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Defining the Modeling Standard for 3D Character Artists

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ABSTRACT

The focus of this thesis is to find the most modern methods to craft 3D characters for implementation in game engines. The industry is constantly adapting to new software and my study is to cover the most efficient way to create a character from an idea to fully realized character in 3D. The following is my journey in learning new techniques and adapting to the new software. To demonstrate, I will work through the process of creating a character from a 2D concept to a 3D model rendered in real time.

EVOLUTION OF MODELING

The game industry is currently under stress from severe growing pains. Technology is swelling with an overwhelming amount of content, and studios are churning out ground breaking games at an alarming rate. The process in making game content is evolving to accommodate the needs of the artist and allows for an even faster workflow. 3D modeling focuses more than ever on true-to-life sculpting techniques. Texture work often demands a painter's hand as brush strokes now paints UVs on the model. The traditional low to high workflow has now become a largely archaic concept for 3D modeling. Improvements in graphics processing hardware now allow for a high to low workflow. This process involves sculpting a model with millions of poly detail and then breaking that high-fidelity model down to a lower, cleaner resolution mesh. The lower resolution model created from the high would then be used for texturing, rigging, animation, and finally implementation in a game engine.

This workflow is vastly more catered to crafting organic models than the traditional low to high method which would start from the lowest form of geometry (typically as a cube) and build outward by extruding new geometry. The new high to low method allows artists to sculpt on 3D simulated clay and opens the doors for a far more intuitive solution for artists to craft characters.

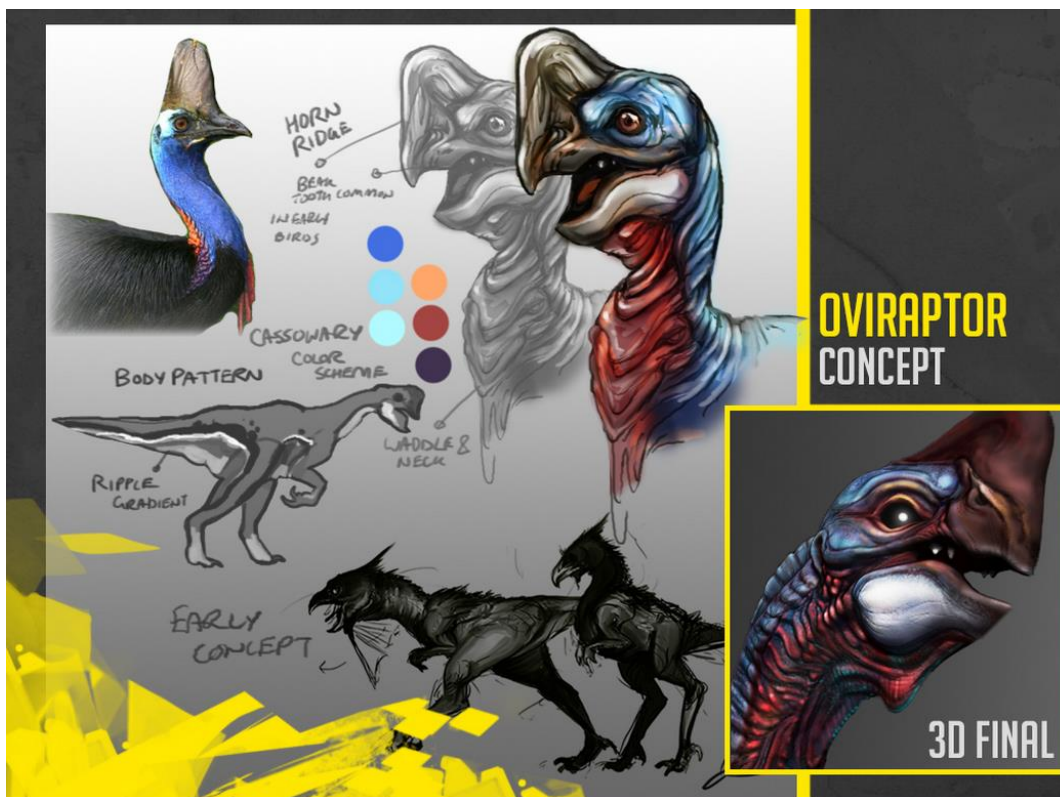
PROJECT OVERVIEW

For my thesis, I wanted to take the time to try multiple workflows to create a successful model quickly, efficiently, and with an overall pleasing aesthetic. The following is what I found to be some of the best ways to produce beautiful models that use the best of modern software to highlight my artistic skillset. The purpose of this thesis, is to remove the disconnection often found in translating art through technology by experimenting with new software and techniques. I wanted this piece to be about the discovery and dissection of how I go about modeling, and how I've tried to adapt to the changes in the industry as well.

