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Oval Office.

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Oval Office

Thesis submitted in partial fulfillment of Honors

By

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Introduction

The Oval Office is the most iconic room in the White House and one of the most recognizable interiors in the United States. I have recreated the Oval Office as a three-dimensional, interactive environment for the purpose of studying 3D modeling, texturing, and environment creation. The Oval Office is almost 36 feet long and exactly 29 feet wide; it is filled with unique furniture, paintings, and sculptures ("Oval Office Dimensions"). My recreation of the Oval Office contains more than 30 unique pieces of furniture which use over 100 high-quality texture maps. The final project is designed for the Unreal 3 Engine, and still image renders were created with the Mental Ray renderer from within Autodesk Maya. The software I used to complete this project included Autodesk Maya, Autodesk Mudbox, Adobe Photoshop, Quixel's nDO2, XNormal, and the Unreal Development Kit 3 (UDK) by Epic Games.

Rationale and Goals: Why Recreate the Oval Office?

When I was younger, I toured the White House but never saw the Oval Office. After the tragic destruction of the Twin Towers, it has become very difficult to tour the White House and nearly impossible to see the Oval Office as a tourist ("Tours & Events"). This experience is what first spurred the idea of recreating the Oval Office. I wanted to make an interactive version of my work so that others could tour the Oval Office for themselves.

I am an entry-level Environment Artist with aspirations to find employment in the video game industry. I wanted to build a case study around the creation of a detailed environment that could easily be rendered in a video game engine. My goal was to study the creation of both organic and hard surface models as well as learning which workflows were best suited to each object within a scene. I also wanted to study how different textures might be created and what workflows resulted in the most efficient and effective results, especially when creating Normal maps. I planned to accomplish all of this by recreating an easily-recognizable location so that the end result could be appreciated by the widest possible audience. Using a recognizable and well-documented location also provided more opportunity to compare my work to its source material, requiring a higher degree of quality than a more-obscure location to appear authentic or believable.

I decided that the Oval Office was an ideal fit for all of the above criteria. The scope of the project was manageable for an undergraduate thesis, so I had time to focus on minute details that would enhance the quality of the scene as a whole. I was able to achieve better results by recreating one high quality room than by attempting to bring an entire building or a large landscape to life single-handedly. Also, the components of the Oval Office vary in form, structure, and texture, offering a variety of models and textures for my case study while keeping the project scope reasonable.

The Initial Challenges and Preparations

Because the Oval Office cannot be toured, I resorted to using images and information found on the internet for my source material. By the end of the project, I had collected 120 reference images of the office itself and individual props. Working from source material was integral to the success of this project. My source images and research allowed me to keep my pieces proportional to one another and to ensure that the detail I created was as accurate as possible. I found the dimensions of the office and used them as my starting point, estimating the scale and location of each asset based on my source images. After the assets were created and placed within the environment, I fine-tuned their proportions so they more closely resembled the source material and were consistent between images. Determining the consistency of asset proportion among images was challenging because the images were taken by various photographers using different cameras, lenses, and focal views that were not specified within the original image files. I accounted for image variance and ensured that my models matched up with as many references as possible.

Another challenge was that many of my source images depicted different iterations of the Oval Office. The Oval Office changes frequently, sometimes in minor ways other times being completely redecorated. I chose one moment of Oval Office history and recreated that instance, but most of my source material depicted different furniture, materials, and object placement. My Oval Office represents the August 31, 2010 redesign in which new, microfiber couches were added and the curtains behind the Resolute Desk had just been replaced.

The final challenge was that, due to time constraints as an undergraduate student, I could not feasibly recreate every single detail or even every single object within the Oval Office. I was selective in determining which objects would take too much time to recreate to the standard of accuracy to which I was holding this project. I also had to factor in which elements of the office were least important when deciding which ones to exclude. I also took into account whether I could find the appropriate quality and number of source images to allow me to recreate each object. My final result contains almost everything in the Oval Office just after the August 31, 2010 redesign, but a few less critical objects were excluded, including the plant on one of the couch endtables and some of the bookshelf objects.

Modeling and Texturing Methods and Workflow

I decided to use a “Low-To-High, High-To-Low” modeling workflow for the vast majority of these assets. This means that, when creating a new asset, I would first create a base mesh without focusing on its polygon count or its UV layout. The purpose of this mesh was instead to represent the silhouette of the object I was recreating; during its creation, I focused on maintaining consistent edge flow and clean, even topology. I then either sculpted a very high level of detail into the mesh or otherwise ensured that the model looked as accurate to the original object as possible without worrying about excessive polygon cost. Finally, I baked the details from the high-polygon model into a Normal map that allowed a far less costly model but retained the look of the detailed sculpt. The final, low polygon mesh was created by retopologizing the high polygon mesh. Retopology is the process of creating a low-cost version of a higher polygon mesh by rebuilding a simpler polygonal form over the silhouette of the more detailed mesh. This modeling workflow allows the final mesh to retain the look of the high-detail mesh without the excessive polygon count, which would slow most computer processors.

When baking the Normal details from the higher-polygon mesh into a texture, I also chose to bake an Ambient Occlusion pass into the texture based on those same Normal details. Ambient Occlusion is "a rendering technique used to mimic the way a surface shadows under very diffuse illumination" and is commonly used to generate indirect shadows along points of contact between meshes ("Ambient Occlusion"). By integrating baked Ambient Occlusion texture into my diffuse texture, I very quickly added self-shadowing and extra detail to each object at a level of accuracy that I most likely could not have reproduced manually. I created many of my specular maps by altering either a grayscale conversion of my diffuse maps (without the Ambient Occlusion texture) or from one of the Red, Green, or Blue data channels of the diffuse texture graphic. This approach allowed me to easily reproduce the effect in which depressed or heavily-textured materials exhibited specular variance along the unique grooves and threads of that material.

This general workflow was decided on early in the project after having created a few assets and determining which techniques created the most effective and efficient results. However, the creation of almost every model involved the variance of this workflow due to the diversity of the objects within the Oval Office in terms of both shape and material. In order to succinctly demonstrate this variance, I will describe the process of creating a few of the more interesting models that were included in my Oval Office.

