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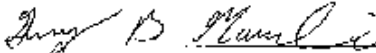
Creating 3D Smear Frames for Animation

Matt Drury

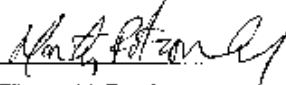
An Undergraduate Thesis Submitted in Partial Fulfillment
Of the Requirements for the
Fine and Performing Arts Honors Scholars Program
Honors College
East Tennessee State University




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Abstract

In the transition between 2D and 3D animation animators tried to be able to replicate all of the styles and techniques in 3D that they utilized in 2D. Motion blur eventually came to replace a popular 2D technique known as a smear frame. A smear frame is much more than a path of motion or a blur though, it has a style that cannot be replicated with such methods. I present a creative project with the intent on creating 3D smear frames in a self-made character rig. In order to achieve this I will be designing, modeling, texturing, rigging, animating, and rendering the character of Champ Champions.

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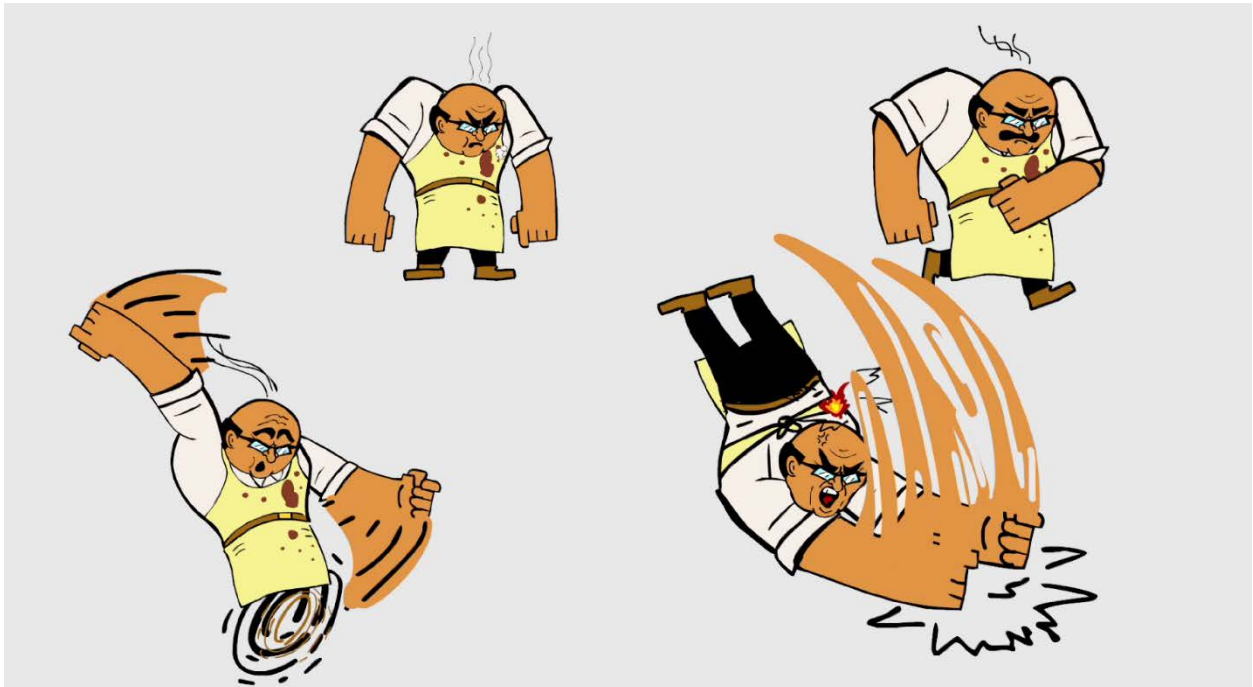
Introduction

The goal of the creative thesis was to utilize a technique from 2D animation and implement it into a 3D rig to where an animator can simply turn smear frames on and off and have some simple controls to manipulate the shape and size of the smear. I also wanted to include an option of what type of smear frame it would be. There are two types of smear frames in 2D animation, which is either a “classic” smear frame, which is where for a fast movement a persons would stretch and smear into an odd looking shape for only a frame or two to simulate a kind of motion blur effect, or a duplicate smear, which is where there are multiple instances of the subject such as 4 hands in different parts of a motion path. With smear frames being the ultimate goal of the project I knew that whatever I would animate would have to have very fast movements to warrant the use of such an extreme style. I decided that boxing would be a great example of that because then I would only have to really worry about the gloves and the arms smearing because most of the really fast motions would be various punches and blocks. I would do all of the 3D work in Autodesk Maya and render with Render Man, but before I could start on 3D I needed to truly understand the source material so I started by learning how to utilize smear frames in 2D animation first.

2D smear frames

Smear frames are a heavily stylized attempt at motion blur in 2D animation. Each animator has a specific and personal way of rendering these smear frames. In the summer of 2015 I started really diving into 2D animation to figure out what my style of smear frames were. I knew that at this point my final character was going to be a boxer, and was going to be heavily stylized with a top heavy build and very small legs. His build would be almost gorilla like, the only part of the design that was hard difficult to nail down was the placement of the head. Would placing the head too low make him unappealing or would it sell his brutish build? In the pipeline of 2D animation rendering smear frames is close to one of the last passes of animation.

I had two characters that I made animations with that had the boxer build that I utilized smear frames with. On the first character I made I used a very cartoony style. I smeared them almost to the point of Chuck Jones did with the Roadrunner in Looney Tunes. I decided that this was not the style that I thought would transition well into the 3D animation that I had in mind.



The second animation was Teddy Roosevelt upper cutting a man into the sky and smashing him back down into the Earth. In this animation I did it frame by frame and got the smears that I liked. These smears were more painterly in style than the last one. They felt much closer to an exaggerated blur rather than the very cartoony smears of the previous one. The animation was also closer to what the final 3D animation would be.



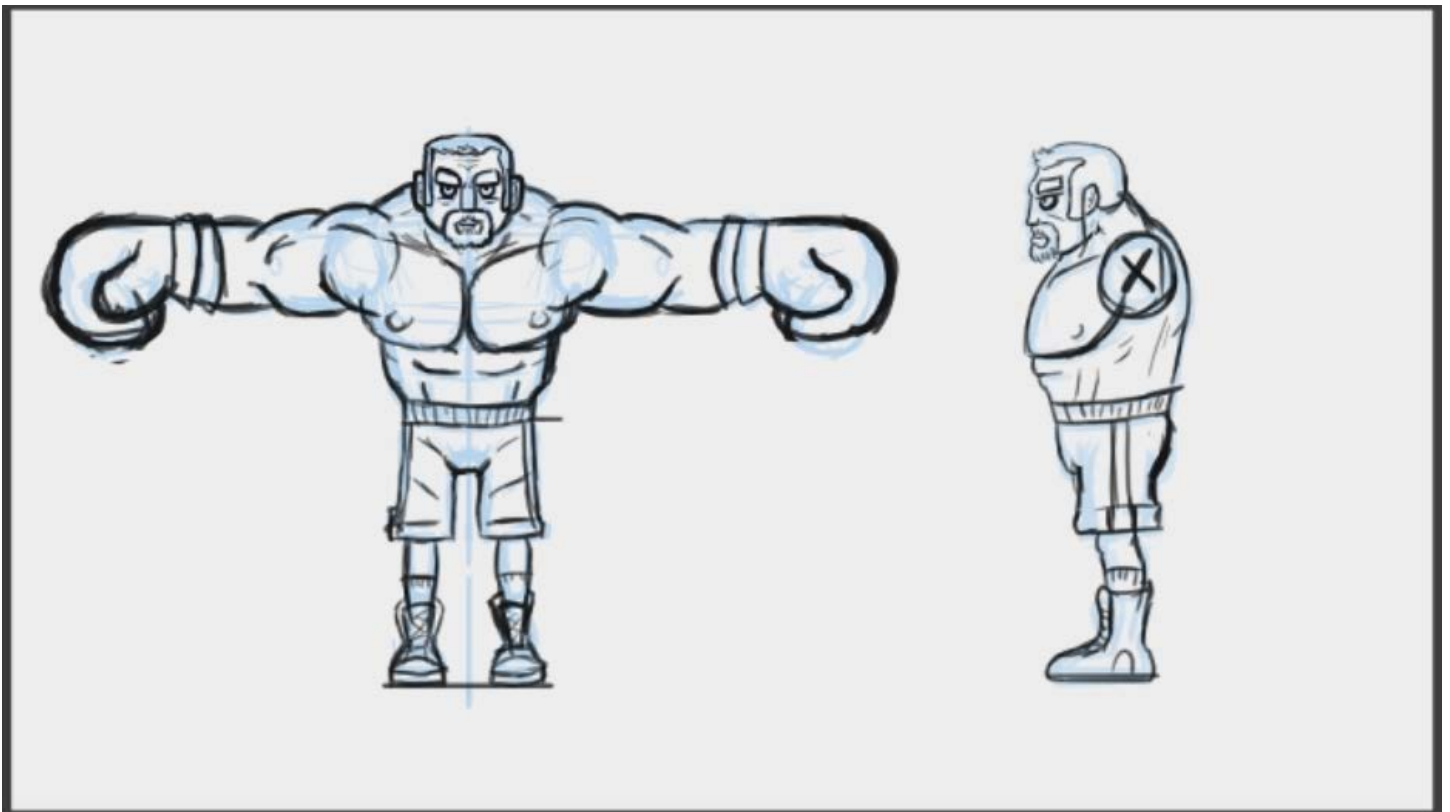
Animatic and Character Design

While I was designing Champ I had some problems trying to make a boxer that identified immediately as a boxer, but also had a unique look and feel. Another problem that I had while designing him was making sure that he was likable. It was very easy to push his muscles and his lack of neck just a little bit too far and end up with a result that made him look far too brutish. Originally I designed him as a comedic character that was such a jerk about being the current heavyweight champion that audiences would love to hate him. This did not read well and his appeal just was not quite working. I decided that instead of having a humorous backstory, a tragic backstory would do better. I changed him from an arrogant current world champ to a retired world champion who lost it all in a single fight. With this redesign I made him significantly older and much more likable and humble. He still instantly read as a boxer.