FLESHING OUT A CONCEPT

Before even sculpting simulated clay, I will typically use 2D reference or concepts to inspire my design. In my experience, I feel a combination of photography and personal sketched designs help best when laying the groundwork for a new character. Even the giants of media fantasy such as Stan Winston studios creators of Jurassic Park and Alien, always grounded their work in reality by sculpting their creatures based on living beasts on Earth. For one of my dinosaur sculpts, the Oviraptor, I took heavy inspiration from living birds especially the South American Cassowary. I used the cassowary's bright plumage and distinct facial features to bring out

unique traits in my dinosaur sculpt. Taking elements from nature dramatically aids the believability of your designs and will take your creations to another level of creativity.



(Fig 1. Breakdown of Oviraptor model design process.)

While trying to draft concepts for new models. I tried to consider what challenges would come about in translating the design to 3D. When I first drafted the reptilian bird, the Hunhow, I had difficulty assessing how I would tackle the wings or what type of bird I would base the creature on.



(Fig 2. Above are some of the rejected design of the Hunhow. Each taking elements of different birds and reptiles in a different way

Below is final concept silhouette that I went with.)



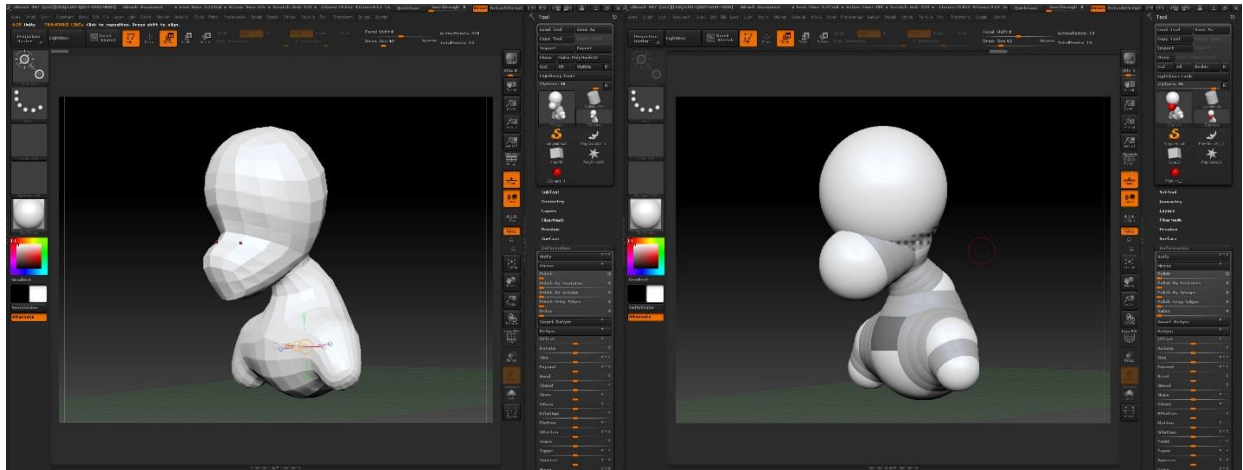
Finally I would settle on a more slender bird body and wing structure based frigate birds and chimney swifts with accents of tropical birds to give it more unique elements (like a hornbill's crown).

MODERN TECHNIQUES TO BLOCK OUT A DESIGN

Once the concept is complete and your photo reference is at the ready, it's time to select the right software and begin sculpting in 3D. Depending on whether or not your sculpture is organic or inorganic may narrow which program you're likely to choose. Inorganic modeling toolkits like 3D Modo, specialize in creating hard surface objects with intricate shapes such as vehicles or other hard surface props from scratch, while organic modeling software such as Mudbox, sub-divide existing low poly geometry into smoother lifelike forms. While many sculpting programs only focus on one sect of the 3D modeling platter, Zbrush R7 currently dominates the 3D modeling scene by offering the best of both worlds in one package. Taking notes from the streamlined 3D Modo workflow with the ZModeler brushes and improving on the sculpting functionality of Mudbox, Zbrush has become the go-to for thousands of clients from both the film and game industry.

