Moana: Foundation of a Lava Monster

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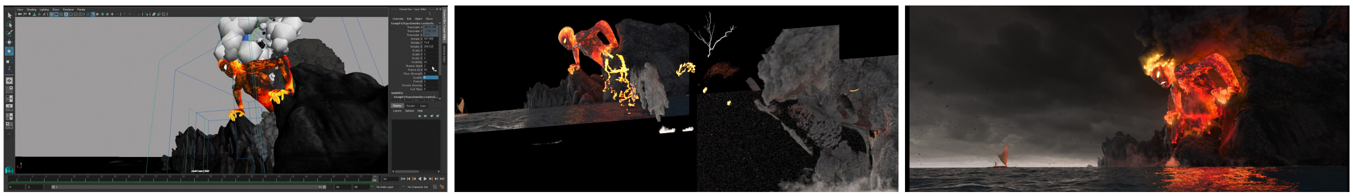

Figure 1: Taking Te Kā from layout (left) through effects (middle) to final render (right).

ABSTRACT

For Disney's *Moana*, the challenges presented by our story's fiery foe, Te Kā, required cross-departmental collaboration and the creation of new pipeline technology. From raging fires and erupting molten lava to churning pyroclastic plumes of steam and smoke, Te Kā was comprised of a large number of layered environmental elements. Effects artists composed heavily art-directed simulations alongside reusable effects assets. This hybrid approach allowed artists to quickly block in and visualize large portions of their shot prior to simulation or rendering. This *Foundation Effects* (or FFX) workflow became a core strategy for delivering Te Kā's complex effects across multiple sequences.

CCS CONCEPTS

•**Computing methodologies** →**Physical simulation;** *Animation; Rendering;*

KEYWORDS

FX, effects, layout, pyro, lava, volcano

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1 THE ORIGINS OF TE KĀ

Te Kā evolved during the years of pre-production. Lava was an integral part of her initial character design, so we spent a great deal of time researching the different magma compositions and resulting lava flows of volcanoes. Early tests focused on replicating the different types of lava (e.g., pāhoehoe, a'a and pillow lava), as well as the interaction of water with lava. Her design eventually evolved into the more pyroclastic look seen in the film.

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Bringing Te Kā to life required new approaches to allow our front-end departments to visualize large scale pyroclastics and other effects. On past shows, effects artists were integrated into layout and animation. Artwork produced from this collaboration was referred to as *tempFx* and was not expected to be passed downstream beyond the layout stage. For *Moana*, this idea evolved into a reusable FFX asset library. Production took a leap of faith and devoted early artistic resources and director approvals to create the library prior to the start of shot work. Once the initial design for an asset was established, variants of each effect could easily be added to the library. This library allowed artists to quickly search for appropriate shot assets by name or animated thumbnail.

2 SUMMONING THE LAVA MONSTER

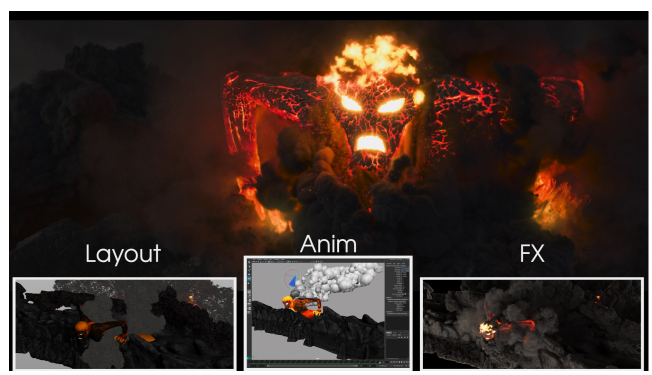

Figure 2: Example breakdown of Te Kā.

The Layout Department kicked off a Te Kā shot (Fig. 1) by staging assets from the FFX library to compose and retime the smoke plumes surrounding her. The character animator could then finesse Te Kā's performance against these plumes. They also controlled the smoke streaming from her body using a simplified Houdini Engine rig. This gave them an effective way to communicate their intent for the shot: wind direction, speed, size, and overall level of activity. Additionally, it flagged potential problems. If Te Kā backed up into her smoke, the Effects Department could anticipate this complexity and plan accordingly.