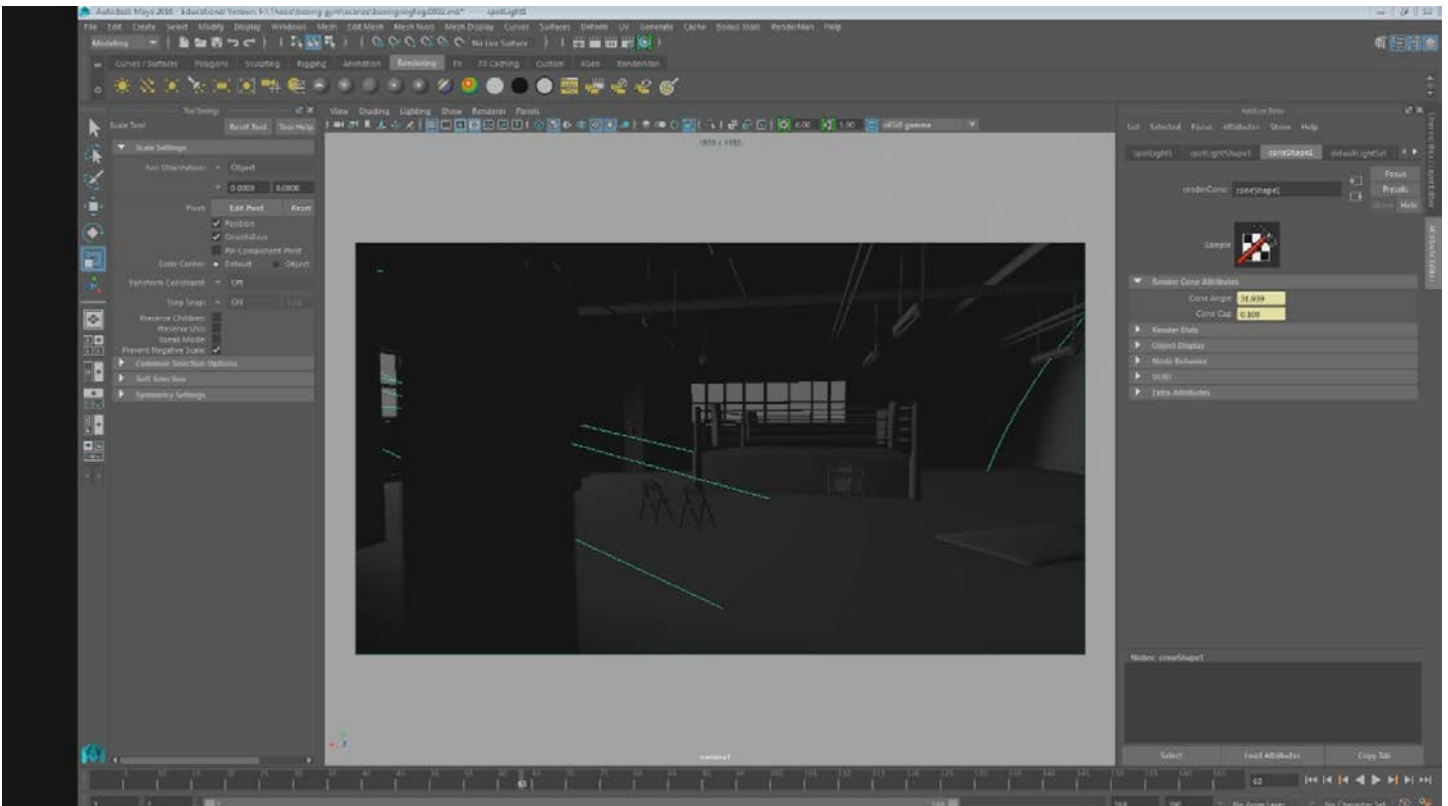
After I had the basic character design I started making an animatic about Champ training in his gym remembering the day that took it all away from him. In doing this I was also trying to lock down a design for the boxing gym as well as camera shots, and a feel for how Champ actually boxes. I

researched several different styles of boxing, and pinned down exactly how he would move, react, and even smear. In this animatic I actually used elements of the original champ to be his rival in the ring. A lot of the animation in the animatic is very sketchy and simple, but it got me all of the information that I needed. The kidney punch specifically is my favorite.



The Gym

Before Modeling Champ himself I decided that creating his environment first would give me a better idea of the 3D style that I wanted Champ to be designed in. From the animatic and story boards I replicated those designs in 3D while ensuring that everything was in real world scale. The boxing ring specifically was hard to get in the right scale due to preconceived perceptions of the size. It seems from movies and TV that it would be a lot higher off the ground when in reality it is only 3 to 4 feet off the ground. Once I got the ring modeled I moved on to the rest of the scene using this as the reference for the style and the scale. From there I built in key pieces that would make it read as boxing gym, such as; a punching bag, several speed bags, lockers, and florescent lighting that you would see in kind of an older warehouse type building. From there it was a matter of texturing and lighting.



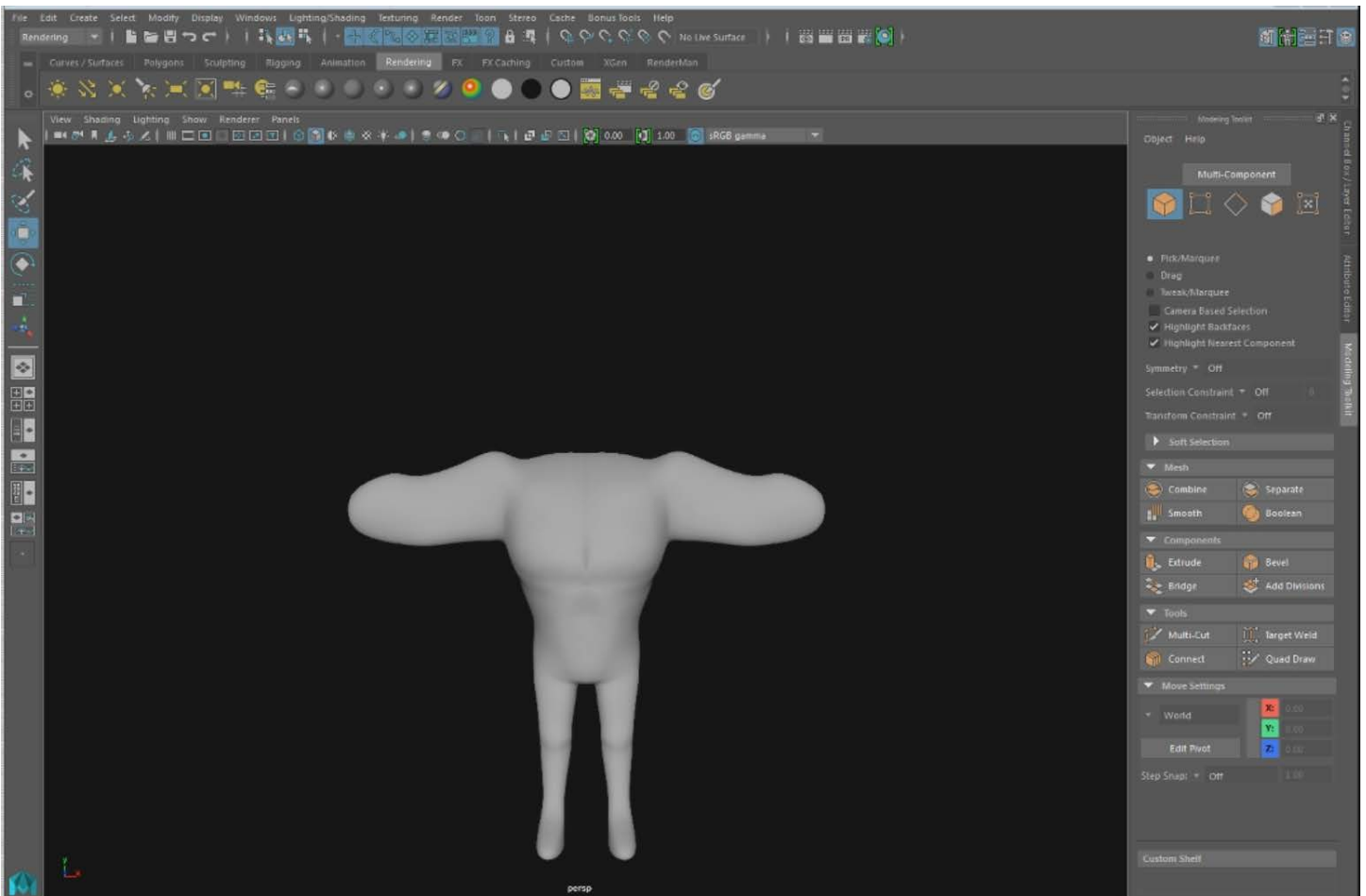
I knew at this point that I wanted to use hand painted textures on the character model, but I wanted the environment to have slightly more realistic textures so that Champ could stand out in