Hard Surface Models

1. Resolute Desk

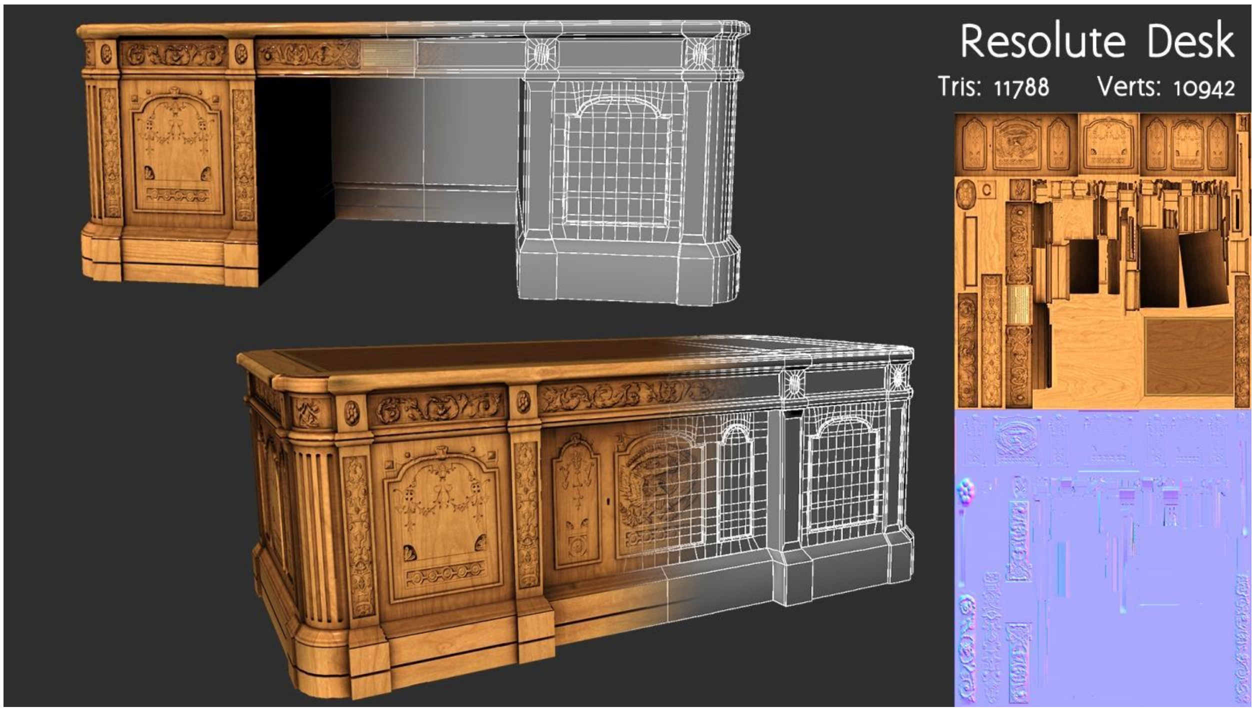

Figure 1: The final Resolute Desk with the model's wireframe (left) and the Diffuse and Normal maps (right).

The model that took the longest to create was the Resolute Desk. The decorative trim that covers this beautiful piece was a challenge to recreate, and the model had to be redone multiple times to produce crisp, clean details. Many of my models went through this iterative process, but the Resolute Desk had more versions than any other piece.

I started by first creating the base mesh which I would later use to sculpt my high-polygon, detailed desk. I modeled the desk's detailed corners separately and merged them into the base mesh. At this point, I believed that I was ready to sculpt in the details using Mudbox, but attempting to do so was nearly impossible when importing the entire desk. I underestimated how much detail and how many polygon subdivisions this desk would require to create an acceptable high-density mesh. The computers I used for this project could not handle the number of polygons required for such a sculpt. My solution to this problem was to separate each panel from the base mesh, leaving only the desk frame in one piece. I then imported the panels separately into Mudbox and subdivided each as needed.

Next, I had to determine how to recreate the detailed trim of the Resolute Desk on my Mudbox model. I first created a stencil from a few of my source images, overlaid the stencil on my sculpting brush, and etched the details into the desk directly. The result of this process ultimately fell short of my expectations due to the blotchy resolution of the details. Instead of using stencils for this process, I elected to recreate the desk by hand, using the source images solely as reference. This method cost fewer polygons and yielded cleaner, crisper results.

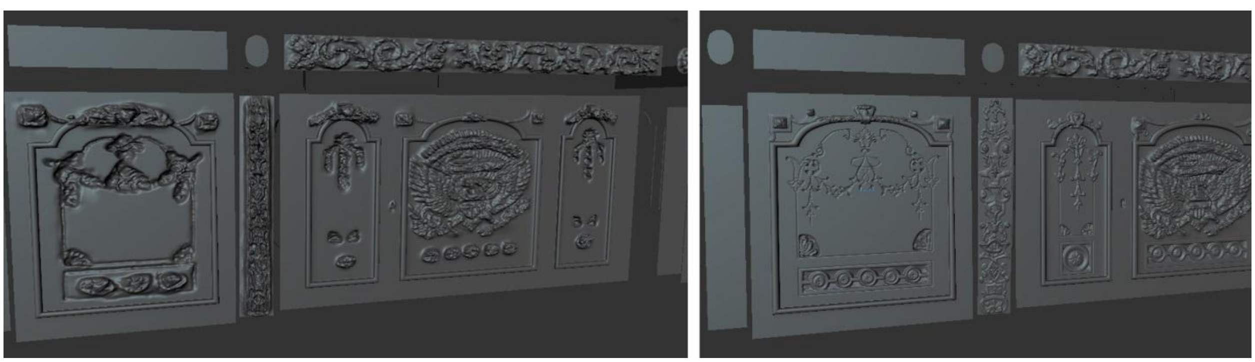

Figure 2: The stencil sculpting method (left) and the by-hand sculpting method (right).

The finalized, low-polygon mesh for the Resolute Desk was created by optimizing the base mesh by hand because it already had clean topology and an accurate silhouette. Many of the panels and half of the desk were duplicated after laying out the UV map for each mesh. Each mesh's UV coordinates describe how two-dimensional images should be applied to a three-dimensional object. As with most of the models I created for this project, I baked Normal and Ambient Occlusion maps from the high-polygon sculpt using XNormal. The Ambient Occlusion map was combined with my diffuse texture to create the majority of the details.

