Moana: Performing Water

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Figure 1: Small scale interactions (left), Simulation Activation (middle) Walls of water (right)

ABSTRACT

For Disney's *Moana*, water was a dominant part of island life, in fact it had a life of itfis own. Presenting itself as a character, water was ever present, in a multitude of shapes and scales. An end-to-end water pipeline was developed for this film [Garcia et al. 2016], including the creation of proprietary fluid APIC solver [Jiang et al. 2015] named Splash. This gave us physically accurate simulations. The challenge with performing water was to provide art-directed simulations, defying physics, yet remaining in a grounded sense of possibility. Incorporating natural swells and flows to support the building of designed shapes limited anthropomorphic features, and played to our goal of communicating that this character is the ocean as a whole.

CCS CONCEPTS

•**Computing methodologies** →**Physical simulation;** *Procedural animation;*

KEYWORDS

fx, effects, water, fluid, character

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1 COLLABORATION

We treated the water character as any other character in the pipeline, with rigging providing a base framework for the layout and animation departments. Effects added flow curves, and a pre-baked low resolution simulation to accompany the rig for visualization purposes. The consistent base mesh and flow curve inclusion ensured that the data received farther downstream was easy to abstract for effects treatments. The Layout Department sculpted the shapes to hit compositional goals. The Animation and Effects departments worked in collaboration to determine character performance. In particular working together to identify how much movement was to be done in animation, prior to effects simulations and treatments being added. Providing broad stroke movements, and establishing timing, Animation played a key role in making sure the foundation of the character worked for the shot direction, and the Effects Department.

It was key to collaborate with the Animation Department in identifying the strategy for each shot, and understanding who would be adding what in order to plus the performance.

2 APPROACH

Initial development led to the creation of a single workflow, built around the upstream rig. Demands for performance water within the film became more prevalent, with additional behaviours, narratives, and emotional states desired. This lead to the primary workflow becoming the foundational bookends of a process that adapted to be far more modular. Having consistent data from upstream allowed for this modularity to work, and for the designing of additional procedural workflows that could plug into the main system. Each component was an open workflow, giving artists a basis for bespoke refinements. Shots could be treated as one-offs, yet derivatives of a common core network. A combination of simulations, and procedural deformations were assembled to author the core effects deliverables.

3 WATER AS A CHARACTER

Figure 2: Water character integrated with the ocean.

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Having collaborated on the base character animation, the requirements for emotion and dynamism were established. An initial wire simulation provided secondary movement, lag and further fluidity of motion. A guided fluid simulation was then run over the surface. The animation rigs flow curves were applied to control the main directionality of the fluid. Artists also had the ability to manually comb these directions. Using the gradient of the main surface volume as the direction, a uniform two-dimensional noise was applied to the position. The resulting curves maintained their overall flow tangent, but pointed towards or away from the surface. Sampled into a vector volume, these directions relative to the surface gradient, and velocity, were key to enabling a proprietary seeding method, FAB [Stomakhin and Selle 2017]. This allowed for the perpetual birthing and sinking of particles, and provided a consistent volume of fluid. Typically the simulation was run in a rest position, and bound to animation. Controls were added to blend between simulation, and the base model, as desired, to either reduce or increase the activity of the performance.

We devised a combination of projection and blending methods to integrate the skirt of the character with the ocean surface. The skirt simulation module advected flow towards the character, and also reacted to the forces of the ocean expression authored by the layout department. By leveraging geometry and vdb blending techniques these simulations were combined into a single level set ready to render through our proprietary level set rendering pipeline.

Secondary effects such as surface foam, drips and bubbles were added to further enhance the dynamic aesthetic.

4 SIMULATION ACTIVATION

Many shots required the water to perform an action, then break apart naturalistically. This grounded the effects in the natural world, and ensured the character does not appear overly articulated above the main ocean level.

Using the main bound simulation as a source, a secondary simulation was emitted into. In the instance of the ocean performing a high five with Moana, we used Moana's hand to detect the initial collision, emitting fluid from the localized contact area. As the water retracts, further breakup is applied manually via noise, eroding away the base simulation, and replacing it with new gravity compliant particles. Collision objects were also used in the secondary simulation for further naturalistic interactions.

5 WALLS OF WATER

There are two sequences in the film that featured parting of the ocean – seemingly the same effect, each however on a completely different scale. In the smaller scale scene, the shoreline parts for toddler Moana. The brief was to create an aquarium-like feel, something non-threatening and beautiful. Base shapes were modelled, and ocean deformations were applied to the top portions of the walls. We found the walls needed to be very smooth in order to limit refractions and allow the audience to see far into the water. The index of refraction was also modified in some scenes. Additional dynamic elements were added for foam, bubbles, and additional splashes were surface details when required. Less is more with this treatment, whereas the climactic sequence of the film encompassed everything previously learnt to be applied. The opening of the ocean itself utilizes art-directed flow curves. The scale of the environment meant conventional solutions struggled to process over such distances. Distributing the simulation gave us access to the much needed RAM required, a key feature of Splash.

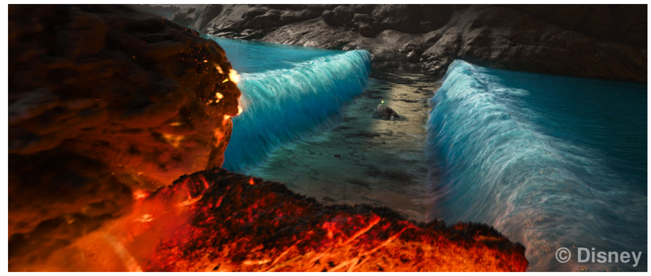

Figure 3: Final water wall render.

Once established, the walls of water sustained for the subsequent shots in the sequence. We needed to design the water wall set piece in an economical way, and something relatively light for artists to handle.

Using a modular approach, we created high resolution wall panel simulations, with accompanying whitewater and sand churn elements. The panels were reused multiple times, translated, time offset and mirrored along the axis of the trench. Artists used a proxy representation to compose the layout in real time. The data could then be deformed in its new location to adhere to features of the modelled wall design. We reused the huge data set as often as possible. Bypassing the custom deformation and using generic panels also gave a saving. The transform and time offset data were parsed into a proprietary level-set compositor. This handled the multiple surface blends. Additional point blending was required for the particle-based elements to be tileable. The economical nature of the workflow was key to ensure the sequence was delivered on time.

Collaboration early in production set the foundation for consistent data and deliverables. Modularity of approaches allowed for flexibility, using specific workflows as a base to further customize. These aspects were key to enabling artists to make the water to feel natural, yet exist in a world far from that.

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