many different ways. I carried the story of Champs descent from grandeur to get the feel for this gym. At one time it might have been a nice boxing gym in the 70's or 80's, but at the current moment it has decayed and become a dismal scene that really has only become a solitary place that champ keeps up by himself. With that idea in mind I decided that I wanted all of the colors to be very subdued. I decided that I would base this palette off of older gyms and pools, so I used light blues, teals, and greens. I used that palette for the walls and lockers, but it didn't quite work for the punching bag and speed bags. I looked up reference, and decided to go with subdued browns, tans, and yellows to compliment the walls. With the idea of dim lighting in mind I wanted most of it to be naturally lightning. I modeled large windows that you would see in a warehouse and set up a Render Man environment light to shine through the windows. With that in place I started adding lights into some of the fixtures and changing up the colors of the bulbs so it would feel more natural, and I could successfully light corners that seemed too dark or add a shadow to accent.



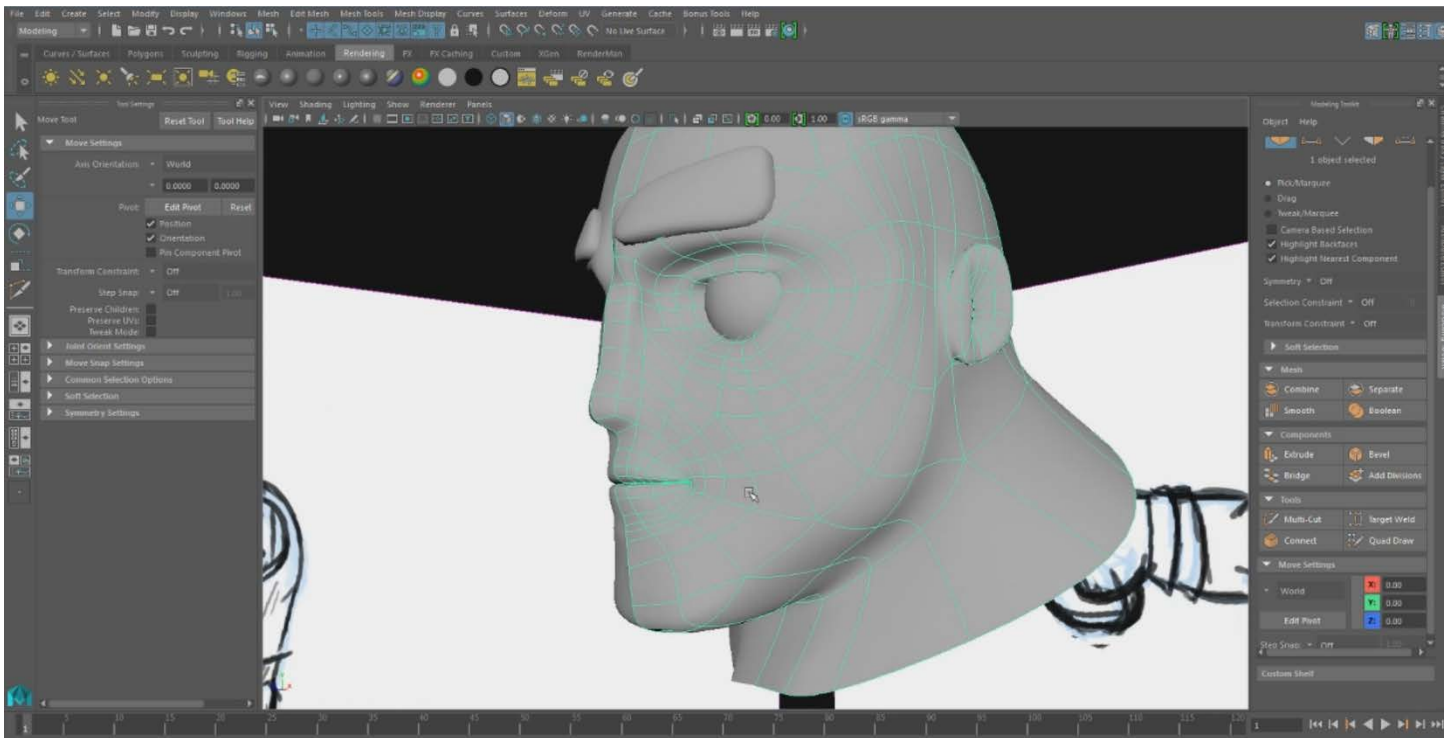
Character Modeling

From the concept art I knew I was going to have to model a stylized muscle structure, but I also knew I wanted to keep Champ relatively low poly. The way I chose to model Champ was to box model all of him. Box modeling is the process of starting from a cube and expanding and adding extrusions, edge loops, and detail in order to shape it into the correct shape. In order to this symmetrically I deleted half of the cube and duplicated a mirrored instance of the half of the cube that was left. An instance of an object means that any changes that you make to the original it will apply it to the instance. Once I got the body entirely done all I did was delete one and mirror and combine the geometry. In terms of his actual geometry I spent a long time trying to get the topology to be correct.

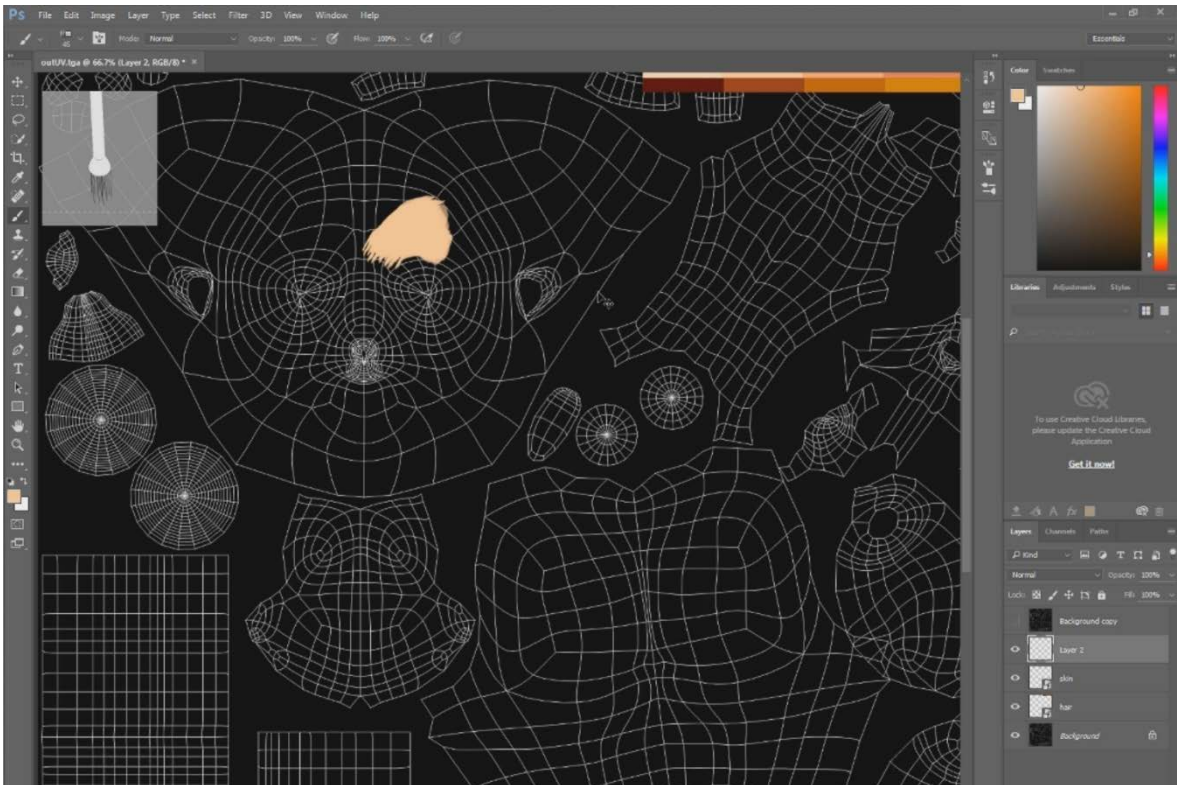


Topology was one of the most important parts because with incorrect topology the deformation of the character can potentially be disastrous. The most important areas were the face and the

shoulder area, specifically the armpit. Also, edge loops around the elbow and knee really help for the rig to be more malleable. The face topology and shape was specifically hard to nail down. There is a very specific flow to the edges especially in the areas around the mouth as well as the eyes. These areas have the most movement associated with them, so if they move incorrectly then it is very noticeable. Another part that I spent a lot of time retopologizing was the nasal labial fold. This is the part of the kin that deforms from the start of the nose and runs to the corner of the mouth.