2. Picture Table behind Desk

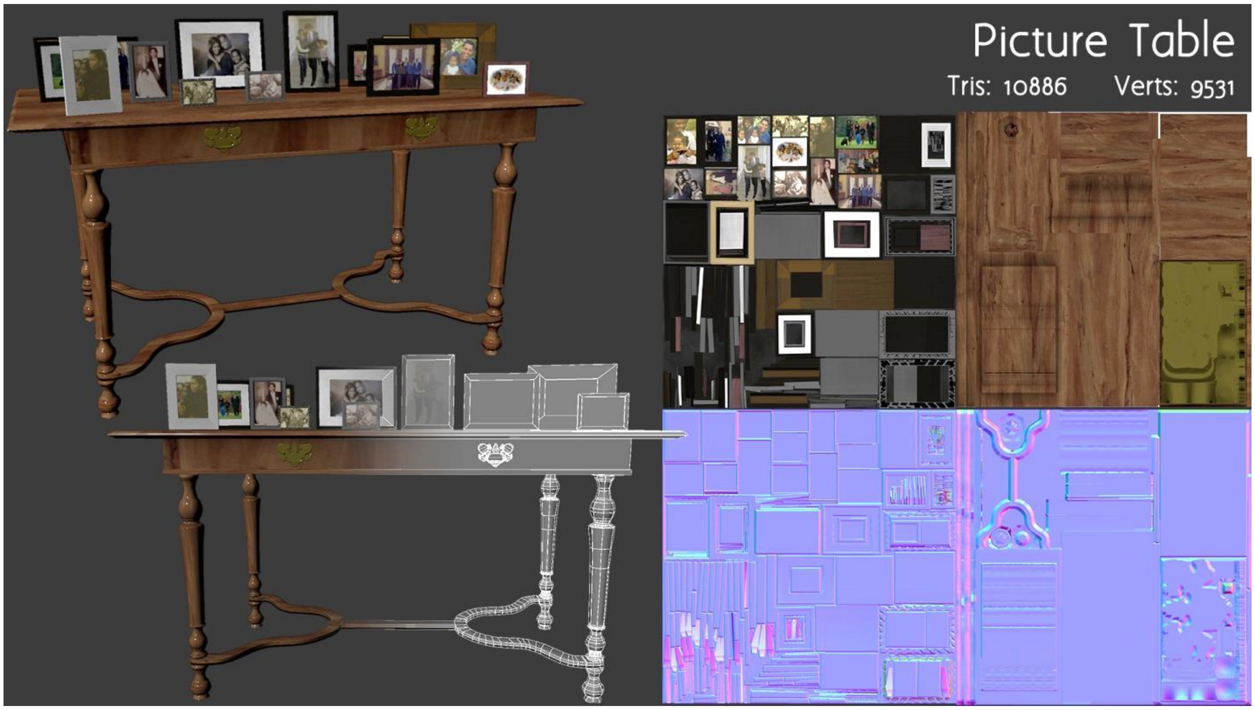

Figure 3: The final Picture Table with the model's wireframe (left) and the Diffuse and Normal maps (right).

The picture table is a completely hard-surface model and was created without using Mudbox. I began by creating the base mesh for the table, forming each part individually as floating topology. I then created the high polygon versions from these base meshes by adding edge loops and beveling the forms as necessary. Most of the pieces were straightforward modifications of cubes or cylinders, but the gold drawer handles required a different method. I drew an outline for the shape of the handle's base using a NURBS curve before extruding that curve and converting the result into polygons. I then repaired its topology and used the Smooth

Geometry brush to redistribute the vertices more evenly across the mesh. The handle itself was a much simpler modification of two spheres and a cylinder (Figure 4, right object).

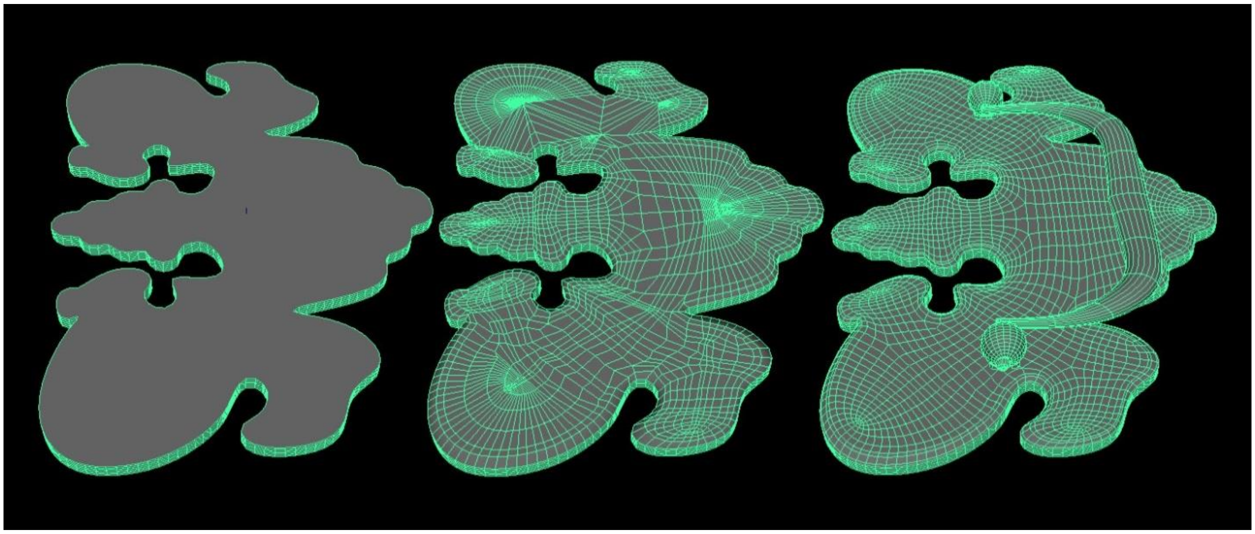

Figure 4: The progression of the drawer handle model: from a polygonal object converted from the NURBS surface (left) to a polygonal mesh consisting of only quads (middle) to the clean, final result (right).

The picture frames were fairly simple, but one of the metal frames had a more complex shape and required more polygons to recreate. Extra pieces were extruded from the inside of the frame outward and bend back subtly toward the outer edge of the frame. This detail was preserved when creating the low polygon mesh by creative use of triangles in the center of the picture, allowing for optimal silhouette and polygon count. The rest of the low polygon meshes were created from duplicated and optimized versions of the high polygon meshes. By simply removing extraneous edge loops and tweaking the position of select key edge loops, I was able to retain much of the forms' silhouettes and edge flow without using any retopology tools, resulting in a simple and quick pipeline. The Normal and Ambient Occlusion maps were baked from the high detail model using XNormal with cages exported from Maya.

Creating the table's diffuse texture was straightforward, but the various portraits on the table were challenging to accurately recreate. Few images of these pictures were found on the internet, especially ones large enough to use as references. Of the ones that do exist, many only contain cropped or obscured parts of each portrait. My recreated portraits are composited from multiple reference images taken at different sizes and perspectives, and a number of the details were hand-painted in Photoshop. A couple of the pictures were impossible to recreate and were replaced with other images of the president and his family.

Figure 5: The completed, textured Picture Table and picture frames within the final Oval Office scene.

Organic Models

3. Bust of Abraham Lincoln

Figure 6: The final Abraham Lincoln Bust with the model's wireframe (left) and the Diffuse, Specular, and Normal maps (right).

