Vegetation on *Monsters University*

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From blades of grass, to ivy on buildings, all the way up to massive trees, vegetation played an important role in establishing the look and feel of *Monsters University*. We were tasked with creating vegetation that was familiar in subject matter to audiences, but that also fit into the "monstery" theme of the film.

Our vegetation needed to span multiple seasons, requiring density and color progression throughout the movie. The generated assets had to be easy to art-direct, light, and render. Finally, we needed to be able to put all of these assets into motion, interacting with characters and the world in a realistic manner. In this talk we cover the methods and tools used to create, distribute, and bring to life the vegetation of *Monsters University*.

Figure 1: *Campus vegetation on Monsters University.*

1 Trees and Bushes

Modeling: The bushes and trees in *Monsters University* were created using *Ponga*, a proprietary tool developed for the show. *Ponga* started with a modeled trunk, from which it created a hierarchical bone structure. From that structure other branches were recursively grown with user-definable thickness variation, curvature, phototropism, and detail level. Leaves were defined by points along any of the branch levels. The whole branch structure could be clipped by a mesh-based voxel grid, allowing for easily art-directable silhouettes. This allowed us quickly generate a number of variants for each tree species in order to add variety and complexity to the world.

Simulation: A significant part of selling the look of the trees on campus was subtle keep-alive wind motion. We created a hybrid pipeline for simming our trees where the branches were simulated via a rigid body solver, and leaf flutter was procedurally calculated. This helped keep the generated sim data as small as possible. Basic tree keep-alive sims were created for every tree on campus and enabled by default to minimize TD intervention.

We also had an entire sequence where Sully was trying to escape through a forest. To narrow down what needed to be simulated in specific shots, we used a simple simulator that checked for collisions between bounding boxes. This generated a list of all the objects in the shot that the character may have collided with. The next step involved reviewing and filtering the data to determine which of these objects, if any, was a type of vegetation that could be promoted for simulation (i.e., a 'hero type' vegetation). Then, using a collision proxy of the character, we ran simulations of the contact between the character and the promoted vegetation in the shot.

2 Grass

Modeling: Grass is seen in the majority of the shots in *Monsters University*. We started with the grass system used on *Brave* then tweaked it to get a more groomed, Ivy-league school grass look. Important attributes of the grass could be painted, such as density, color, and length. We leveraged those signals significantly to produce a variety of looks for grass that played a big role in selling the different seasons seen on the film.

Simulation: Given the number and complexity of characters in *Monsters University* interacting with the grass, it was necessary to develop a rig to deform the grass with minimal set up. Grass modifiers were used to procedurally bend or deform the grass at render time. Initially, these modifiers were hand animated to push the grass down under the foot as well as leave a foot trail behind. This process was both tedious and time consuming.

We used our rigid body solver in a novel way to create a rig specific to each character that could be used for monsters walking, sliding or rolling in the grass. The rig could detect when a body part comes in contact, slides over or is lifted off of the ground and automatically creates a simulation prim. This prim is given an initial velocity off the normal of the ground in order to mimic the sponginess of grass. A drag field was added to bring the simulated prims to a stop to be sure to leave a foot trail behind. The simulation exports the transform matrix of each prim into a data file that is then read into *Presto* to scale and animate the grass modifiers.

3 Ivy

The ivy was created using a maya based custom sketching tool. An artist could sketch on a surface (such as the side of a building) and that would be converted into curves, which would render as tapering vines. After a suitable number of vines were created, the tool would allow for the creation of appropriately placed, connected and oriented leaves.

The orientation of the leaves was driven by a rough ambient occlusion calculation, which ensured the leaves would look right in nooks of buildings and around corners, both preventing intersections in places where walls met and keeping the main surfaces of the leaves oriented towards the sun.

4 Lighting and Rendering

Considering the amount of pixel real estate that vegetation had on the show, we tried to keep rendering cost of vegetation at a minimum. We made heavy use of Level of Detail (LOD) using a proprietary library to prune a large number of leaves, branches, and grass blades. This turned out to be very important with grass, as we could get away with agressive pruning, especially at grazing-angle camera shots.

Along with LOD, we improved our rendering stats by baking as much lighting and visibility information as we could. We stored those as Spherical Harmonics (SH) coefficients in pointclouds for all our trees and bushes. For grass, we encoded occlusion information in 2-D textures and heavily compressed the data.

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