trolls*. It is featured in over 1500 shots. As a production design element, it is *the* recognizable feature of the *Trolls* and it unifies traditional effects elements with the tactile world they live in. As a story element, it prompts *Bridget's* transformation to *Lady Glittersparkles* and allows the *Trolls* to interact with their world in imaginative new ways. Our unified hair pipeline, centered around *Willow*, allowed us to streamline our toolset to provide artists across multiple departments full access to all components of the hairstyle. Further, this technology could be exploited for non-traditional hair assets, such as fire.

REFERENCES

Arunachalam Somasundaram. 2015. Dynamically Controlling Hair Interpolation. In *ACM SIGGRAPH 2015 Talks (SIGGRAPH '15)*. ACM, New York, NY, USA, Article 36, 1 pages. DOI: http://dx.doi.org/10.1145/2775280.2792541