The Lincoln bust was one of the more interesting organic models to accurately recreate because of the bust's hair and bowtie, both of which had very specific and complicated silhouettes. Significant time and care went into the creation of this particular asset. Most bust models start with a premade head and skip the base mesh process. However, because I wanted to reconstruct an existing bust with a complicated silhouette, I decided to maintain my low-to-high, high-to-low workflow. I had created a basic head from scratch for an earlier project, so I decided to repurpose this head for the Lincoln bust. I overlaid various reference images of Abraham Lincoln and of the specific bust over this generic head, and within Autodesk Maya I rebuilt his face until it took on Lincoln’s facial structure. I then extruded faces of the mesh which were located where his beard and hair would be placed.

Figure 7: Development of the base mesh from within Autodesk Maya

Creating my own base mesh allowed me to integrate Lincoln’s shirt and collar into the sculpting process with greater ease and control. Creating this foundation for the neck was an easier task that consisted of extrusions, especially for the creation of the collar. The bowtie was created separately in Maya, requiring significant manual vertex manipulation and edge flow reconstruction to reduce its polygon count while maintaining its unique structure and details.

After some minor topology tweaks and optimizations, the base Lincoln bust was ready to be sculpted. Adding accurate detail within Mudbox to my own base mesh was much easier than it otherwise would have been because its silhouette was predefined. It took time to fine-tune the hair and ensure it had appropriate volume, hard or soft edges as needed, and folds that curved in the proper direction. The shirt details were sculpted, facial lines were placed in specific locations to match the bust, and the beard and eyebrows were etched to match the bust as closely as possible.

Figure 8: Development of the high polygon, sculpted mesh from within Autodesk Mudbox

The original base mesh, having been influenced by subdivision sculpting in Mudbox, was brought back into Maya along with the highest subdivision-level mesh. A Normal map was baked in XNormal using the high-polygon mesh and cage meshes that were generated in Maya. The Ambient Occlusion map was also generated in XNormal and was integral in creating the diffuse map and the specular map because it retained the extra “wear and tear” texture that was sculpted into the high-polygon mesh.

4. Recreation of Frederic Remington's *Bronco Buster* statuette

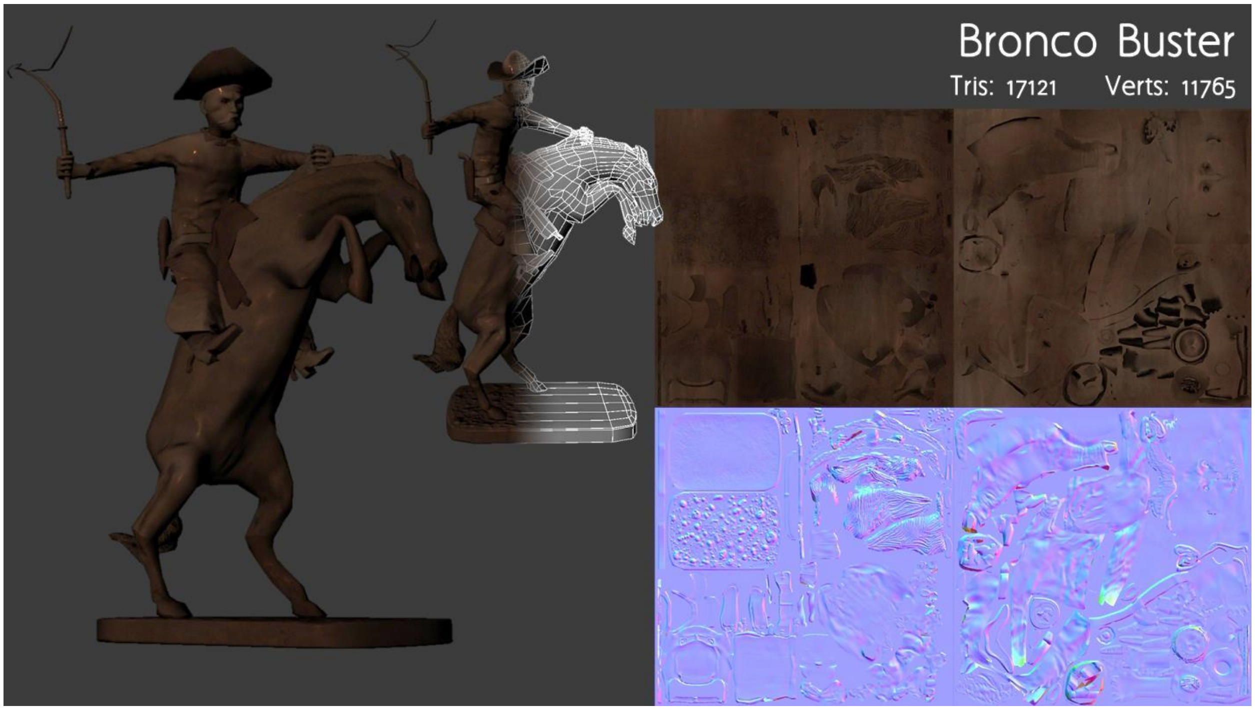

Figure 9: The final Bronco Buster statuette with the model's wireframe (left) and the Diffuse and Normal maps (right).

The *Bronco Buster* statuette was one of the project's more ambitious recreations. The bronco and rider were created separately, and then the rider was rigged and skinned so that it could be posed on the bronco. The rigging and skinning process refers to the creation of a virtual skeleton and the designation of each bone and joint to a particular part of the mesh. This skeleton is often used by 3D animators to bring objects to life. Because this statuette was so detailed, its UV coordinates were separated into two sheets so that I could use two sets of texture maps for this model. This functionally doubled the model's texture quality.

The first step in recreating Remington's statuette was to model the basic form that would become the horse. The rider, saddle, and even the location of the statuette's base depended on the horse, so I created the horse first. I had modeled a centaur in a previous study, so I repurposed that mesh and used it as the basis for my horse. The human half of the centaur was separated and reused as the starting point for the rider. A horse head was added onto the animal part of the centaur, and a basic saddle was modeled based on extracted faces from the bronco's back. I altered the facial structure of the human part so that it more closely resembled the rider in *Bronco Buster*, and a mustache and small piece of hair were created and placed over top of the head mesh. The lower neck was modified so that it had a collar and a neckerchief, and the rest of the torso was adjusted to more closely resemble a clothed body.

The rider's cowboy hat was based on faces extracted from the rider's head; its brim was extruded and then carefully bent into the proper position using bend deformers. The top of the hat's bent-in shape was made using Maya's Sculpt Geometry brush, and I modified both the top and bottom sides of the hat simultaneously with a wrap deformer. The rider's lower torso was formed around the saddle mesh, shoes were extruded from the pants, and a gun holster and revolver handle (nothing more of the gun would be visible and thus was not modeled) were created and placed on the belt as floating geometry.

