Code To The Cosmos: Animation Outside the Box, in Pixar's *Elio*

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Amongst a variety of alien species in Pixar's *Elio*, one of the more unusual characters in the film is the Universal Users Manual (or UUM for short) - a sentient alien book harboring all the answers to the universe.

The UUM is a "character" consisting of a stack of pages with the ability to zoom along distinctly shaped paths and is rigged and animated in our traditional pipeline within Presto with the additional hookup of Houdini Engine (HE) to create the distinct look of the character with traditional FX layered on top. By hooking up a base shape to Houdini Engine we have the ability to combine native ease of manipulating a character in presto with the power and sophistication of our FX pipeline.
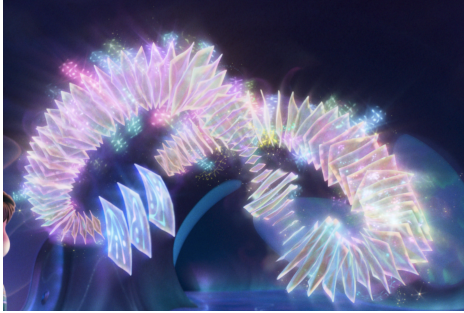
1 RIGGING

Fig. 1. Universal User's Manual, or UUM, in *Elio*. ©Pixar

The UUM consists of 3 assets; the main rig of the stack of papers (UUM), a prism in which the UUM folds into in its compacted state (UUMPrism) and a rigged single piece of paper (UUMPaper) that could be added to shots needing individual manipulation.

The main UUM rig furthermore consists of 6 different spline rigs in which the stack of papers can blend between; 3 open and 3 closed, each with a different control density. The underlying rig controls a simplistic squared hull shape within presto, where each edge loop later through Houdini is procedurally converted to a page and the general shape and size of this page is dictated by the hull shell (with some additional behavior added procedurally).

What sets this character apart is its unique ability to blend between rigs on a parametrized level making it possible not only to switch but to blend in various ways between open and closed spline rigs and different control densities and with the ability to control one end of the character with one rig and the other end with another rig - resulting in an intensely flexible yet complex rig. Rigging the UUM in this way also gave us a ton of freedom in the system driving the

hull shell as we could optimize for the characteristics of the character as story changes came through and the character got more complex without redoing work.
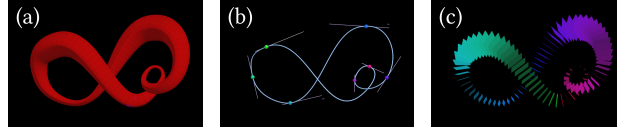

Fig. 2. The hull geometry of the UUM (a), the short closed spline (b), and the corresponding pages from Houdini Engine (c). ©Pixar

To visualize the speech of the character we utilized the parameter values already existing on the hull shell and sampled these by animated live splines along the path to create a wave pattern. These animated weights were then sampled by a curve and the UUMPage rig weight values were sampled via a page index. The transform delta of translate, rotate and scale were scaled by the weight value and applied to each page rig allowing for an easy way to animate a wave of sound passing through the shape of the character.

Late in production a complex shot was added and the UUM needed to explode its shape into individual pages and then come back together bypassing its native behavior of pages moving through a curve. We came up with a solution where proxy geometry mesh pages were warped to the deformed hull shell and then frames on each page's proxy mesh provided rest transformation spaces. The posed space was derived from the offset positions (which could be constrained) and a slice of the hull shell geometry would transform to this new space.
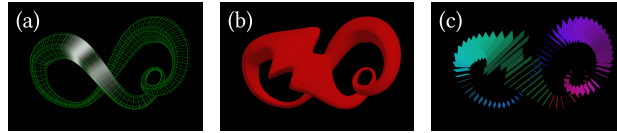

Fig. 3. Showcasing the animated weights (a), driving the deformation of the hull (b), and hence translates to the pages (c). ©Pixar

2 CHARACTER SHADING USING FX WORKFLOWS

The UUM is a character rigged and animated to move in a precise way, but also required dynamically created procedural elements. We created the primary look of it in character shading, but incorporated efficiency methods and pipeline of the FX team for a unique collaboration on the asset.

To start, the UUM was created as an FX asset, which allowed us to use a workflow to process the asset in different contexts depending on the stage of the pipeline. The final look version of the UUM required several simulated effects for symbols and particles to fly out of the pages, which was only processed at render time. A lighter version was created for animators who only needed to visualize the individual pages but not have their performance bogged down by extra instanced effects.

Another way FX methods were leveraged was to add visual interest to the UUM with several types of particle systems and volume effects. Not typically used in character shading workflows, FX artists helped guide the characters team to set the base-line particle and volume elements to be efficient in memory and computation time. FX artists then added additional elements to support shot-by-shot performances after the base look was established. The UUM's final look was heavily determined by characters work coupled with FX work to give it the best from both teams.