

Star Wars: The Last Jedi - Effects Simulation

Industrial Light and Magic

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Figure 1: Some effects simulation shots in Star Wars: The Last Jedi

ABSTRACT

For Star Wars: The Last Jedi, Industrial Light and Magic had to create a vast amount of effects simulation shots to make the story envisioned by the filmmakers believable. The film posed not only highly technical challenges to the effects team, but also strong aesthetic requirements in order to deliver such an anticipated movie.

From massive spaceships taken down during space battles to simulating interactions between characters and the various environments, a wide range of techniques and new developments had to be created to deal with the huge amount of work across all four of the company's facilities.

CCS CONCEPTS

• Applied computing → Media arts;

KEYWORDS

Star Wars: The Last Jedi, Effects Simulation, Industrial Light and Magic

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1 SPACE BATTLES

Many of the film's sequences showcase various types of spaceships being destroyed. From Tie Fighters to the massive Dreadnought, all had to convey the right structural properties. In addition, digital pyrotechnics had to be simulated to achieve visually compelling results, sometimes bending physics in favor of dramatic requirements.

1.1 Tearing Metal Simulation

In order to convey the realism of the various fictitious space vessels, we used a rigid body approach where the structures were fractured into many detachable pieces. These main fragments were then represented by a second level of simple fracturing to be fed into Bullet simulations. Soft constraints spanned across the fragments to enable bending. Because each type of spaceship appeared across many shots, each of them was rigged once and brought into each scenario ready to be simulated. This rigging procedure was particularly challenging given the extremely high resolutions of the models. The main benefit of this rigid body approach was its speed and stability, with some vessels simulated as thousands of pieces needing high artistic control.

An in-house extension of Bullet added hardening to constraints, so when deformations occurred, these wouldn't spring back. This enabled for a very straightforward adjustment of apparent "stiffness" by changing constraint parameters. In the case of large scale spaceships like the Dreadnought, softer constraints helped convey their enormous size, the opposite being true in the case of Resistance Bombers or tie fighters.

Most of these events had to be driven by laser bolts fired by enemies, so a system was put in place to drive destruction blasts directly from the bolts provided by the animation department.

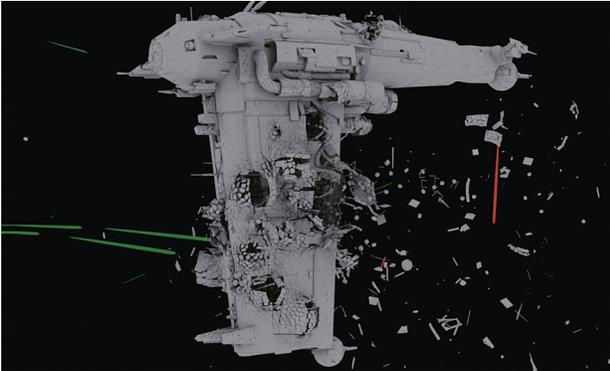


Figure 2: Simulation output of a Resistance Bomber, showing the small pieces used to represent deformable metal.

1.2 Pyrotechnics

Every destruction event carried with it some sort of fluid simulated element such as explosions, smoke and fire. The simulation and look of these was tied directly to the core rigid simulation. While these are common practice nowadays, the key to their look relied on custom rendering techniques for scattering light inside the massive plumes.

2 BATTLE OF CRAIT

During the final battle in the planet Crait, the effects work was crucial to integrate the action taking place in the salt flats. As speeders race along and firing takes place, the red crystal below the ground is exposed and was simulated using an in-house implementation of a Position Based Dynamics solver and a newly developed in-house technology for fluid simulations.

Moreover, the design and execution of the massive cannon beam and creating the mood for the face-off between Luke Skywalker and Kylo Ren posed strong aesthetic and technical challenges.

3 MEGA DESTROYER

The effects team was heavily involved crafting both the interior and exterior destruction sequences for the massive Mega Destroyer spaceship.

3.1 Light Speed Destruction

The shots of Mega Destroyer destruction from space are another visual highlight of the film and brought an additional challenge



Figure 3: Red crystal simulation as speeders race around.

in creating the illusion of a massive imperial ship of approx 60 miles across. The sequence features striking shot design, a near monochromatic palette and high contrast lighting with detailed effects simulations inspired by particle cloud chamber photography and subatomic particle collision dynamics scientific visualizations. This effect relied heavily on instancing elements from a vast library of spaceship debris components.



Figure 4: A light speed destruction shot.

3.2 Collapsing Hangar

Rose and Finn find themselves in a collapsing and dangerous environment. The series of vast interiors was created using extensive digital extensions and simulations.

The challenge in creating this chaotic environment was to deal with a large number and species of effects like fire, smoke, explosions, falling tie fighters, debris on fire, electrical plumes of space tech burning and other destruction oriented elements. Establishing robust, fast and flexible simulation work flows and techniques was key to successfully deliver the show.

Besides complex setups for detailed foreground simulations of digital pyrotechnics, for which ILM's in-house GPU fluid solver Plume was a key tool, we created a large visual library of pre-rendered effects elements ranging across all effects species and sizes. Those were used to quickly populate the backgrounds and mid-grounds of a large number of interior destruction shots. This library proved to be a time saver, allowing us to concentrate on foreground hero effects.

For the exterior escape sequence we used a combination of fluid simulations for explosions and smoke, debris fields, volumetric modeling, volumetric lighting passes and multiple particle simulations to create the illusion of scale and danger.