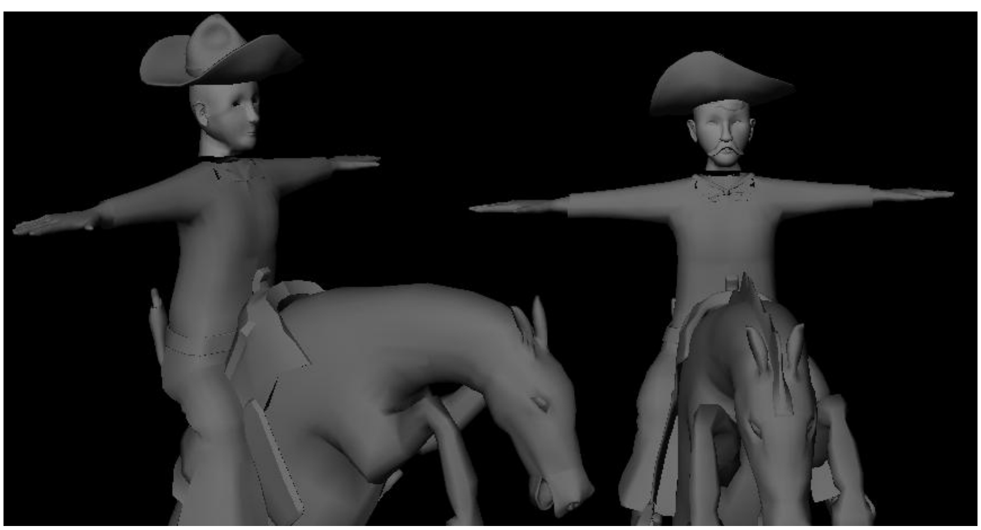

Figure 10: The rider in a "T pose" (left). The same rider with facial hair and neckerchief (right).

Before bringing the various base meshes into Mudbox to be sculpted, I adjusted the position of the rider so it matched Remington's statuette. His upper torso was initially in a "T pose", a position in which 3D characters are commonly modeled and rigged (Figure 10). This approach allowed me to create most of the detail for half of the rider's body and then mirror those details to the other side, making my model symmetrical and cutting my work in half. I decided to rig and skin the upper half of the rider and position his arms, back, hands, and fingers quickly and accurately by manipulating his skeleton. After this was accomplished, the rig was deleted and the majority of the meshes were sent to Mudbox for sculpting.

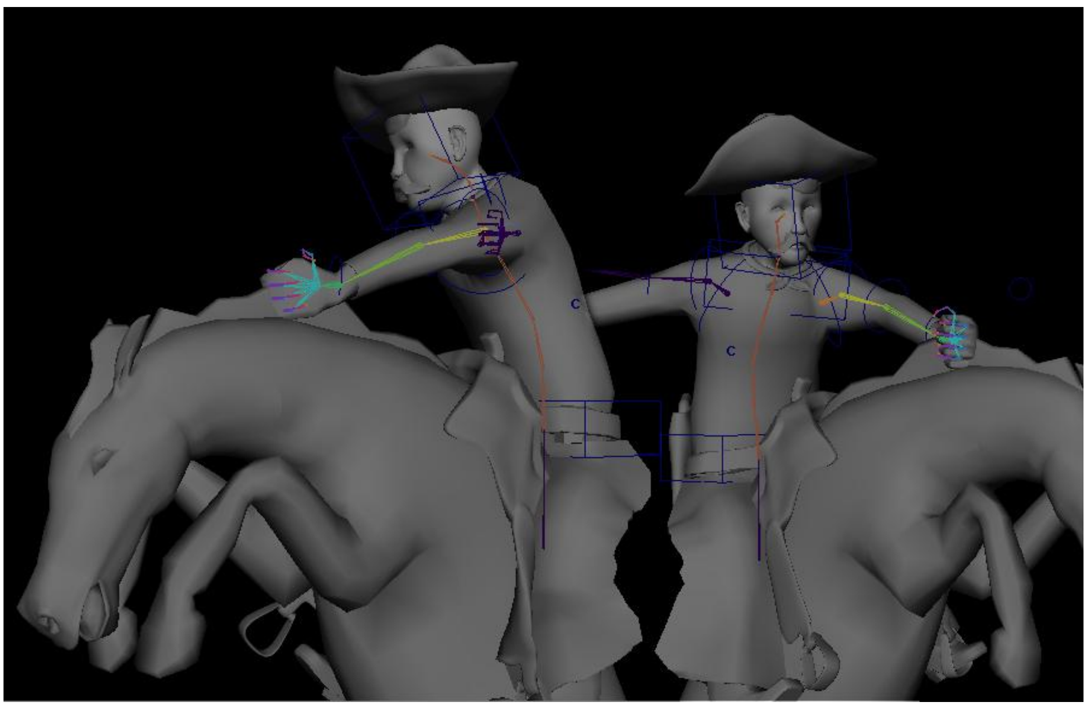

Figure 11: The rider posed on the horse with its skinned skeleton and rig controls visible

The shirt and pants were brought into Mudbox where folds and wrinkles were sculpted to mirror the original statuette. The horse's body was sculpted to add muscle details along the legs, chest, and back; substantial detail was added to the horse's mane and tail to simulate

Remington's detailed representation of horse hair. The saddle, hat, and statue's base also had sculpted details which provided an accurate silhouette and texture. The other meshes were given high-polygon details from within Maya as they were more geometric or otherwise technical surfaces.

Figure 12: The low-polygon mesh with details which were baked from the high-polygon mesh into a Normal map

The final, low-polygon meshes of the bronco and the rider were created using Maya's Reduce tool, and the other meshes were retopologized within Maya and altered by hand as needed. Normal and Ambient Occlusion maps were baked using XNormal with exported cage data from Maya, and diffuse textures were created in Photoshop with most of the detail being handled by the Ambient Occlusion maps.

Cloth Models

5. United States and Presidential Flags

Figure 13: The final flags with the model's wireframe (left) and the Diffuse and Normal maps (right).

A few models required the creation of cloth, including the Oval Office flags and curtains. The flagpoles were an interesting combination of hard surface and organic modeling, and the flags themselves were created using Maya nCloth simulations. I began by creating the flagpoles by extruding a cylinder and merging it with a polygonal sphere at the top, initially increasing the resolution of this model to medium polygonal density. The Oval Office flagpoles are topped with a golden eagle, so I created the base meshes for each part of the eagle and sent them into Mudbox to be sculpted.

I chose to sculpt the eagle flagpole topper in high detail despite how little of the detail would be seen as a sculpting study. The eagle's head was sculpted multiple times, and the feathers on the wings, body, and legs took multiple iterations to perfect. Few source images of the actual Oval Office flagpole toppers were found, so I used other eagle flagpole toppers as my source. I decided to combine elements that best matched the silhouette of the eagles that could be seen from the few images of the real flagpoles. I baked Normal and Ambient Occlusion maps from these sculpts using XNormal, and I created the remaining maps in Photoshop.

