Delivering Doomsday
The Meteor FX of Ice Age : Collision Course

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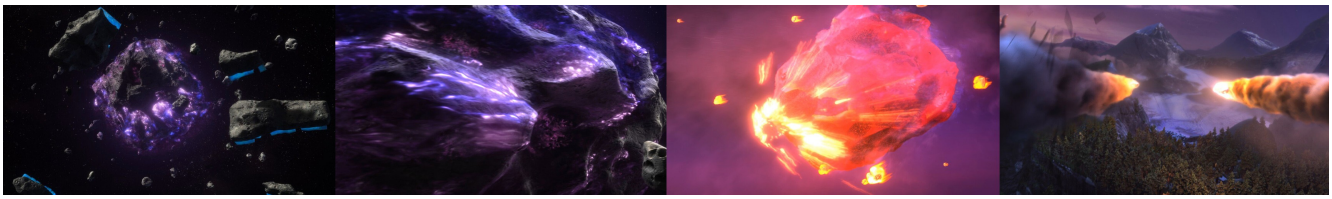

Figure 1: Meteor FX*, Ice Age Collision Course © 2016 Twentieth Century Fox Film Corporation. All Rights Reserved.*

Introduction

Throughout our film, *Ice Age: Collision Course*, a cloud of meteoroids as well as one colossal asteroid are on a direct path with Earth. The size and scope of the effects for these space rocks presented us with the need for new tool development and novel ways to interact with fluid simulations. First, we designed a stylized plasma element to give our hero asteroid some menace before reaching the atmosphere. Next, we managed dozens of realistic smoke trails, simulating them efficiently throughout the movie. Finally, we created heat shield events reminiscent of iconic re-entry glows, but visually fit into the Ice Age franchise.

Keywords: fluid simulation, particles, meteors

Concepts: • **Computing methodologies** ~ **Procedural Animation; Physical Simulation**

Plasma

When the art department approached our effects team, very little was known about how to describe the visual impact an asteroid the size of Manhattan hurtling its way to impending doom would have on our audience. It was important this massive destroyer-of-worlds maintain a sense of physical correctness and scale while having specific motion and shaping to consistently sell a level of intimidation to our viewers.

To accomplish this in outer space, we designed a plasma effect using a combustion based solver within Houdini in collaboration with a series of custom fields and inputs to the simulation. Painted emission areas as well as curvature analysis of the model provided a source to emit a user defined particle system carrying temperature and fuel values which would eventually be splatted into a voxel grid for fluid simulation. Using a modulus loop in conjunction with the complemented density of our meteor, an input wind direction carrying noise was defined and masked out on every nth voxel. This created “air gaps” of initialized values so the wind force could naturally evolve within the container at the same time limiting it's exposure within and along the meteor's surface.

A double cross product of the geometric normal against an animated orientation provided us with flow vectors around the meteor. This flow field in combination with the meteor's velocity and any discretionary modification by the artist was injected into the simulation along with the additional fields described above.

Finally, color ramps were described in the fluid so our lighting, compositing, and rendering teams would have both a diffuse beauty layer, with light and shadow scattering correctly, as well as an incandescent RGB pass containing the per-voxel color representation of our normalized temperature values.

Trails

With so many fast moving meteors in this film, heavy fluid simulations quickly became an unfeasible solution. Instead, we used a much more directable particle simulation to drop slightly drifting points behind each animated meteor. These points have a natural scale distribution and grow as they slow down. They are then converted to a volume using their distance from camera to determine voxel size. A second VDB channel is produced storing distance from the meteor and rendered as a red to green signal baked in to the emission (or inner) color of the smoke. This acts as a separate pass with which the compositing department can adjust the meteor trail's light contamination in post-production. This technique minimized simulation time, disk space and render cycles for such a ubiquitous effect across this film.

Shields

The first step in creating a fireball was to generate an attribute on the animated meteor driven by the dot product of its normal with the overall velocity of the object so a tumbling rock would always emit from the front facing portion of its geometry. That signal could be augmented with noise functions and also painted in the case of more foreground meteors. Next, particles are birthed within that same mask and animated with a wind force using flow vectors calculated along the surface of the meteor. At

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this point, the element is converted to a volume and treated with stylized noises to make the tail flicker cartoonishly. A few of these shields were generated on spheres and stored in the effects department's library for use on far background meteors. Additionally, for hero meteors, the particles were culled down to make a second, higher detail volume and then culled even more significantly to create geometry for ablative sparks. Generating all the components from the same source simulation helped tie each element together into one detailed effect.

Conclusion

Direct-ability and efficiency reign king in both the simulation and procedural worlds of complex effects that require high resolution volumetrics. Preserving plausible motion while retaining artistic control has found an important place in our animated feature pipeline here at Blue Sky Studios. Using a combination of the techniques described above has empowered us to improve the look, quality, and ultimately the story of our films while keeping the audience on the edge of their seats.