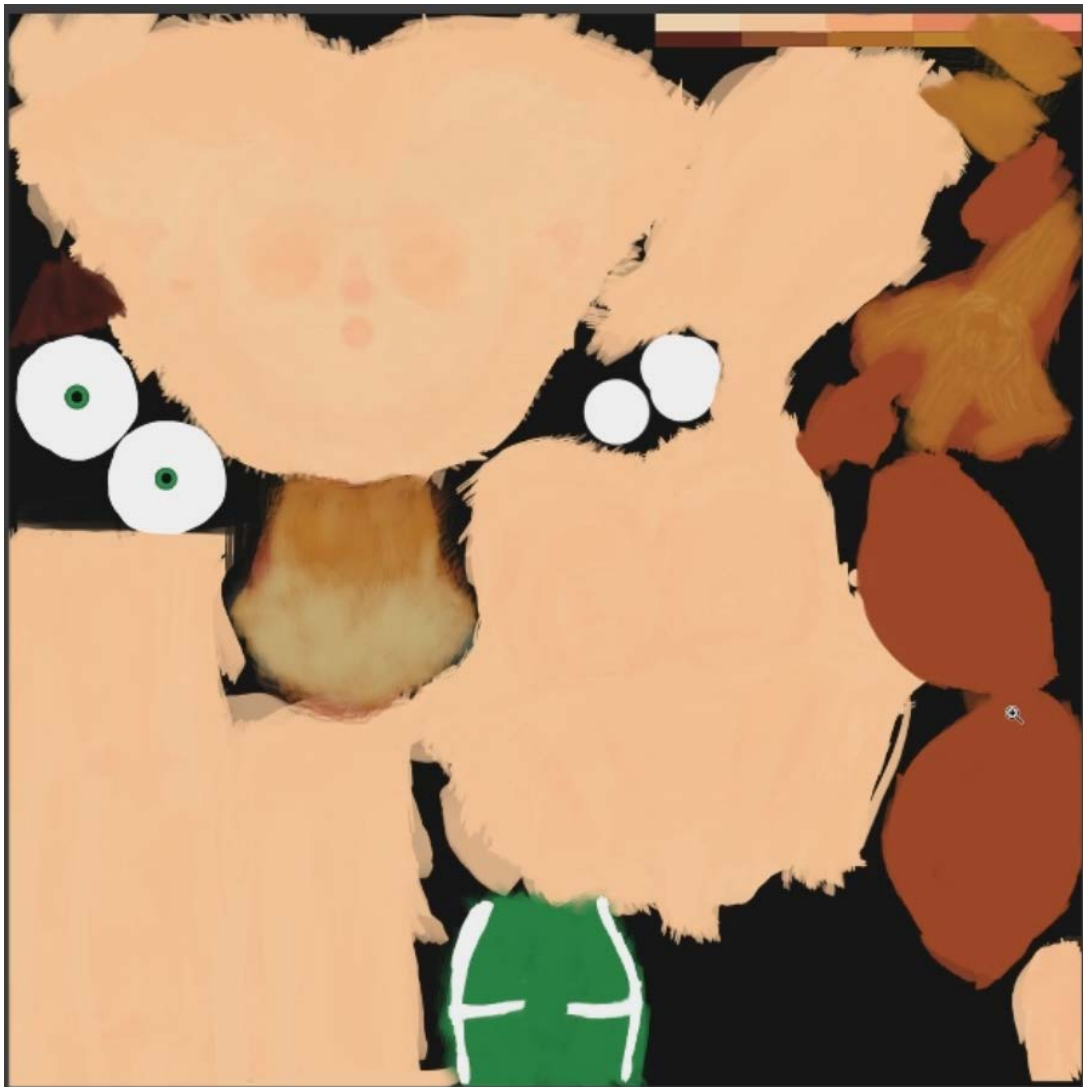


From there I modeled the accessory pieces such as his gloves, his hair, his shoes, and his shorts. These models were much simpler in comparison. They didn't have nearly as much topology importance since their movements were much more manageable. In the sketch I made his hairline recede a good deal, which caused some problems on lining that up with where on the head that would fall. Once I had all of the finalized model I had to UV the character. I decided that I wanted all of his different geometry to share a single UV set. I rationed out the space accordingly, giving considerably more space to the face and the chest, as opposed to things that won't be nearly as prominent such as the bottoms of his shoes.



Texturing

Once I had the UVs spread out I had to paint all of his maps by hand. I decided that instead of the pseudo real textures I used for the gym, that I would use a painterly style on his texture maps. I hand painted the textures making sure to get some variance in the skin tone and making some areas a little more red in the face than others. The hair proved to be quite difficult for the brush strokes to read as hair instead of just variance in the color like the skin. Finally, I added in a muted blonde to his red hair to give the feeling that he is going gray. I used this color to make the hair lines this read a lot better and solved the majority of my problems. The rest of his texture work like on his shoes gloves and gloves were pretty much just color blocking. After that I started painting the subsurface layer.

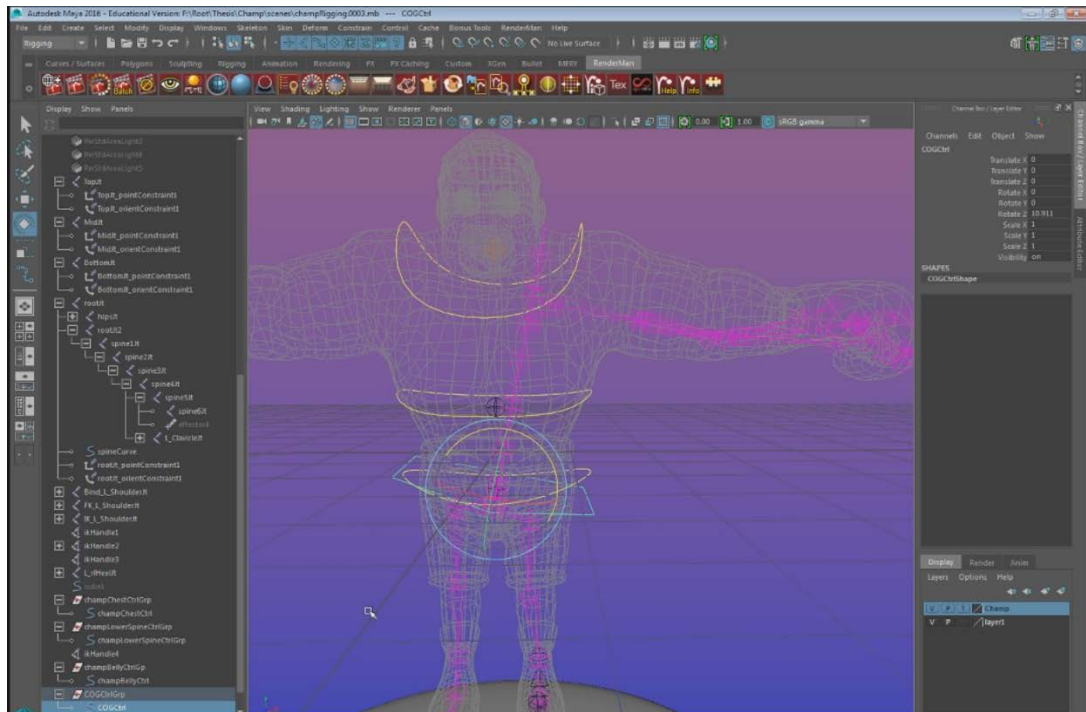


The subsurface layer was a bit different because I wanted to paint in the muscular structure underneath his skin. I looked at several reference pictures to see what this would look like and then exaggerate it with the way that Champ's muscles are exaggerated. From there I made a spec map, to really bring out some of the areas that had become muddy. The spec map brought out many of the muscles especially in the chest and in the arms. In the face I used the spec to make the brow more pronounced. With all of these maps done I made different Render Man materials for his skin, gloves, shoes, shorts and hair. This way I didn't have to paint a map for every single difference, but could assign values to the roughness and other controls. His eyes were a bit trickier. Eyes are something that we see every day and they make or break a good character texture. In his eyes I originally got a photograph and put them in place, but this looked really weird on the painted skin. I hand painted them next, and had to be very mindful that they were perfectly round and that they transitioned well from one color to the next.