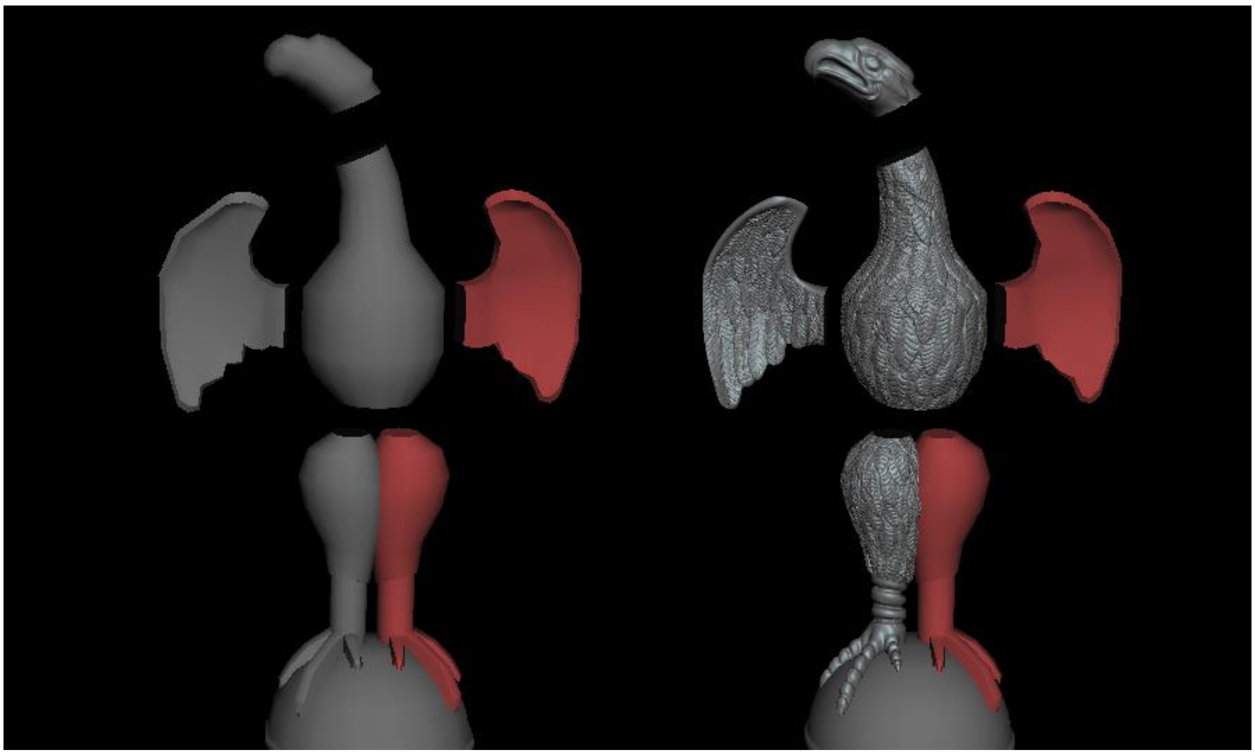

Figure 14: The low-polygon (left) and high-polygon (right) flagpole topper separated into pieces. The red meshes are duplicate placeholders.

The flags themselves are polygonal planes that have been subdivided enough times to allow for believable nCloth simulation. I constrained the edge of the flag that connected to the flagpole using a Transform nConstraint, made the flagpoles passive colliders so the flags would not pass through the poles, and converted the planes into nCloth objects. I altered the nCloth settings and recreated the dynamic properties of flag canvas by mixing Maya nCloth presets and adjusting various values by hand. My experiences handling, raising, and retiring flags in the

Boy Scouts of America contributed to my knowledge of a flag's material and how it hangs on a flagpole, so I was able to achieve realistic results quickly.

6. **Oval Office Curtains**

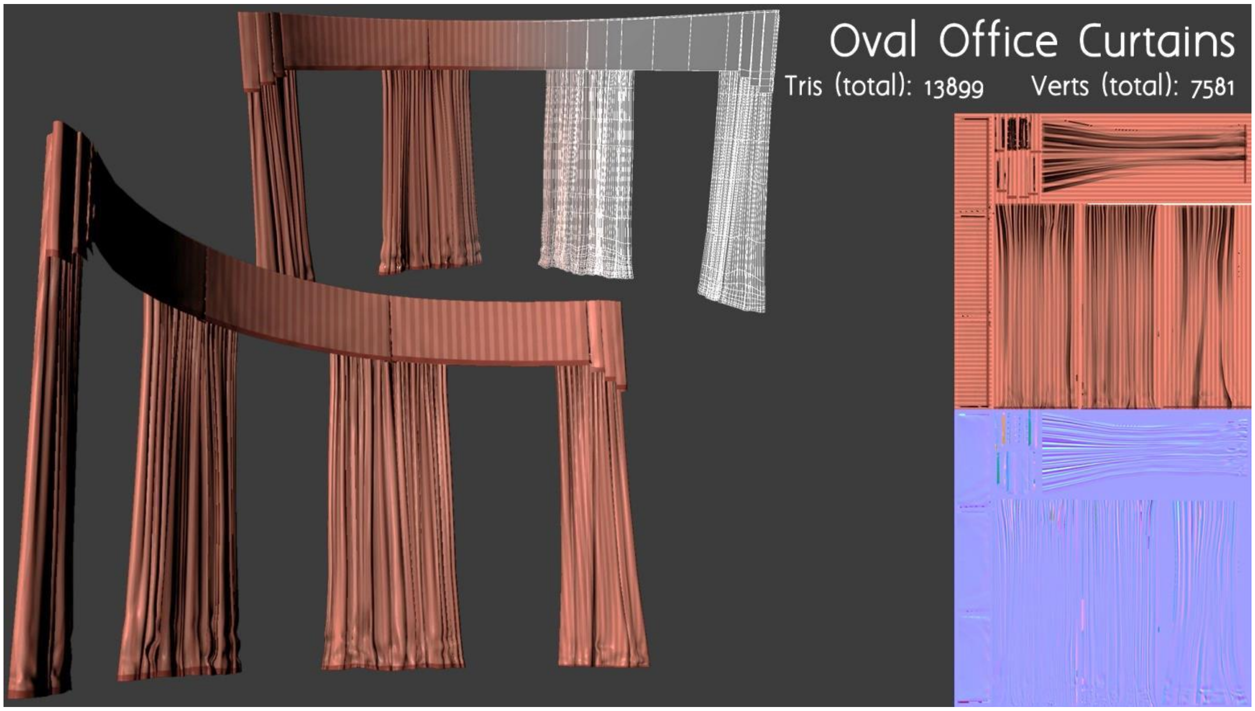

Figure 15: The final curtains with the model's wireframe (left) and the Diffuse and Normal maps (right).

