Magic Beanstalk Ride in *Puss In Boots*

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Figure 1. *Beanstalk in various stages of growth*

In the animated movie *Puss In Boots*, a magically growing beanstalk propels the characters into a cloud world. Some of the challenges posed by the effect include a topology that changes dramatically as the beanstalk grows (thus limiting the use of many deformation tools that assume a constant topology), highly art-directed vine models reminiscent of *Art Nouveau*, different animation styles as the sequence progresses from a powerful "rocket launch" to a graceful and magical ride with character interaction, and close-up and wide-angle views with the camera transitioning between the two within the same shot.

Modeling

To build a miles-long beanstalk model in a neutral pose, we rely on a suite of procedural tools. We start with a base set of hand-modeled NURBS models that includes four topologically-compatible trunks (large central vines) and a dozen of smaller secondary vines. We stack the trunks on top of each other to make a compound beanstalk with the necessary length, and use our tools to align the edge CVs to get rid of seams. Next, we use various methods to create secondary vines and leaves; e.g., they can be instanced graphically using a stamp brush, or they can be sketched as curves on a parent vine. Custom extrusion, merging, and remapping tools turn curves into final vine NURBS surfaces. For leaves, our model is rigged for non-uniform scaling, which provides a reasonable degree of leaf variation when instanced onto the vines. Finally, we create a "young" version of each trunk and large vine by smoothing the creases and other detail on the stalk down to a cylindrical shape while preserving the topology.

Vine Growth

The animation setup consists of a particle system to guide the overall trajectory and growth of the beanstalk and a geometric algorithm to remap any vine in a neutral pose to the final path. The power of our approach is that most of the animation work, including timing aspects, is done in the context of the remapping process and not with the particle simulation. This enables the animator to work mostly using keyframes with real-time feedback.

The particle simulation produces a particle chain that traces the path for the beanstalk over time. The simulation does not rely on dynamics, so the growth is entirely procedural: the distance between consecutive particles increases as the particles age, and new particles are concurrently added to the tip of the chain, which simulates the growth of "new matter". To drive how particles are emitted, we can sample any number of curves, thus making it easy to shape the path. For example, a corkscrew motion can be created using one circular driver curve combined with vertical bias. The particle system controls the orientation along the path, so twisting is also possible. Finally, we create joints along the particle chain as needed, and use them as aim and parenting constraints for cameras and character rigs.

A Maya plug-in takes any vine in the input model, and optionally its parent, and remaps it onto the particle chain. Different mapping modes help achieve different looks. For example, vines spiraling around a parent vine use a growth mode that has *a priori* knowledge of their final shape, which reduces collisions. Timing operations such as lag, growth speed, radial growth, etc. are also controlled, perhaps counter-intuitively, by the same plug-in: they are simulated by equivalent operations in the parametric domain. For example, the growth speed is controlled by scaling – possibly non-linearly – the parametric domain in the remapping process. Because the remapping is hierarchical, child vines never grow before their parent does, and they always stay connected. Any world-space deformation in the neutral model is automatically transferred to the remapped version. Typically, we add ambient motion to the neutral vines with a combination of standard Maya deformers and a noise node that works in the UV and normal space of the parent vine. As we grow the static vine model, we use the particle age modulated by texture maps to blend between the default model of the beanstalk and the young model built during the modeling phase, enhancing the illusion of continuing growth.

Finally, the leaves are instanced onto the vines, using the same hierarchical timing to ensure they do not appear prematurely. Each leaf's lifespan begins with an unfurling animation cycle, and then it transitions into a script-driven fluttering motion. The animation cycles, scale, and speed can be adjusted for each leaf.

Rendering

Using a combination of exported per-CV attributes (i.e., age) and level of detail, we are able to handle various effects at render time, including translucency, color, texture blending, and sampling density of our point-based global illumination.

Conclusion

The system provides ample artistic control to tune the look and address notes rapidly without being limited by the automated nature of the particle simulation. Thanks to UV-based vine and leaf attachments, we are able to make large-scale changes to the beanstalk trajectory and layer additional vines without sacrificing the finer detail.