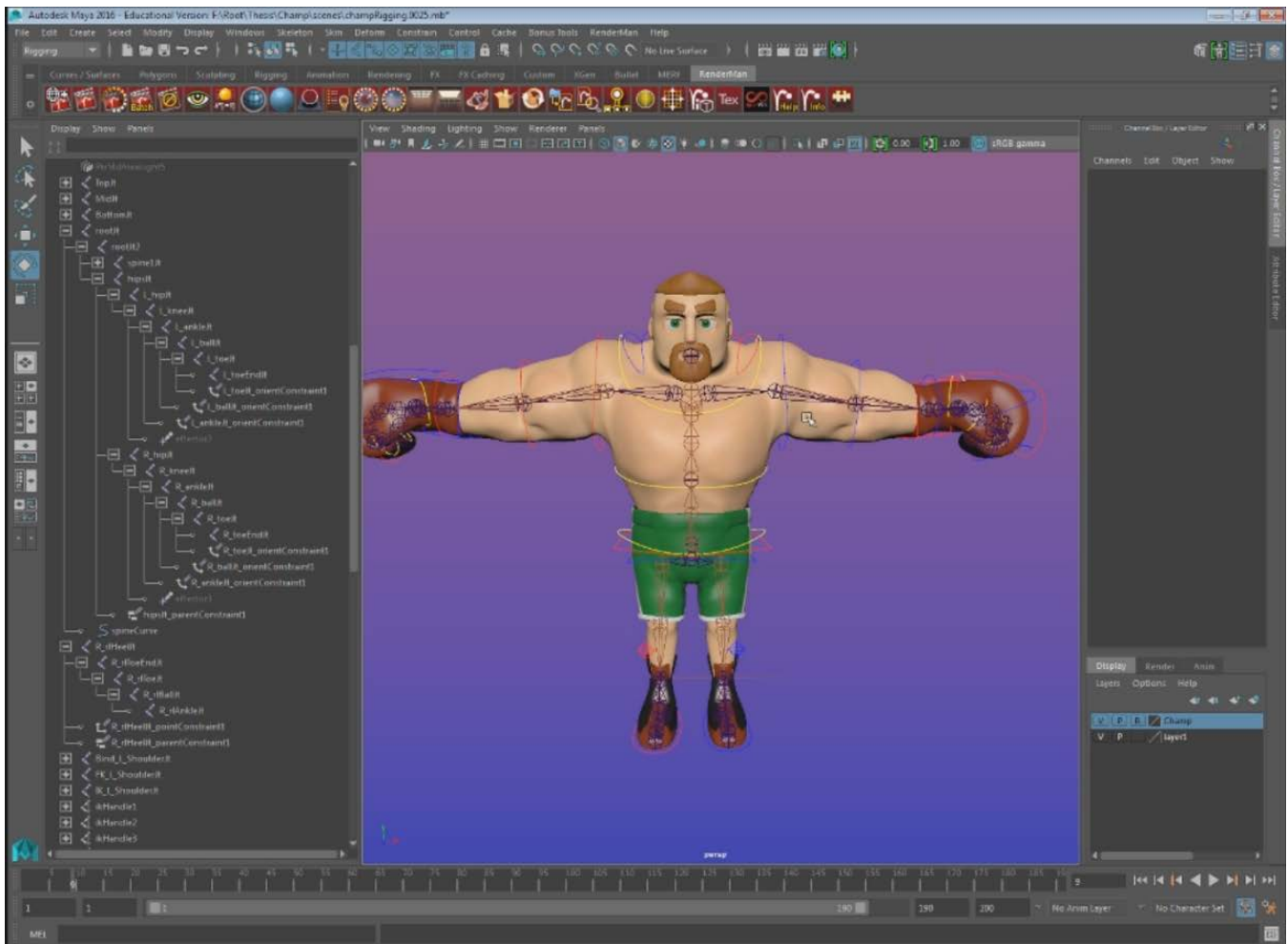


Character Rigging

In the placement of joints I had to specifically be careful to make sure that they were in the proper place. For Instance, since the shoulders were models very large and stylistic I needed to make sure that the shoulder joints were placed a little bit further out than normal allow for better deformation. Rather than making a full hand rig I decided that with his boxing glove that I only really needed a single finger chain to control it. I wanted the pine to be flexible, but easily controlled. I had to decide if I wanted the spine to be FK or IK. FK or forward kinematics would give Champ a better range of motion, but IK or inverse kinetic spines have a much easier way placement. I decided to go with a combination of the two using an IK spline handle. This handle gave me the most flexible spine with the simplest controls for an animator. The arms had FK, IK, and Bind joint chains. The Bind joint chains had been orient constrained to both the FK and IK joint chains and their influence controlled by an FK/IK switch located on the hand customs control. Another important aspect for a boxing character was how his feet would be controlled, specifically heel raise. In order to accomplish this used a reverse foot rig.

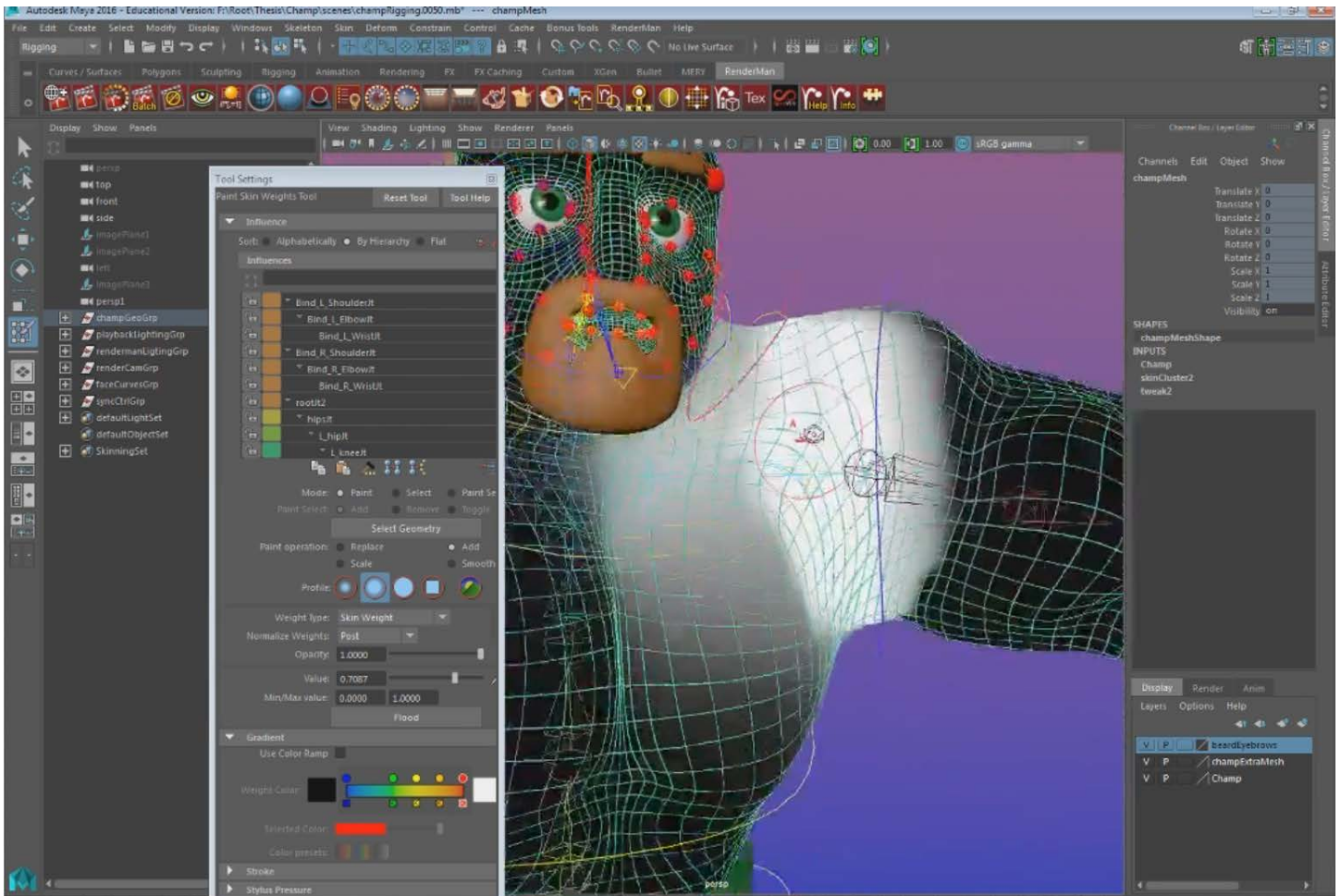


A reverse foot rig is where you start a separate joint chain at the heel, and move up to the toe, the ball of the foot, and then the ankle. The current joint chain that are in the feet then get orient constrained to the corresponding joint in the reverse foot rig. Once these were in place I used set driven keys to drive the feet so that heel raise can be utilized. Once all of the joints were placed and constrained accordingly I made NURBS curves to control all of the joints.