The curtains in the Oval Office went through multiple iterations and a number of approaches before I found a suitable modeling workflow to create them. The most significant challenge with the curtains was recreating the seemingly-random folds in the cloth and crumpling the bottom of the curtains as they touched the floor. My first instinct was to make the curtains from subdivided planes and then add the folds using a Sine deformer, but the resultant folds were far too uniform no matter what I did to adjust and randomize them. I then attempted to use Maya nCloth to simulate hanging curtains, but I quickly discovered how difficult it is to control the way in which nCloth deforms and folds. Neither of these methods yielded curtains that behaved like those in the Oval Office.

I ultimately decided to draw the folds out myself using NURBS curves. Using the images I had collected of the curtains as a reference, I recreated the curves in the curtains as I saw them and filled in the missing information by drawing my own folds in a similar fashion. I then duplicated those curves, increased their scale along their major axis, and removed various points to simplify the duplicated curve. The original curves represented the top of the curtains, and the duplicated curves became the bottom of the curtains. I lofted a NURBS surface between these curved to simulate curtains that gradually lost some of their folds as they approached the floor. I further adjusted these forms with Lattice Deformers to give the curtains a curved silhouette rather than a linear widening as the cloth descended.

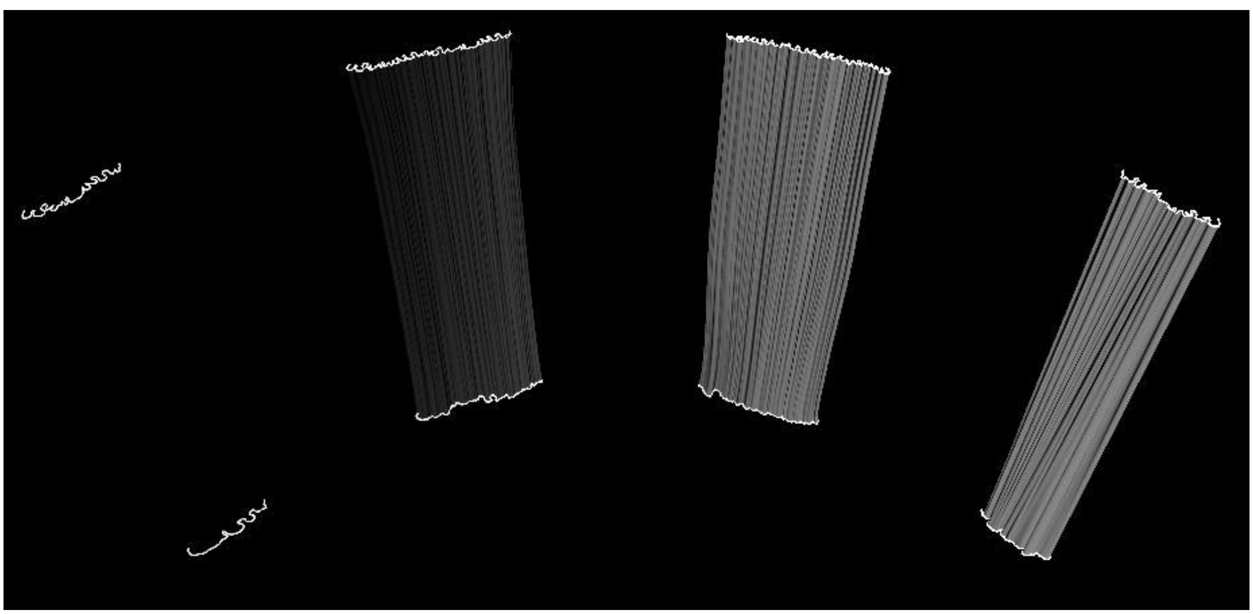

Figure 16: The NURBS curves (white) and the lofted NURBS curtains before applying the Lattice Deformer (grey).

After converting the NURBS surfaces into polygonal meshes, I increased the polygon density of the curtain bottoms and imported them into Mudbox. By increasing the polygon density for just this section, I could sculpt the scrunching effect of the curtain bottoms without needlessly increasing the entire mesh's polygon count. Once it appeared as though the floor was displacing the bottoms of the fabric, I brought the sculpted, high-polygon meshes back into Maya. The curtains were still expensive assets at this point, so I decided to use Maya's Reduce tool to create low-polygon versions of each curtain and to bake the details of the high-polygon versions into texture maps using XNormal. These reduced meshes were adjusted to better match their high-polygon counterparts, and cage meshes were generated and altered in Maya so that Normal maps could be generated more accurately. The results lowered the triangle count of the curtains by more than 3000% while still retaining the look of the original drapery.