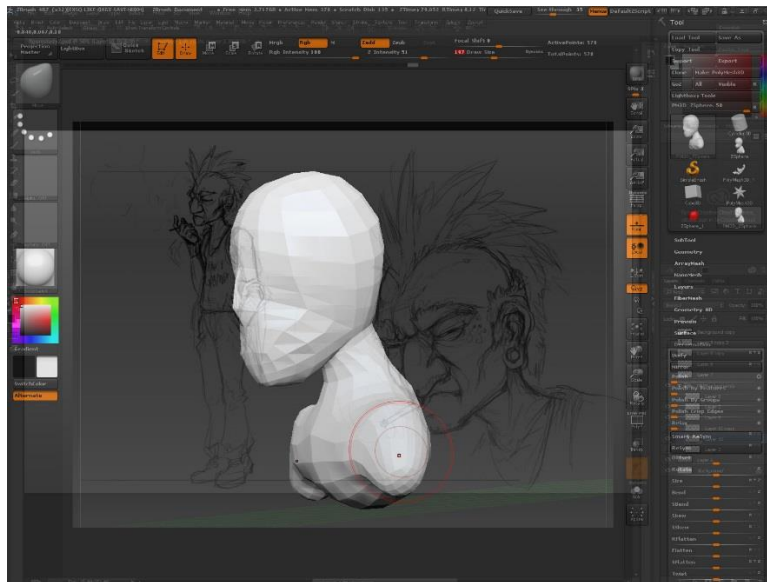
This program is rapidly becoming the industry standard as it comes with a wide spread of unique modeling features, one of which is how groundbreaking the software is in the field of concept modeling. ZSpheres, or Pixelogic's simulated sphere-extrusion tool, help create the

foundation of the model with simple connected tubes. Just like a sculpture using wire armature to define the simple shapes, ZSpheres make it easy to structure how the character will be laid out.



(Fig 3. On the left is the simulated model created from the Zpheres and on the right is the underlying Zsphere armature)

Also while testing the different features of Zbrush, I found the document transparency setting to be especially helpful in lining up the model to my concept, and was undoubtedly faster than the traditional workflow of placing planes on a grid. In this way, I could easily change the concept image if something wasn't working rather than having to import and realign it in the program.



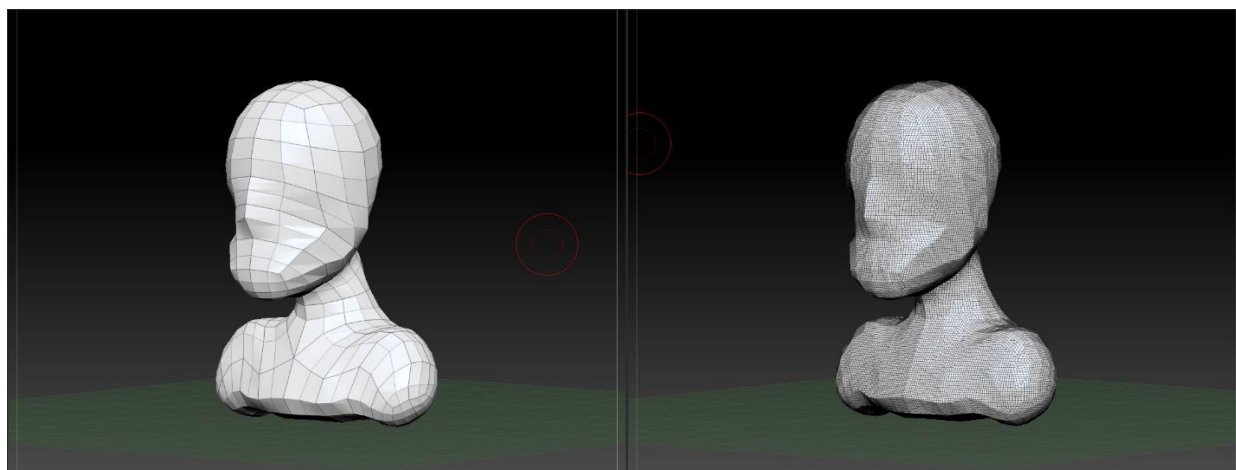
(Fig 4. Zbrush document with the transparency setting active, a Photoshop document with the character design is shown underneath.)

This workflow was especially helpful to my design process as it allowed me to get a rough concept on how the design would translate to 3D without too much struggle. I've been

using this method for nearly all of my pieces, and has been especially helpful in allowing me to experiment with my designs. Since the Zspheres are so malleable like a true armature, I could try a number of different poses or stances before I began fleshing out the character.

