Concurrent Monoscopic and Stereoscopic Animated Film Production

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1. Introduction

The number of theater screens domestically that are equipped for digital 3D exhibition is currently only about one quarter of the total number that are reached by an animated feature film in wide release. Any such film could not ignore the aesthetic demands particular to 2D exhibition on a statistical basis alone. However, the cost and effort of producing a 3D version, despite the numerical disadvantage, might indicate the type of commitment to this burgeoning medium that would dictate putting out only the best 3D product. As it is not always practical to create two completely artistically divergent versions of a film, the manner in which a production navigates through the compromises between the two will determine the success of the results. In the face of this reality, the production pipeline for *Bolt* was designed with the goal of delivering the full artistic vision of the directors for the 2D film that the majority of filmgoers would see, yet deliver an uncompromising immersive experience to 3D audiences.

The left and right eye images of a frame from the 3D film.

2. 3D Philosophy and Techniques

The philosophy for using 3D on *Bolt* was to optimize for both the immersive effect and the viewing comfort. To make *Bolt* immersive our goal was to create scenes with full, believable volume, and use depth as a storytelling tool. By using depth in this manner we hoped to draw the audience into the story, rather than pulling them out of it with cardboard like scenes and random 3D gimmicks. Following a depth script that mirrored the emotional intensity of the film, and adopting a grammar for the application of depth, allowed stereoscopic depth to be meaningful. This simultaneously optimized for comfort by regulating the amount of depth, reserving it for big moments in the story. Viewing comfort would also be maintained by adopting parallax limits, controlling the continuity of stereoscopic convergence across shots, and minimizing retinal rivalry.

The use of a technique that we refer to as the "floating window" helped to reduce one of the main causes of retinal rivalry, the "window violation". The window violation is the paradoxical effect that is created when an element that is being occluded by the vertical edge of the frameline, lies in front of it in depth. The result is a perceptual flattening of the image, as well as uncomfortable retinal rivalry due to part of the element only appearing in one eye. The "floating window" is a masking of the left and right eye images that is given a stereoscopic disparity in order to float it in front of the element that is breaking frame. This eliminates the window violation and removes the retinal rivalry. The floating window also helped us to use depth for storytelling by giving us a means of independently controlling the perceived location of the screen, allowing that to become part of our 3D film grammar.

3. The 2D/3D Hybrid Pipeline

The *Bolt* production pipeline was designed with the goal of producing a single version of the film in which the left eye image of the stereoscopic version would be identical to the monoscopic version of the film. This would obviously be the most efficient scenario, both in terms of storage and rendering requirements. However, acknowledging that an acceptable solution meeting the aesthetic requirements of both formats would always be possible, the pipeline would have to allow for certain shots to have a unique left eye image for the 3D film. Sequence based work, such as storyboarding, editorial and animatics, was done in 2D. Once this process resulted in final shot breaks being determined, the shots went to the layout department. From this point on, at the inception of each shot, the *Bolt* pipeline was fully stereoscopic. The exception was the initial 1K resolution lighting and compositing pass which was performed in 2D and then picked up by a render team, which created the final 2K renders. The render team was also responsible for correcting 3D artifacts arising from the renders as well as from 2D mattes and paint fixes used in the composite.

4. Bridging 2D and 3D Aesthetic Differences

Let's examine a few aesthetic differences dealt with on *Bolt*.

4.1 Editorial Cutting Pace

Creating two cuts of *Bolt* would quickly and irreparably thwart our goal of unified 2D and 3D films. Acknowledging a perceptual difference in how editorial pacing works in 3D, however, we took the approach of delivering the right 3D film for the cut, adjusting depth to make the pacing work.

4.2 Composition and Lens Choice

By creating the cinematography for both formats at the same time, we were able to head off some camera choices that would have been disastrous for 3D, but for which an equally successful solution for 2D was available. In 2D cinematography there is often a compelling reason to use a longer lens. Long lenses however, will tend to cause the "cardboard effect" in 3D, in which a scene appears to be composed of flat objects arrayed in depth. Our pipeline allowed for such schisms in lens choice, through the use of a multi-rigging technique, in which individual elements in the shot are assigned to separate stereo bases, allowing the depth to be re-sculpted.

4.3 Depth of Field

The creative use of depth of field has become an important part of the 2D film grammar, causing animated films such as *Bolt* to simulate this artifact of live action photography. In 3D, limited depth of field is not always as desirable, as the viewer's eyes which are free in terms of vergence to roam throughout the depth of the scene are not being afforded the same latitude in terms of focus. Fortunately on *Bolt*, the depth of field effect was not rendered in camera, but was introduced in the final composite, allowing it to be dialed down or removed for 3D.

5. Conclusion

The 2D/3D hybrid production pipeline utilized on *Bolt* allowed the efficient creation of both a monoscopic and stereoscopic version of the film while being flexible enough to accommodate their individual aesthetic requirements.