Rigging Octopuses in *Penguins of Madagascar*

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Abstract

On *Penguins of Madagascar*, we had the unique challenge of rigging several octopus characters to antagonize our heroes. Unlike normal octopuses, they spend most of their time on land, and had to be able to scurry around, operate machinery, and do kung-fu. However, tentacles are notoriously difficult to animate, so we needed a solution that Animators could easily pose both for walking and gesturing, without taking significantly longer than they would for a normal bipedal character. On top of that, combining the range of motion that a boneless octopus requires with the exaggerated cartoony motions and art-directed shapes that are a part of the *Madagascar* style, meant we needed shaping solutions far beyond those found on a typical character. We solved these needs through careful design choices, a custom tentacle setup, special silhouette controls, and a unique approach to combining the face and body deformations.

1 Troublesome Tentacles

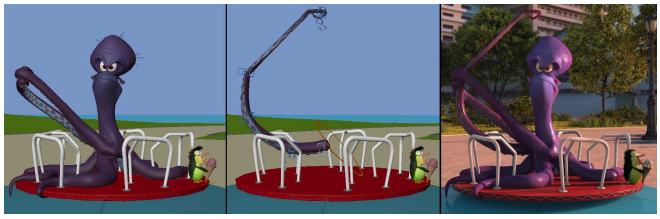

Figure 1: *Since the film's octopuses only had six arms, stunt tentacles were provided as separate character assets to allow Animators to achieve specific effects.*

Octopuses obviously have eight legs, but eagle-eyed watchers of the film might notice that ours only have six. During early tests, it became apparent that having too many legs actually made the poses more difficult to read - preventing Animators from achieving the clean silhouettes essential to the *Madagascar* look. With six legs, we got cleaner poses, yet in motion, it was nearly impossible to tell that two were missing. With fewer legs to animate, this creative decision also had the practical advantage of increasing Animator throughput. For shots where the legs were easily counted, or the six legs couldn't achieve a desired pose, we rigged a stunt tentacle. This separate character asset consisted of a single disembodied tentacle, which could be instanced in shots as needed. The Animators could load this in and hide the connection with the body based on the camera position.

To allow the Animators to easily pose the tentacles, we developed a new system based upon the existing DreamWorks tail package. This gave us a great start with layerable FK and multi-jack IK controls on a spline, but we were able to extend the functionality, creating some key differences between the needs for a tentacle and a tail. To be as flexible as possible, the tentacles required a wide range of high level controls in combination with very fine tuned localized controls. This included features such as the ability to slide rotational pivots up and down the length of the tentacle, and the ability to create general wave and curl shapes, along with localized per-joint translate, rotate, and scale controls along the tentacle length. Because the tentacles are used interchangeably for locomotion and gesturing, advanced space controls were created so that Animators could always work in an intuitive fashion. Walking required the ability to lock a section of a tentacle under particular IK jacks, while for gesturing it was desirable to have the IK system merely define a shape. For either case, it was important for the tentacle to flow through the jacks to avoid skin stretching. Several specialized offset controls allowed Animators fine control over grasping and localized compression, to fine tune the shape of a particular area of the tentacle without risking changes to the tentacle as a whole.

We also worked with R&D on updates to Premo, DreamWorks Animation's proprietary animation package, to accommodate needs particular to the tentacles. These included updates to the Pose Library, so that poses using world-space IK goals could be reapplied in any space (essential for octopuses stuck to non-horizontal surfaces). We also had to make adjustments to our IK space matching system, so that some tentacle IK goals could remain stuck to a surface while others moved in local space relative to their neighbors.

2 No Bones About It

Without the arms, an octopus appears fairly simple. But when said octopus needs to emote, gesture, and chase penguins, it becomes quite complex. When typical animated characters rely so much on squash and stretch techniques, an animal without a skeleton relies on these features even more so. The most noticeable octopus feature other than the arms, is the 'mantle.' This bulbous sack on the head had to be fully deformable. It not only had a tail system running through it to act like a simplified tentacle, but it also required a control cage to allow for specific silhouette tuning.

Figure 2: *The two types of octopus faces provided different challenges. Dave (left) needed a very expressive mouth that blended seamlessly into his squishy body, and his octopus henchmen (right) required all the expression to happen in their eyes and brows.*

The faces of the octopuses had to be incredibly flexible as well. We had two styles of octopus faces in the film: Dave, the main villain, with a large expressive mouth, and his mouthless henchmen. For the henchmen, special attention had to be put into the eyebrows and cheeks, since they do not have mouths to help convey their emotions. They actually have a number of the standard mouth controls as well, so the animation team could add some motion when they make their gurgly vocalizations.

Not having mouths made the henchmen octopuses difficult, but Dave's huge, expressive mouth was more difficult still. It required an extensive range of motion, complete with a toothy grin. Animation needed the ability to completely change the layout, shape, and spacing of his teeth on a per-pose basis.

The range of Dave's mouth caused some big challenges. In our pipeline, face riggers and body riggers work on a single character in parallel, with the face deformations being applied as vertex offsets onto the bodies before final output. These offsets are normally applied in the space of the head joint. Since Dave's face bleeds into his body, and his character required him to be able to open his mouth incredibly wide, we had to develop a system that allowed his opening jaw to follow the curvature of his neck (which was created in the body rig). We needed a more dynamic space than a single head pivot. Ultimately we were able to create a flexible space that was generated differently for various areas of the face on a per-pose basis. This allowed his mouth deformations to be applied in the space of his neck when the mouth was open wide, or in in the space of the head when closed. Without this solution, Animators wouldn't be able to rotate Dave's head when the mouth was opened without breaking the rig.

The extreme mouth shapes on Dave also caused issues with stretching geometry on the inside of the mouth. This area is typically not very noticeable on other characters when lit, but for Dave, we had to set up a number of automated and Animator-controlled relaxation techniques to make sure his throat always appeared as smooth and graphic as possible.

We also had some other tools for animation to help create some interesting squashing effects on a per-shot basis. We installed 'sculptor' objects to allow Animators to create more dynamic deformations. Animators could shape and place these objects as they need to deform geometry contained within the sculptor's bounds. This allowed them to do things such as having Dave pull a beach ball into his ear and through his brain, or to cram his body inside of a tiny jar. In cases where these sculptor objects created crunching or tearing deformations, 'smoother' objects could be placed or parented where needed in order to dynamically relax contained geometry.

Figure 3: *The flexibility of the rig controls, along with the specialized 'sculptor' and 'smoother' objects allowed Animators to create some drastic shape changes.*

These 'sculptors' and 'smoothers,' in combination with the flexible range of the rig controls even allowed Animation to essentially create a whole new character without having to go through the entire character pipeline. At the end of the film, there is a 'cute' version of Dave. The tight production schedule and release date change meant that there were not a lot of resources to create a whole new character from scratch. Instead, Animation was able to use the existing controls to contort Dave into a completely different shape (such as enlarging his head and eyes, removing most of his teeth, fattening his tentacles, and scaling his body) and and have him act and perform from this new character design.

3 Discussion

The techniques developed for octopuses in *Penguins of Madagascar* proved successful. Though the characters remained somewhat more difficult to work with than a typical biped, the results were good enough that the octopus characters could have far more screen time than originally envisioned. They were also easy enough to apply that even minor octopus characters could be added part-way through production. Furthermore, many of the techniques used here have applications beyond octopuses, and the tentacle system is increasingly being used as a tail replacement for other characters.