HIGH POLYGONAL SCULPTING

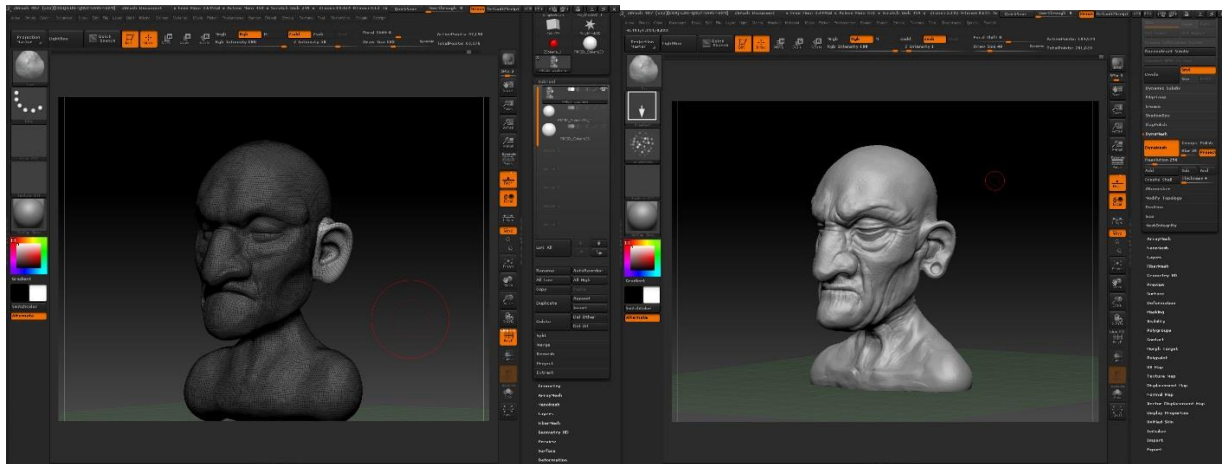
Once the Zsphere armature is complete, I move on to add more detail and inevitably more polygons of resolution to the model. One of the most striking features of Zbrush is the ability to constantly add clay to the model as if you sculpt. In past iterations of modeling software the only way to sculpt detail at a higher resolution was to subdivide the mesh which often lead to the wireframe becoming stretched or far too dense in certain pressure points as the artist sculpted. With Zbrush's Dynamesh feature, I, along with many modern 3D artists, was able to sculpt free of the concern of the mesh's edge-flow underneath, and now it is a fundamental part of my process in creating most of my concept sculpts. Dynamesh projects an even grid of square polygons across the entire frame of the model and will dynamically re-project that mesh each time the polygons are too unevenly spaced. I like to think of Dynamesh as if it were healing a laceration and the polygons were cells. Whenever the sculptor would disturb the mesh, a Dynamesh projection would try it's best to repair the model. What I found to be so incredible about this technology is that even when attaching separate geometry to the existing model, the Dynamesh would adapt and fuse together the two parts in a fairly clean manner at high resolution. (Now this could also be achieved without Dynamesh by using two open faced geometry slices in close proximity, however the welding between the two meshes often causes spiraling geometry and may not be as clean of a result).



(Fig 5. Left, mesh's topology is untouched from Zsphere generated PolyMesh. Right, highly dense grid topology formed by Dynamesh.)

Dynamesh has played a huge part in allowing more artistic freedom in the concepting phase of 3D modeling, and allows for quick and easy changes to be made should a character or set piece need to be altered last minute. Even AAA studios have noted what a drastic change the technology has brought their artists. Kurt Papstein, the lead creature concept artist for TurtleRock studios, praised the change, noting that “...during the development process on Evolve, the tools got better and better. Particularly with ZBrush. The concepting stage for me got way faster, and the tools allowed me to jump right into production on these monsters. Dynamesh was a huge one.”

One tool revolutionized the industry into accepting a high to low workflow, and made modeling for me an actual fun and artistic endeavor. While moving up from the primitive form I generated from Zspheres, I slowly add more density to my sculpture, and work out the forms from simple shapes to more refined concepts. One of my favorite parts to sculpting a model is shaving down the mesh with the Trim brushes, because it makes me oddly nostalgic to the traditional sculpting methods I love with less mess. Once I built up some forms on my mesh with a ClayBuildUp or Standard brush, I would sharpen the forms with a TrimAdaptive brush. This allowed me to keep some of the texture and detail without sacrificing the form like a Soften brush might. Some of the brushes, or sculpting tools, Zbrush provides may be foreign especially to those without a sculpting background, and I found that experimenting with each tool helped me greatly with the beginning stages of learning Zbrush.