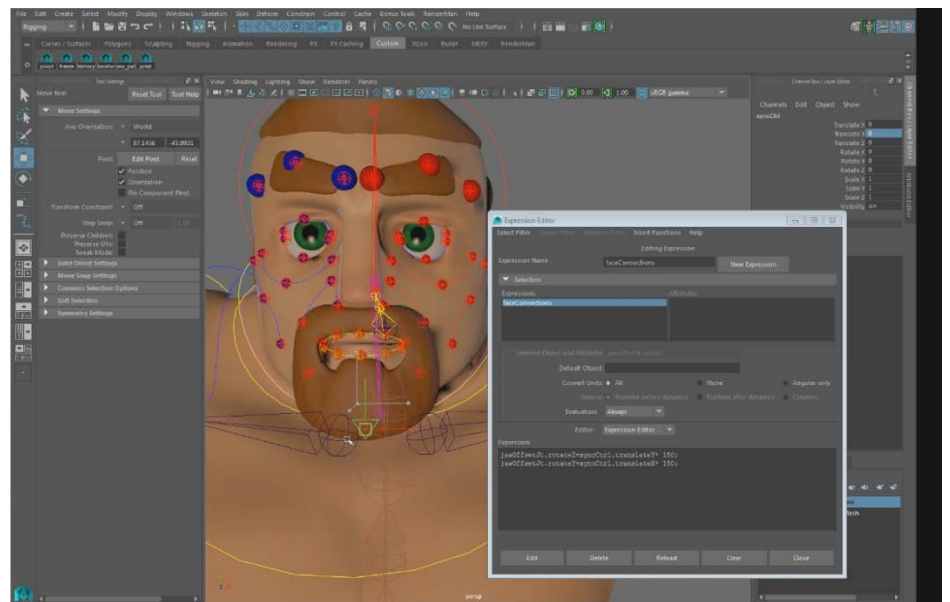
Most of these curves were made out of altered NURBS circles that the joints are constrained to. Then in the attribute editor I used the drawing override to change the colors of the curves so that the right and left sides of the body can be easily distinguished and there is no confusion on what each curve does. Another aspect that was important was for there to be some more cartoony elements in

the rig. I added a squash deformer to the boxing glove mesh, and then had it be controlled by the hand Customs controller. From there it was only a matter of painting the skin weights. The shoulder weights were the only real problem they took several passes and some influence objects to get the deformation correct.



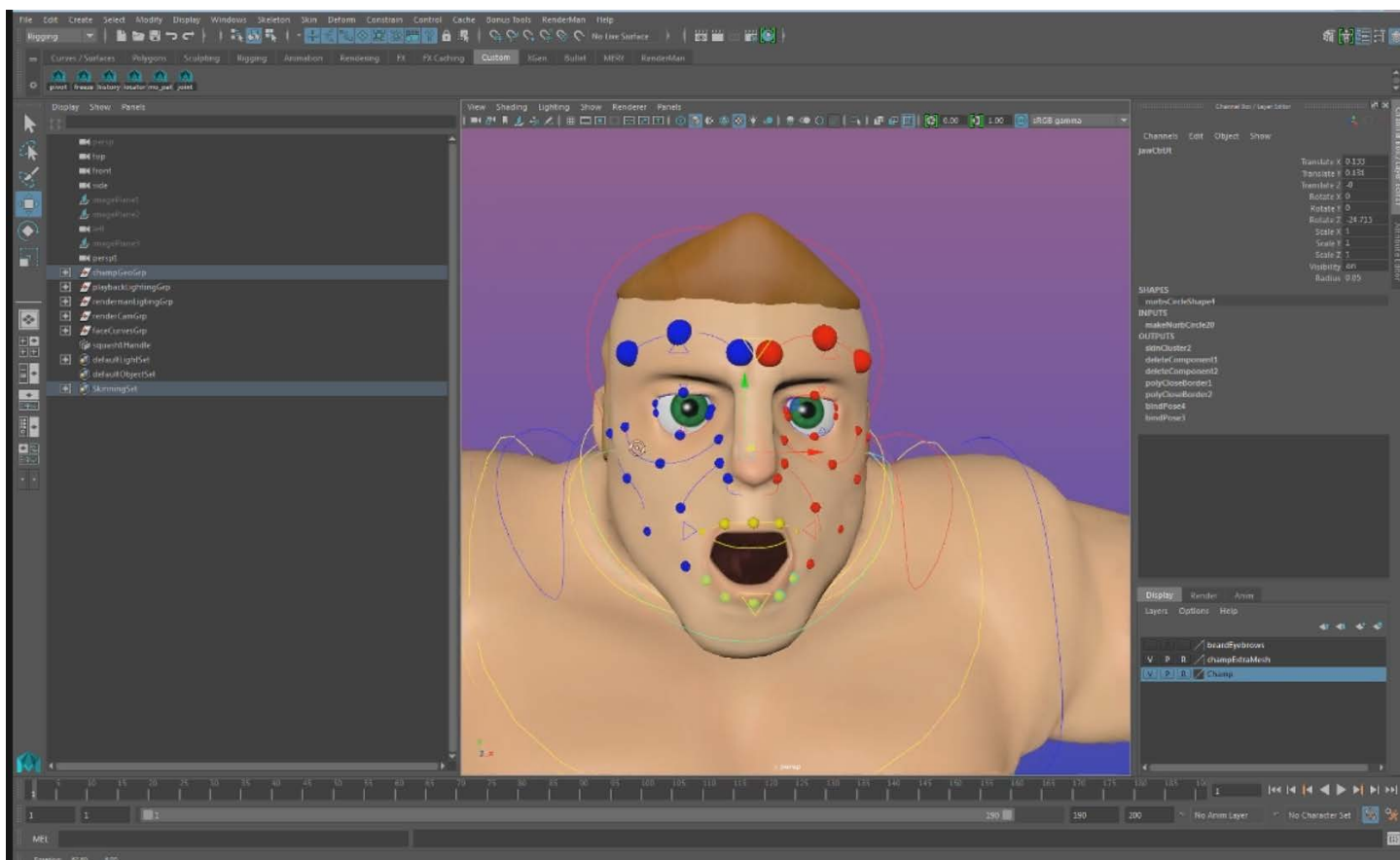
Facial Rigging

Most commonly a face rig is made out of blend shapes that have a control panel that is separate from the mesh making it easy to see your face shapes. Blend shapes are different geometry that are applied that can morph your current geometry into that shape as long as the number of vertices match. This is normally done by duplicating the mesh and then editing it. On this rig particularly I wanted to try a joint based facial rig. Joint rigs are normally avoided because when painting weights there are usually more than 24 joints all in a close proximity to one another which makes skinning a pain. However, there are benefits to rigging with joints, namely if the TD is not comfortable making more models. Even in this there are some blend shapes that are necessary, but they don't have to be applied to the mesh. The system I used to make the rig was by making several NURBS curves the lined the major muscles and deformers of the face: the eyes, the brow, the lips, and the cheek. From here I used an offset and control joint system that are parented to a locator, which is attached to these curves via a motion path. With this in place the control joints are what the animator selects directly, so to stream line that I stole the shape node from a NURBS sphere to act in place of the joint shape node. This system allows for the TD to hide the joints, but make the NURBS surfaces still visible and selectable.



All of the joints and locators follow the NURBS curves that outline the face so the final step was to make blend shapes of the NURBS curves themselves. With these in place I used set driven

keys to automatically activate the blend shapes when you make certain adjustments. When you open the jaw for instance the mouth narrows slightly and becomes more ovular in shape. Skinning these control joints proved a more difficult challenge. The mouth was the most difficult as any influence on the roof or top lip that doesn't belong can cause massive problems when the jaw lowers. Eventually though I had all the blend shapes of the curves in place, and this system gave me the idea of how to make the 3D smear frames.



3D Smear Frames

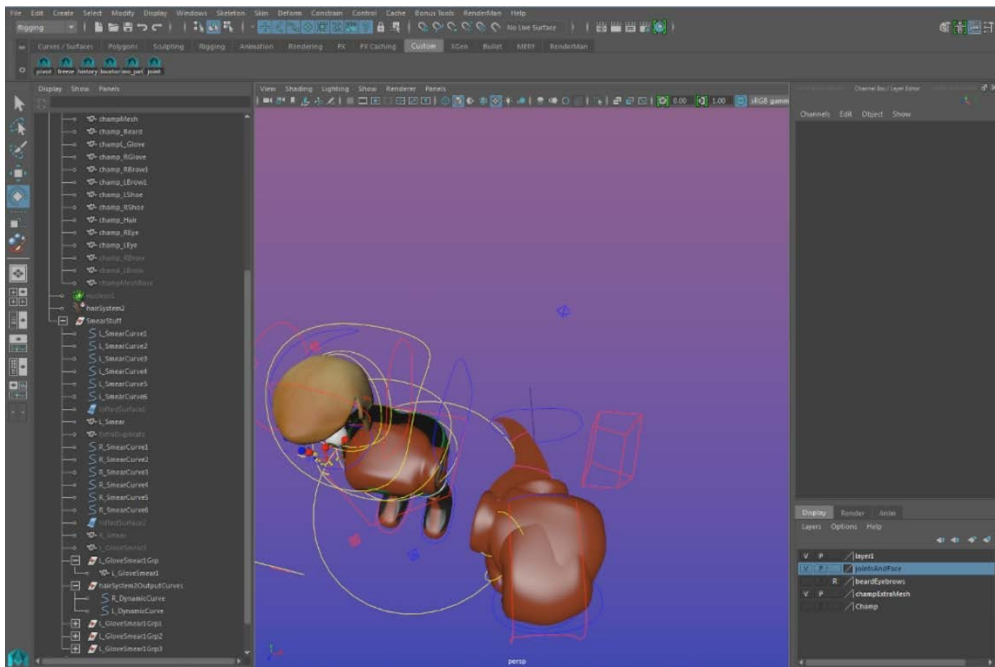
With the smear frames I tried out many possible solutions. The first one I had seen before, which was to manually duplicate geometry and key it into the correct position. I used this method when I made a replication animation of Mulan in 3D. This worked, but was messy and difficult to rig or