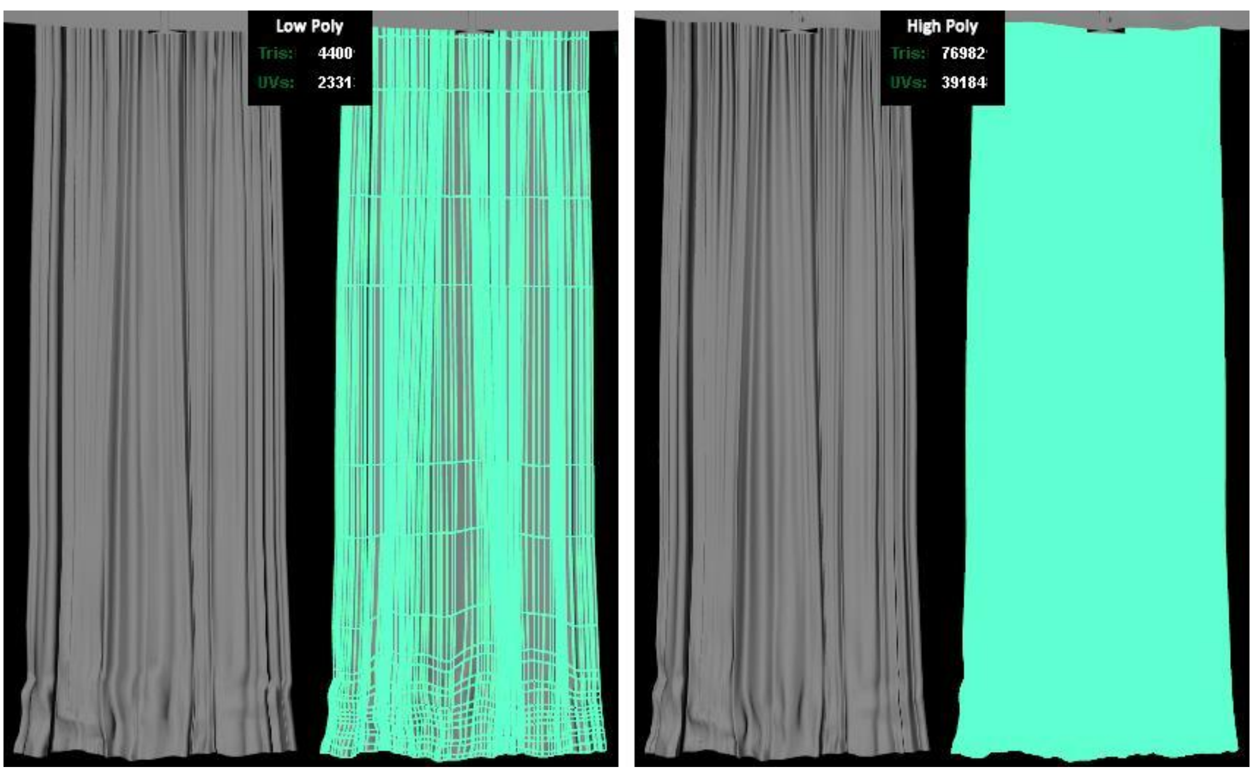

Figure 17: The final, low-polygon curtains (left) and the high-polygon curtains (right).

Lighting the Oval Office

While studying my reference images, I discovered that the Oval Office is lit primarily by indirect light. During the daytime, the sun casts natural light into the room through the large wall-sized windows. Additionally, many small lights are aimed directly at the ceiling so that they illuminate the room by means of bounce lighting. I decided to set my scene during mid-day, allowing the sun to be positioned overhead so as to light the exterior scene without blowing out the image with intense sunlight. This approach still allowed the exterior scene to affect the direction of the shadows and subtly influence the colors perceived from within the room. My interior lights consisted of 64 small spot lights along the edge of the ceiling, and they cast virtual photons via Mental Ray's Global Illumination or the Unreal Lightmass system. Behind the large windows are two curved planes with the scenery image mapped onto them. These planes cast their own emissive light from within their shader, and they allow for a natural parallax effect based on their placement in relation to the windows.

Figure 18: The final scene's lighting, rendered using Mental Ray

Bringing the Scene to Life using the Unreal 3 Engine

By exporting each of my Oval Office models and their smoothing groups from Autodesk Maya into FBX files, I was able to import them into the Unreal 3 game engine. Maya's default FBX export format was incompatible with the Unreal Development Kit (UDK), so I had to use a previous FBX version that would retain the models' smoothing groups. The smoothing groups are essential because they hold the Normal direction for each vertex of the corresponding 3D mesh, and that data is used to calculate both how the meshes are lit when viewed at certain angles and how Normal maps affect the meshes. I also imported the various texture maps I had previously created into UDK, and with them I recreated the materials I had built in Maya using the Unreal Material Editor so they looked the same when showcased in the game engine.

After importing and recreating these various virtual assets, I rebuilt my 3D scene within the Unreal Engine and recreated the lighting. I used a Scene Capture Cube Map Actor to create a cube map (six textures that depict a three-dimensional space) of the room so that I could add reflective properties to many of my materials. After I had brought my models into the game engine, I found that a few assets needed special collision meshes to denote what parts of the model the player could or could not pass through (for example, the room itself acted like a solid, impassable box by default). To solve this problem, I created custom collision meshes in Maya and included them in the FBX file with a special object name that UDK would recognize and handle. Once I had modified the Lightmass and post-process settings for my UDK game level, the environment was finished and fully functional.

Final Details, Comments, and Advice

I have thoroughly enjoyed the learning experience and the problem solving process that this project has offered. I have always learned the most within my field by tackling large, difficult projects that drive me to experimentation and research. My skill as a 3D Modeler was greatly increased by the end of this project, and I researched and learned some key information that I will list here for aspiring Environment Artists in the hope that they can learn from my experience.

One of the major skills I cultivated during this project was the ability to accurately bake Normal and Ambient Occlusion maps and how to use them effectively. I found that I could consistently achieve clean baking results by using cage meshes, also known as envelope meshes in Autodesk Maya. When baking data from a high-polygon mesh down to a low-polygon mesh, rays are cast out from each face of the low-polygon mesh in order to determine how far the Normal map should pretend to displace the mesh. This raytracing are cast out at a predetermined distance for every face, and the data is used to calculate lighting angles that will be baked into the Normal map. Cages limit the distance for each ray cast on an individual basis so that extraneous or overlapping information does not result in a flawed Normal or Ambient Occlusion map. I also learned the importance of the smoothing groups of the low-polygon mesh during the baking process and for game engine optimization. I found that maps would consistently bake properly if I divided a mesh's UV shells along all of the mesh's hard edges, selected the outside edges of those shells and hardened their smoothing groups, and then softened the smoothing groups of the remaining edges. By dividing the UV shells in this manner, the model was also further optimized for use within a game engine because the shader vertex count for that model would be minimized while still retaining proper smoothing group information for Normal details. This approach to Normal and Ambient Occlusion baking improved the appearance of my models while drastically decreasing the time it took to manually edit these maps.

There are two other points of advice I would like to share before concluding this thesis. Firstly, when sculpting my Resolute Desk, I discovered that sculpting the desk trim using a stencil resulted in low-quality details. Determining when to sculpt using a stencil depends entirely on the quality of the stencil and the purpose for which it is being used. Stencils tend to produce the best results when applied to highly-subdivided meshes for the purpose of adding texture or very fine secondary details, such as when adding wood grain, surface scratches, or skin details. However, when attempting to add in primary details that define the silhouette of a mesh or need to be crisp, recognizable elements of a mesh, much better results are achieved by sculpting these in by hand. Hand-sculpted elements will look more crisp and sharp than pattern-based sculpting, so I would discourage the use of stencils for important, crisp details.

Secondly, the specifications for what makes a model “low-polygon” or “high-polygon” are constantly changing. When creating environments for a video game, the goal is to create beautiful artwork that loads quickly on as many computers as possible. There is no magic number that defines what is low enough for a game engine or too high for real-time rendering because as hardware and graphics APIs improve, the limit continues to rise. Certain models in my scene have higher polygon counts than others in order to account for more complicated silhouettes and object details, but the scene itself looks accurate and runs smoothly on all of the machines on which it has been tested.

The Oval Office scene had a final triangle count of 375,649. It was created across roughly 18 months while I was also finishing my undergraduate degree at East Tennessee State University. I highly encourage you to see the final result for yourself at http://joshua-houser.com/ovalOffice.html where I have uploaded many more images of my models and texture maps.

Works Cited

"Ambient Occlusion." *Renderman University*. Pixar, n.d. Web. 04 Nov. 2013.

"Oval Office Dimensions." *Truman Library*. National Archives and Records Administration, n.d. Web. 01 Nov. 2013.

"Tours & Events." *The White House*. USA.gov, n.d. Web. 01 Nov. 2013.