(Fig 6. Left, Ear is placed as a separate mesh onto the model. Right, when Dynamesh is projected, the ear fuses to the model fairly seamlessly.)

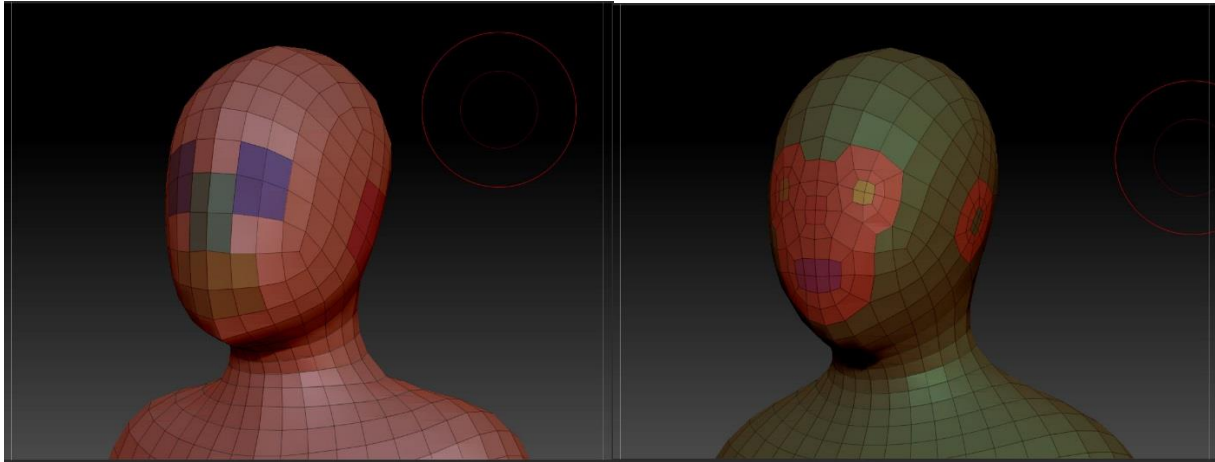
Dynamesh allowed me to sculpt freely and therefore gave me a chance to inject my own style and personality to my designs. For example on the wings of the Hunhow I was having trouble sculpting wings because each time I used heavy sculpting tools on the thin wings, they would collapse or become severely deformed. By using Dynamesh in combination with

BackFaceMasking, I was able to sculpt on the wing in the style of my choosing rather than hampering my artistic output because of the limitations of the software. The final design involved more twisting venous detail and gave it more of an organic reptilian form than the previous iteration that was fairly plain sculpturally.

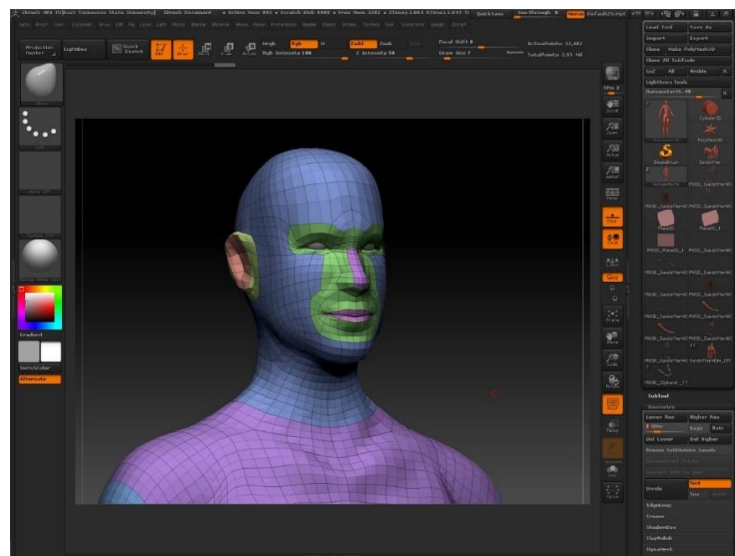


(Fig 7. Work in progress of the Hunhow high poly sculpt.)