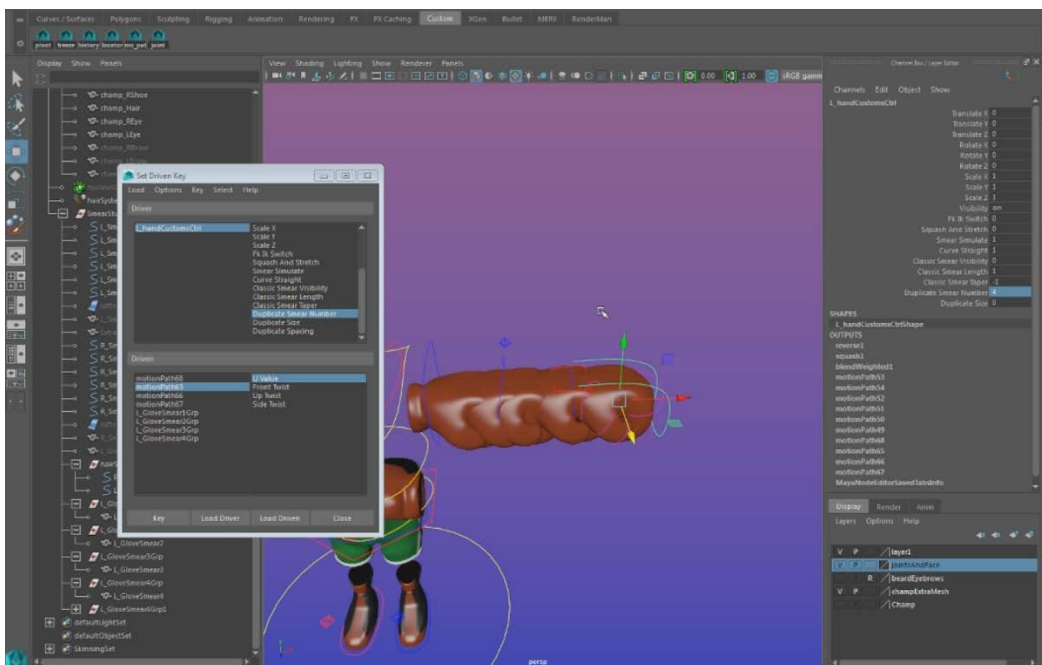
control easily. The next idea I had was to use particles to trail behind which could mimic the motion path of whatever it was emitting from. This however, was not easily controlled and was very difficult to get anything close to the extension of the geometry look I was going for.



So with all of these failed attempts I decided that using what I had learned from the facial rig to get the smear frames to work. I attached a dynamic curve to the middle of the hand, and then using the attach to motion path workflow I had just learned I attached six NURBS curves, which had lofted geometry that was still influenced by the curves to the dynamic curve as well as 4 instances of duplicate boxing glove geometry.

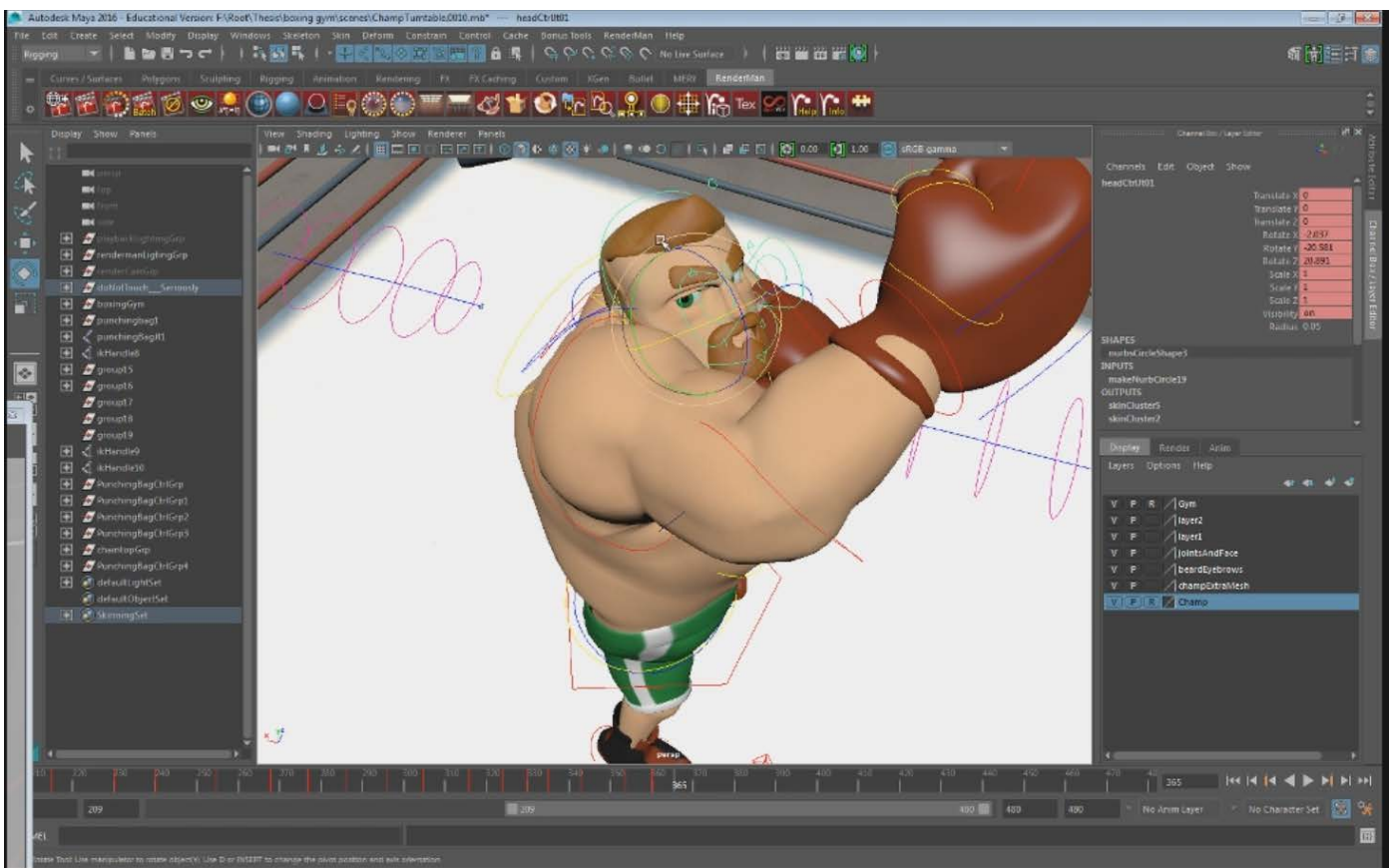


With all of these in place I made controls in the Hand Customs Controller to do the simulation, control the length and size of the classic smear frame, as well as turn on zero to 4 instances of the duplicate smear. Once this was in place the idea was when the finished animation was ready you run the simulation and stop the timeline on the desired frame. From there an animator would control the shape, size, length or number of duplicates to what they wanted. When the smear is at this point all an animator has to do is duplicate the mesh, key the visibility, and stop the simulation.

