Taming the Beast: Fur on an Abominable Snowman

Damon Riesberg
DreamWorks Animation

Eric Warren
DreamWorks Animation

Arunachalam Somasundaram
DreamWorks Animation

Figure 1: Example *Everest* fur shots in *Abominable* showing contact, wind, magic, anger, and silhouette shapes.

ABSTRACT

Everest from *Abominable* is a main character with fur, he doesn't talk, and is in over 650 shots. His huge size, abundance of fur, the fur's emotional response, wide range of biped, quadraped and rolling motions, magical abilities, along with interactive characters, windy environments, and stylized shapes created by *Animators*, produced numerous challenges to his fur grooming and motion. This talk presents the various techniques used to tame those challenges encountered on that fantastic fluffy snow-white fur-covered beast.

CCS CONCEPTS

• **Computing methodologies** → **Shape modeling**; **Physical simulation**; **Procedural animation**; **Collision detection**.

KEYWORDS

fur, hair, grooming, motion, simulation, collision, wind, effects

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1 INTRODUCTION

Given that *Everest* does not speak, much of his expression came from his body covered with fur. *Everest* explored the world as a playful dog would, and he had a wide range of biped and quadraped motion including rolling up as a ball. Stylized graphic shapes were required by the *Animators* and that increased body mesh self interpenetrations because of *Everest's* huge size, causing issues with fur simulation if left unattended to. The other characters of the *Abominable* film interacted with the soft fur of *Everest* including patting, hugging, sitting on, sleeping on, and hiding the fur which produced challenging scenarios. The wide variety of environments, high-rise chase sequences and adventures, and subtle emotional scenes, required art-directable wind. Uniquely, *Everest* could produce magic. The expression of magic and other emotions, such as anger, needed to be reflected in his fur motion. Given the complexities of *Everest* fur, grooming with motion iterations was employed.

2 GROOMING

Everest was groomed using DreamWorks' proprietary hair generation library *Willow*. The grooming was performed in parallel with his simulation setup. Clumps, shapes, and individual hairs were moved, adjusted and balanced by hand based on multiple performance animations to hit the final look, and final render and simulation times. The artist could view the final render curves in motion in the 3-D viewport with hair shading and shadows using *Willow* which sped up the iteration loop. This symbiotic relationship between grooming and simulation setup optimized the groom for both motion and look, and greatly helped shot work. *Everest* has 1.2 million render hairs for his body driven by about 4000 guide

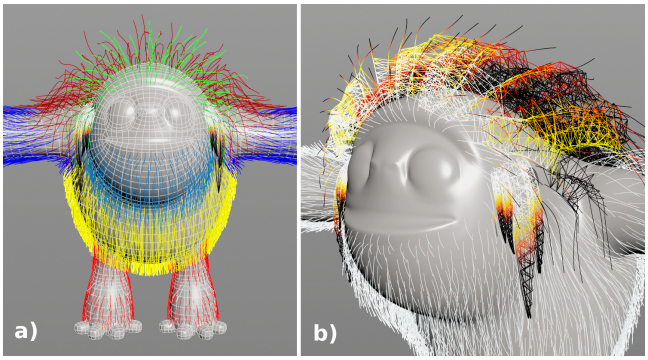

Figure 2: a) Multiple hair solver groups colored. b) Distance based hair-to-hair constraint network for longer fur.

hairs. In addition, he also has separate short fur groups on his face and palms of his hands that are rigidly attached to the skin.

3 MOTION

As a primary character featured in over 650 shots, a variety of approaches needed to be created to hit the artistic requirements. *Everest* needed to maintain a round silhouette at most times, with slight breakaways from the primary shape. The hair needed to feel soft and cuddly, but not distracting to the story.

3.1 Simulation

There were two simulation setups with different controls for different artists. A broad and stable control setup was used by *Animators* that consisted of limited posing controls and a Control Vertex simulation with no collisions for basic approvals. A more detailed simulation setup consisting of about 4000 guide hairs and using DreamWorks' proprietary hair solver *Whip* [Gornowicz and Borac 2015] was used by the *Character Effects (CFX)* artists. *Everest's* groom was also broken into multiple solvers (such as body, back, limbs, and sideburns) [Figure 2] for speed, flexibility, individual control, and the added feature of not having the hairs self collide with the other solvers to avoid distraction. Distance based hair-to-hair constraints [Figure 2] were built to maintain longer clump shapes. Pre-simulation workflows were built to manipulate *Whip's* attributes through randomization to create an organic behavioral variation while still keeping the styling intact. Also, smart controls were used to facilitate communication between the *Animators* and the *CFX* artists that would highlight animation curves and controls that were specifically keyed. These artistically driven animated curves could be blended and fed into *Whip* as animated rest curves or pose curves to dynamically achieve these shapes in simulation.

Abominable being an animated (non-photorealistic) film had both its pros and cons. *Animators* had the flexibility to push the rig beyond the original intent to achieve stronger silhouettes. In the process of doing so, they would often keyframe large interpenetrations of the limbs and body either on or off screen. In order to deal with these interpenetrations, a pre-simulation pass of the skin was run using a custom *MeshSelfCollide* node to automatically correct self interpenetrations. When needed, *Everest's* skin was also sculpted to accomodate the hair dynamics performance requirements. The input guide curves would then be root attached rigidly to this new skin and fed to simulation.

A hair simulation template, which can be used to auto create a setup with default parameters based on artist specified input data, was first developed during the setup of *Everest* fur. This facilitated consistent and quick hair setups across characters in the film.

3.2 Wind

Wind played a prominent role in the film. Characters were often traveling in various windy environments, and also running from various chasers such as helicopters. Uniquely, *Everest* was a magical character and would emit a current of wind when he was using his magic. Wind also helped set the mood of subtler scenes. In order to produce fast art-directable wind, *CFX* artists used post simulation custom procedural wind nodes. While the procedural methods avoided a full hair simulation, they provided time independent artist-friendly controls for different noise patterns, wind gusts, wind shielding, and collisions. For magic wind, an alternative wind solution was used that drove the *Whip* simulation using multiple wind velocity fields to achieve the final look.

3.3 Post simulation

There were a number of post simulation techniques employed by the *CFX* artists to achieve the final look including blendshapes to either the solely posed *Animation* pass or a simple simulation from the *Animation* department. Custom temporal jitter filters that do not remove global motion while filtering jitters in simulation, along with position-freezing techniques were used to limit excess motion to avoid distraction. A custom curve puff node was used to produce fur-raising angry effects. An original goal of *Everest* was to feel soft, and character interaction was encouraged, which led to many shots with characters touching the fur. A *Contract Styler* in *Willow* was used to contract any needed set of render hairs along its length, for example, render curves under a bandage could remain shrunk. A *Replace Position Styler* was built that could replace any set of final render curves in *Willow* over any shot frame range with a new set deformed curves specified by the artist. This allowed an additional powerful layer of hi-fidelity deformation control of final render curves that could be used if a difficult shot demanded it. Precise finaling collisions on these final render curves which can range in count from thousands to tens-of-thousands was performed by FurCollide [Somasundaram 2017] as needed.

4 CONCLUSION AND RESULTS

Grooming in parallel along with the simulation setup unified *Everest* fur's look with its motion and significantly reduced the problems during shot work. Dynamic simulation (including *Animation's* input as needed), procedural art-directable wind, post-simulation techniques, and render hair styler manipulations were all used to tame the beast's fur in over 650 shots. These techniques brought the magnificient character and his fur to life, as can be seen in the rich amount of varied shots in the film, making him a lovable character.

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