Despite how enamored the industry is with Dynamesh, I did try to learn other methods that might prove helpful when modeling as well. The second option I learned was Polygroup Subdivision, which, unlike normal subdivision, Polygroup Subdivision uses the polygroup function to create complex yet smooth edge-flow very easily. As the mesh becomes increasingly dense, the loops adapt to the curves defined in the divides between polygroups (shown as changing color in Zbrush). This method works well for meshes with preplanned topology such as faces, human bodies, and other typical shapes whose edge-flow can be planned out prior to sculpting. This technique, I feel, is harder than Dynamesh, because it takes a lot of precision to map how the loops will divide. This method also has the potential to create density in places you don't need if the modeler isn't careful, however if executed well, the artist may be able to skip the retopologizing phase entirely. Additionally if the polygroups are already laid out, the sculptor can take advantage of the Zbrush UV tool and cut seams along the polygroups quite easily.



(Fig 8. Left Above, Zsphere generated mesh is divided into colored polygroups. Right Above. The mesh is then subdivided from the edges of the polygroups. Below, the resulting facial topology after several subdivisions and sculpting. Edge loops and topology shown are ideal for most 3D model faces.)



REMESHING TO A LOWER RESOLUTION

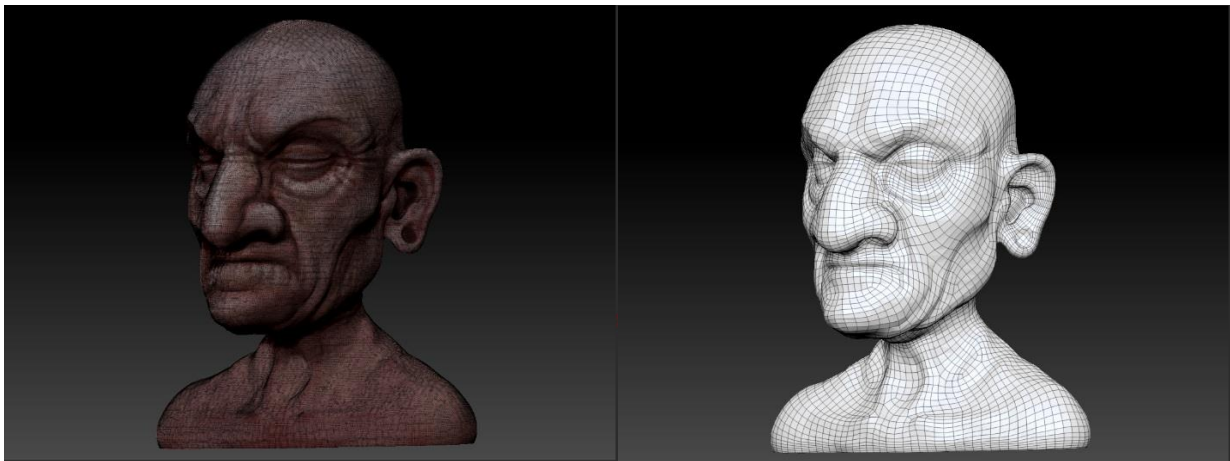
After the mesh is detailed and often in the range of over a million polygons, it is time to prepare the mesh for retopology. At this point I would consider several options to retopologize my geometry. One of the best, but slower options is to use Quad-Draw, found in the modeling toolkit in Autodesk Maya. To begin the remeshing process, the model has to be prepared to enter Maya. Maya doesn't process high density models as well as Zbrush, so it is best to either decimate the model (if you used Dynamesh) or lower the subdivision level (if you used the polygroup method). Also, it is worth noting that it is best to delete any instances of polygroups

temporarily, as Maya may read the mesh as having separate faces when there are none (this usually only applies if exporting an .obj file to Maya).

Zbrush offers a wide range of exporting options, the most helpful of which is the GoZ feature which allows seamless transitions between software. GoZ exports to a multitude of programs including the Autodesk and Adobe Suite, and makes it easier than ever to transition back and forth between programs. Another option is the standard export which provides .obj and .ma files that can be re-imported into a program of the user's choosing.

Once the object is in Maya, I set the object to live, and activate Quad-Draw to trace new geometry across my model in a manner similar to connect the dots. Typically if the model is symmetrical I can save time by retopologizing one half and then mirror the other half later. This process is heavily time consuming, but does ensure complete control over the edge flow of the final low poly model.

