Fluid Fabrics in Trolls World Tour

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Figure 1: Fluid Fabric Shots.Left: Organza River;Center:Tinsel Falls;Right:Silk Lava

ABSTRACT

We outline the development of natural effects like waterfalls, rivers and lava to the small scale world represented in *Trolls World Tour*. Creating natural effects in a world made of various fabrics brought new challenges in representing movement and scale. We examine our problem solving methods and how we blended fluid motion with cloth/fabric motion to achieve the desired effect.

CCS CONCEPTS

• **Computing Methodologies Computer Graphics Animation Physical Simulation**; • **Computing Methodologies Computer Graphics Animation Procedural Animation**;

KEYWORDS

Cloth, fabric, organza, tinsel, lava, textile, natural

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1 ORGANZA RIVER

A river of organza fabric served to tie many scenes throughout the film as a means of transportation for a raft. It needed to appear as a stationary sheet of organza while suggesting the motions of a river and take on the manners of both as it interacts with characters and the environment.

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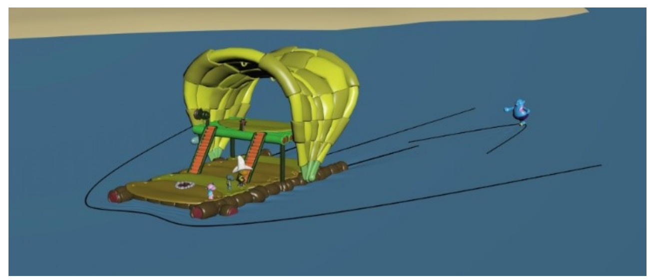

Figure 2: Organza River deformation curves.

Fabric simulations for the river were initially developed using a stationary patch of geometry and injecting velocities from animated assets. The simulations appeared unique and appropriate from a distance but were difficult to art direct for cameras close to the river. For example, folds of fabric around a raft would irregularly build and then quickly diminish. These irregular deformations distracted viewers from the characters and often coalesced into larger, unwieldy deformations.

Instead of simulations, we applied procedural deformers over the entire river and around any interacting geometries. For some general motion, a noise deformer was applied to the entire river wherever there wasn't interaction with characters or the environment. Interaction with characters was achieved by parenting curve shapes to them and using their curves' proximity to the water via custom deformation methods to shape the river around them. For example, a curve on the front of the raft used sinusoidal and noise functions to create a consistent water ripple that also folded like cloth. Additional curves helped create the raft's wake on the sides and back and to create the feeling of buckling fabric around the raft's side. Each curve could be adjusted for timing, position, intensity, and other artistic notes.

Interaction with non-animated geometry was achieved through similar deformation curves based on the intersection boundary of the river and the static environment.

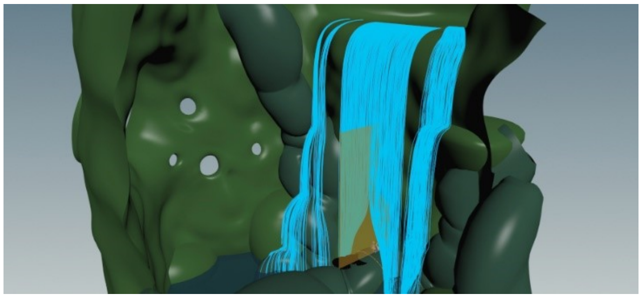

Figure 3: Tinsel Falls Track Lines.

2 ORGANZA UNDERWATER

Organza is also used for the stage in an underwater musical dance after a character is pulled through the river's surface. The primary transition during the pull-through is a simulation using a spiral force and injecting the character's local velocities into the fabric. This was quickly transitioned to multiple layers of organza which need to move with the characters and suggest the refraction of light underwater. The layers of fabric were held in place with a weak constraint force to their initial position. The character's velocities were then projected in screen space to the fabric layers and injected into the fabric simulation. The constraint forces and the character velocities were balanced to allow the fabric to overlap itself but not create too much distraction from the characters.

3 TINSEL FALLS

We wanted strips of plastic tinsel gently falling down as a waterfall, bouncing and flowing around the environment before pooling up into the water. Each strip needed to accurately collide with each other and the environment but couldn't appear too chaotic or collide with the characters.

The tinsel falls were first split between left, center, and right individual waterfalls. Each waterfall has a simulated track to drive its pathing and motion. The track is partially influenced by drawing vector directions on the environment to influence where it bounces. A low frequency noise is applied afterward to give some subtle overall waterfall motion.

Each waterfall simulation starts by pre-allocating the entire simulation's tinsel strips of various lengths and widths. Each strip is assigned a track to follow and align to, a time to start, and a speed. The procedurally-animated strips act as target constraints for the actual simulated geometry, which are allowed to collide with each other and the environment. Animating the waterfall opening and closing was achieved by simply deforming the tracks used to drive the procedural animation. When a simulated strip is near the water pool surface, its target constraint is weakened to allow it to collapse into a pile on the water. These constraints, moving much slower than they would in real-life, helped depict a tranquil flow of tinsel.

4 SILK LAVA

Lava in the third act would mimic the material properties of silk but still had to register as lava. For this to work we didn't want the lava-silk to harden or cool but rather maintain more of a flowing cloth like movement while still maintaining some viscosity and flow nature of world scale lava. We tended to lean more towards the properties of silk given its small scale familiarity to us in the real world and it's less threatening nature as opposed to real lava.

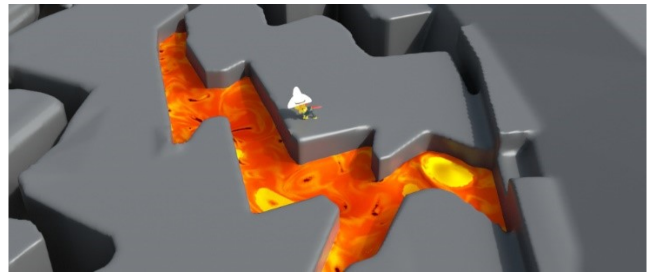

Figure 4: Silk Lava Cloth.

We started with a traditional FLIP fluid simulation to drive the flow. Then a rest mesh that would be the lava silk surface was extracted at the top edge of the FLIP simulation. Curves were then extracted from the fluid data by tracing the fluid back in time by a fixed number of steps on a subset of simulated points. Several forces were derived from these curves, among them a force along the curve's tangent and another force perpendicular to the curve's tangent. Only driving the cloth with a tangential force created too much of a pulling effect, the perpendicular force in combination created the effect of air blowing up at the cloth surface while moving along the flow direction. Curves allowed us to have greater control over the forces that were generated and the resulting influence on the cloth.

Lava interaction was mostly achieved by introducing event-based triggers where pieces of cloth would be tossed into the air and solved with a cloth-like solver. Finer cloth bits, fibers and confetti took more influence from fluid simulations. Based on our physical reference shoots, we thought of these as if we were shooting cloth bits with some type of air cannon rather than traditional lava splashes. Temperature was used to drive tearing in some cases, however, there was no sense of stiffness added to the lava pieces as they cooled. Any landing pieces would be treated as an additional layers of cloth on top of the base lava silk surface with a slight gap added.

5 CONCLUSION

The large-scale natural fluid effects told through small-scale fabrics required a balance of determining which features depict both at the same time and then developing methods to create them. There was an initial desire to create a true-to-life accurate simulation of fabrics or the natural effect, but their perception and performance required alternate methods, such as procedural animation or layering simulations to achieve a desired result.