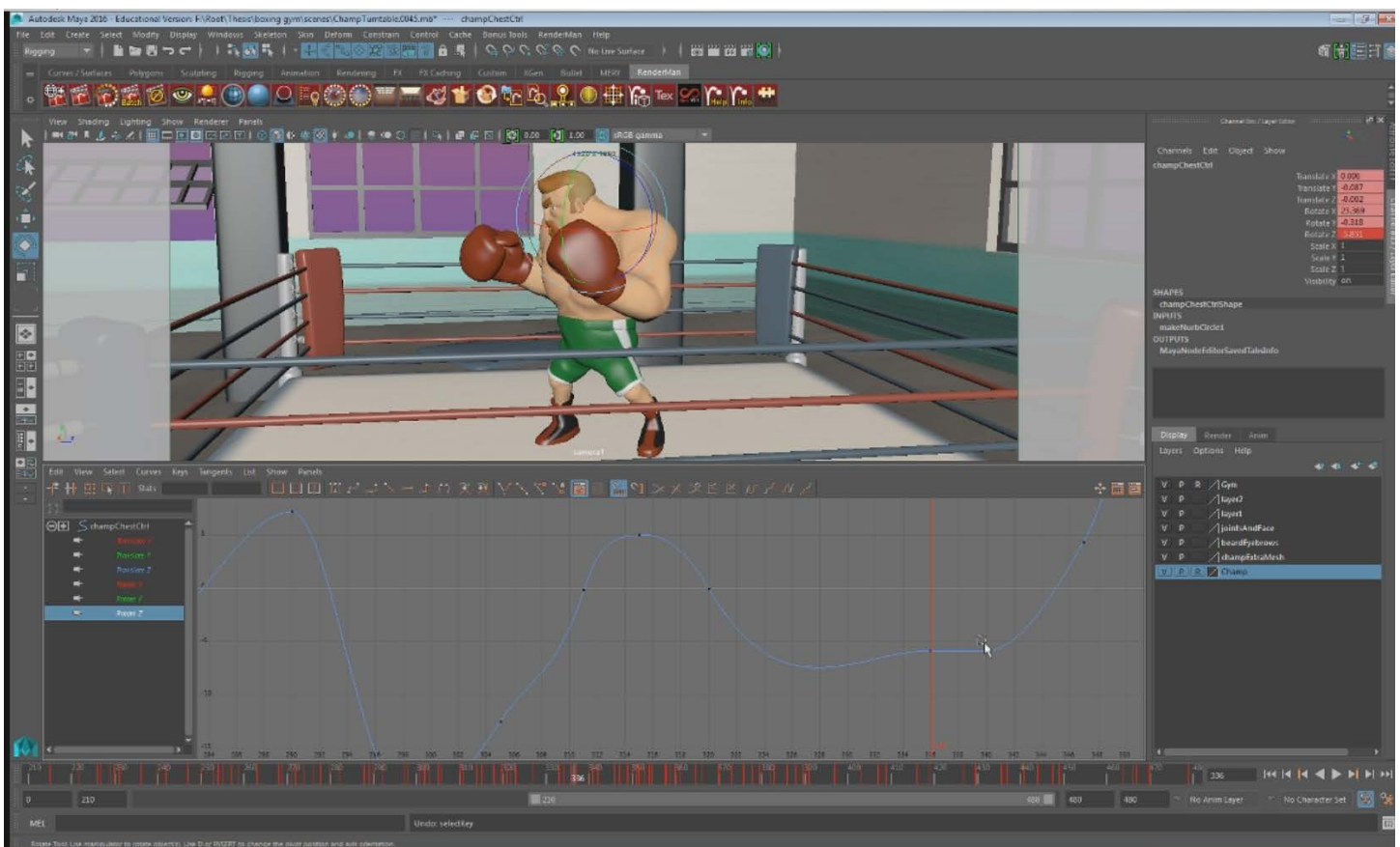


Animated Turntable

From the very beginning of the project I knew that just basic punches wouldn't cut it. I needed to know combinations of punches and boxing warm ups. I watched all of the Rocky movies and anything even remotely boxing related. One of the biggest inspirations of how to animate it was Punch Out. The warm up punches that Little Mac does are what I used for inspiration of this piece. With the amount of work that was done for this project I decided that I was going to want at least a turntable to show off the model. With this in mind I made a turntable that on the second turn around comes to life. Going from T pose into animation I decided that it would be fun to play around with the idea that he was stiff and needed to loosen up and warm up. I filmed reference three or four times of me doing the motions. From this reference I got the key poses for my animation. The key poses were adjusting the neck, rolling each shoulder, the basic boxing pose, and the in and out poses for the punches.

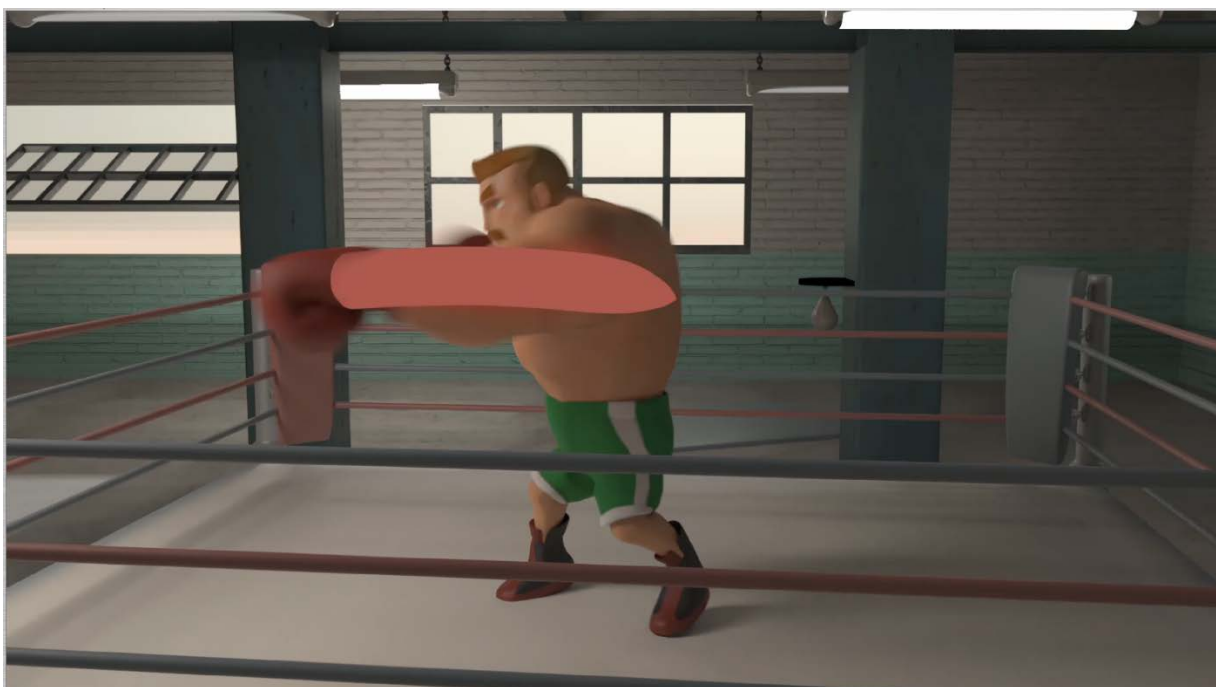
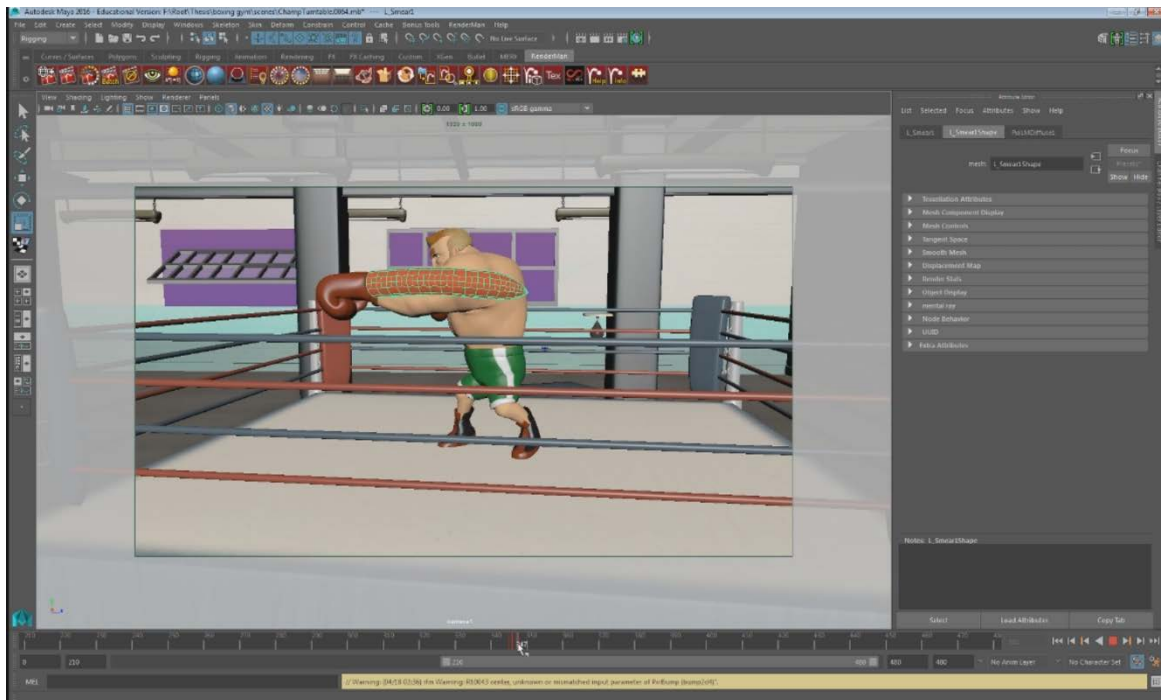


From This point I broke down each of these to add two or 3 more in-between poses to really make the arcs look good. The timing of these were a little off, so I went into the graph editor for the retiming tool. Once everything was retimed I went into the graph editor and started polishing all of the curves. This took four or five passes focusing on something different every time. Arcs were the main thing to look at especially because if the motion trail was not correct than the smear frames would accentuate a bad animation. I focused mostly on the upper body because with his proportions it was the most important aspect, and takes up the most space.



The foot work was very important just like in real boxing. The weight was the second pass that was very important. I needed to make sure even though his legs technically wouldn't support his weight I wanted to give the illusion that they did. The last thing I did was add the smear frames in. I wanted classic smears for the jabs, but I wanted to really accentuate the uppercut. For the uppercut I used duplicate smear frames and edited them to follow as well as possible. Motion blur was

supposed to be the replacement for smear frames, but I wanted to see what would happen with a union of the two. In the render settings I added motion blur, and let it go. I looked at the result and wasn't entirely happy with how bland the camera was. In order to remedy this I added a noise expression to the translate Y. I had to limit this immensely.



Conclusion

When creating a rig from scratch there are many different areas that have to be tackled. Using a stylized method allows for the model to be cartoony, but takes making serious design choices into account at the beginning. Stylized muscle specifically needs detail and a lot of work to look correct as well as deform correctly. Building a rig from scratch gets a more customized control system especially if you are the animator. I built my rig with IK spline spine a facial rig made of offset and control joints, blend shapes, set driven keys, and dynamics. 3D smear frames can be made in a number of ways, but the way that I found was the best for control for an animator was to build it into the rig using a dynamic curve to drive its. Animation is a multi-layered process using the 12 principles to refine the initial key poses you can get a finalized animation that includes 3D smear frames.



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