Another way is to use the remeshing functions within Zbrush. Zremesher allows the modeler to map out roughly how dense the model should be and where the edge flow should ideally go. This method generates fast topology and produces a rough low poly mesh that may come with a few problems. Ideally, it is best to generate a Zremeshed model and then clean it up later in Maya using Quad-Draw. This mixed method cuts the time to Quad-Draw in half while still making a clean low poly mesh to work from. I



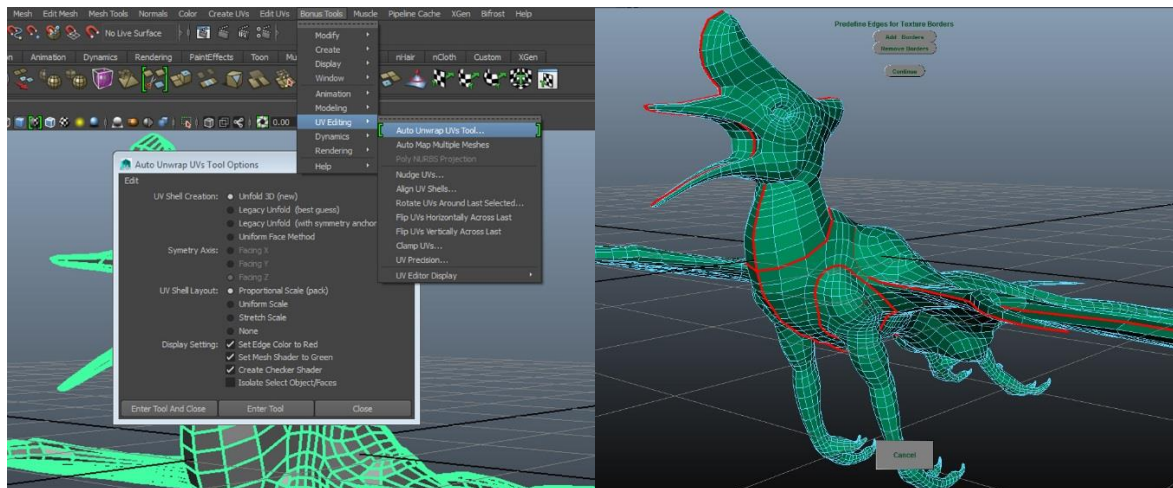
(Fig 9. Left, 1 million poly mesh. Right, is the retopologized mesh generated from Zremesher set to 7.5k faces.)

SKINNING THE CHARACTER

When the lower resolution model is done. The model now needs a UV map to communicate how it reads textures across its surface. UV unwrapping is traditionally done in

Maya by cutting along edge loops and unfolding the faces onto a sheet, but Zbrush also offers new solutions to UV a model. By using polygroups, Zbrush can define where to cut and unfold the seams of a model instead of cutting them manually in Maya. Zbrush can also define what area should be allowed more space on the polygonal sheet. Giving more space on a UV sheets gives the textured area on the model more resolution. Areas, like the face for example, should be given more real estate than a place less seen like the bottom of the foot.

Although Maya still holds true to its traditional method of unwrapping, it now bolsters a new unwrapping tool in 2015 called the Auto-Unwrap UVs tool. This technique is similar to the Zbrush tool but instead of using polygroups, it highlights the seams of the model you want to cut. Once all the seams are highlighted on the model, the program generates a UV layout map, and the user can resize each of the unfolded pieces to his/her liking before entering the auto-layout function again. This method is the current preferred method to unwrapping organic geometry as it takes mere minutes to set up and is more user-friendly than the Zbrush plugin option. I actually used this method to map all of my organic models especially those with multiple limbs like my bird creature which needed more complex seam placement.



(Fig 10. Setting up and placing UV seams with the Auto-Unwrap UVs tool.)

PROJECTION BASED TEXTURING

Texturing workflows have vastly improved since the days of only painting on a flat UV sheet. Now creating texture sheets can be handled in a more artistic manner by painting directly onto the model. Programs such as Mudbox, Mari, or Zbrush encourage this type of workflow and both have their strengths in texture work. Mudbox allows for a simpler workflow and has an arguably easier specular mapping system. Mari is built for painting high resolution

maps alongside more technical methods like adjustable tiling textures or adjusting the levels of saturation of the texture. Zbrush has a more artistic workflow options and offers a polypainting texturing system similar to Mudbox as well as options to paint models in projected 2D. When working out which to choose, I decided to challenge myself with Zbrush's texturing workflow since I was already fairly well versed with Mudbox's painting method and Mari's high-density texture output focuses on maps meant for pre-rendered cinematography.