The FFX library was also used by effects artists, providing a set of flexible building blocks which they could layer and transform

Figure 3: Example set dress (left) and final renders (right).

in creative and unexpected ways. Smoke plumes could be rotated sideways to act as flows, or translated and scaled to achieve the desired sense of motion. Fast iteration on set dressing (Fig. 2) allowed the directors to give early feedback, and approved set dressing could be easily shared among artists and sequences using asset bundles.

In parallel to set dressing, the effects animator kicked off the Te Kā hero rig. This rig was composed of a modular set of automated rigs for pyro, lava, fire, and heat distortion. When invoked, the user's shot area was initialized with the default set of Houdini rigs and elements, which would automatically simulate and render an initial rough pass. In addition to providing the elemental characteristics of Te Kā, these hero elements also grounded her to the surrounding FFX.

Te Kā was almost 300 feet tall, but needed to move quickly in order to hit the performance notes given by the directors. Wrangling the pyroclastic simulations to react in a believable way was always a challenge. Artists experimented with creative methods to manipulate these simulations. A combination of flow fields, modified collision properties, and layered simulations provided good results most of the time. Pyroclastic smoke lent itself well to layering, and we relied on this heavily to seamlessly blend our FFX assets to the foreground hero simulations.

3 FOUNDATION FX RIGS

Historically, creating *tempFX* assets was tedious and involved a significant amount of back-and-forth between Maya and Houdini. To streamline the process, we integrated our character riggers' procedural rig-building system, dRig [Smith et al. 2012]. The FFX pipeline invoked this system via a custom Houdini ROP to give us a semi-automated way to create Maya rigs from within Houdini. This significantly cut down the time spent on creating Maya rigs, allowing us to quickly iterate on the quality of the desired effect rather than on the technical aspects of creating pipeline-compliant rigs.

To address the competing priorities of interactive playback and render fidelity, the rigs incorporated proxy representations. We generated proxy particle systems from the high-resolution source simulation data, and our real-time renderer Nitro [Lin et al. 2015] was upgraded to provide advanced point lighting. This allowed us to view our assets as lightweight, GPU-friendly, decimatable particle systems. Normals, opacity, velocity and temperature were leveraged to provide a clear picture of the light response and motion of an asset (Fig. 3). Equipped with both proxy and high-resolution representations, these rigs could travel through the entire shot production pipeline without ever being touched by the Effects Department.

A simple Maya control interface was procedurally generated for each element to provide channels for speed multipliers, point widths, emissive and diffuse colors, filter percentages, and time offsets. By strategically structuring our rig procedurals, artists could drive each of these dynamic and visual attributes through a single Maya channel that affected both the proxy and high-resolution representations.

4 CONCLUSION

Te Kā was featured in over 100 shots. It was therefore imperative for us to develop tools and techniques to manage her complexity. To this end, Te Kā was constructed as a balanced aggregate of dozens of repositioned FFX assets, reshaped baked volumes, and hero simulations. Our FFX pipeline gave us what we needed to deliver Te Kā and more.

Outside of the Te Kā sequences, we deployed roughly 3,000 FFX instances of splashes, debris, waves, blowholes, steam, torches, and waterfalls. Our open ocean and shoreline Maya rigs [Garcia et al. 2016] were also built using parts of the FFX pipeline. Without this library of reusable FFX assets, it would have been difficult to finish *Moana*.

Our final FFX disk footprint was 35 TB, and by not having to resimulate the FFX assets for each shot, we projected a disk space saving of over 1.6 PB. Since most of our FFX assets were created prior to shot work, we also saved on countless artist-hours. In some cases, all of the onscreen effects were created long before the shot was put into production.

Our FFX pipeline also has long-term benefits. With the resultant dRig node graphs giving us recipes for rebuilding these rigs, we can ensure compatibility with future releases of Maya. By continuing development efforts on our FFX pipeline, we can integrate unit testing, regression testing, and asset turntables, further enhancing our ability to reuse these rigs in future productions.

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