One of the first methods that I was able to adapt to was Zbrush's basic painting method known as Polypaint. Polypaint, also known as Ptex in Mudbox, paints directly on the individual polys and ignores the UV sheet entirely. Zbrush allows you to paint directly on your model at high resolution, and then will later allow you to bake the detail on to your UVs. This method avoids UV map stretch because it does paint directly on each polygon (giving that precise polygon a specific color map), and when transferred will disguise some bad UVs, but not always. Polypaint resolution is effected by the density of the mesh, and is best utilized if the mesh is at a higher subdivision level. Also, it is best to note that the model being Polypainted should have a UV map, otherwise it is often difficult to bake the detail down later. I used Polypaint to great effect to not only clean up the projections created from the other methods, but also provide a more painterly style to my models.



(Fig 11. Example of beginning a polypaint on a model. Sculpting tools become paint brushes when switched to RGB mode.)

Another method is the Spotlight tool which when active turns the Zbrush interface into a painting toolkit similar to Mudbox. Using a command wheel and a large circular spotlight, you can use photographs as a stencil to place textures and detail onto your mesh. By transferring

galleries of photos into Zbrush you can give a model's textures a photo-real quality by painting through photographs.



(Fig 12. Left, Using Zapp-link the mesh is can be painted on in Photoshop. Right, the resulting painting is projected onto the model in Zbrush.)

The last method is the Zapp-link, and is my personal favorite. Zapp-link is Zbrush's tool for transferring modeling data across other applications. For people more comfortable painting in other applications, like Photoshop, Zbrush makes it easy for sculptors to paint in the application of their choice. By transferring the rendered data of Zbrush's document, Zbrush allows modelers to actually paint on a screen capture and then project that data back onto the model. This technique is especially helpful in painting both stylized and photo-real texture maps as Photoshop accommodates both styles easily. This particular method allowed me to use the skills I honed digitally painting in Photoshop and apply that style to my models fairly easily.



(Fig 13. Dog statue textured exclusively with Zapp-link projections)

This was especially true when I used it to texture a model entirely with Zapp-link. The dusty foo dog was an experiment to test whether or not Zapp-link would work with multiple passes on the model. The result was quite striking in the color and design. The model translated well from how it looked in Photoshop, however some instances where the forms curved around the projection became faded or blurred. To quickly remedy this problem I decided to add dust texture work in the crevices of the model to cover up the problems with the projection and also make it a more believable statue.

BAKING DETAIL BACK ONTO THE MODEL

The final step is to bake the high resolution mesh down onto the lower resolution mesh that will be used in the game. This method will transfer information from one mesh to another in the form of a specified map. A normal and/or displacement map can be generated to preserve the detail that was sculpted into the high resolution model. Normal maps simulate the appearance of the detailed mesh when reflecting light and shadow and are far less costly to game engines that must run in real time. Displacement maps warp the geometry of the mesh, typically through tessellation, and while they accurately mimic the silhouette of the original high poly mesh, displacement maps cause a great deal of stress on the game engine if used too frequently. Most 3D modeling artists for games tend to match their low poly model as close to

the silhouette of their original sculpt as possible and bake the remaining detail into their normal maps.



(Fig 14. Setting up the Envelope of the low poly mesh to read the detail of the high poly mesh in Maya.)

In Maya with both the high poly sculpture and low poly mesh lined up directly on top of each other, the Transfer Maps tool allows Maya to read each polygon from the low resolution mesh and map out the detail surrounding that face from a specified envelope. Once Maya processes the transfer, the result should be a fairly clean map. For a normal map this means a fairly consistent gradient of colors stemming from purple to blue and green. If sharp contrast points occur in your mesh, a quick fix is to adjust the envelope size of your bake or to allow Maya to automatically fix the seams of your map within the Transfer Map editor. A better fix, I recommend, is to check your UV map for any problem areas such as reversed normal or overlapping UVs.

REAL-TIME RENDERING

When clean maps are generated for the low poly mesh, the model is then readily available for use in game. While it is entirely possible to implement your assets in a game engine, it is also acceptable to use a real-time renderer to present your work instead of a game engine. Based on my observations of professional 3D modeling portfolios, it is clear that Marmoset Toolbag is among the first choice among Character and Environment Artists for showing off work. Marmoset Toolbag is a real-time rendering software that allows for easy, natural controls to import, light, and produce a turntable of your model. This program's lighting and shader system is also highly similar to those found in modern game engines like Unreal 4, however the layout is friendlier to 3D modelers and lacks the node based editing style of most engines. The software's basic UI is a nicely simplified version of a traditional 3D modeling interface, so learning the software was quite enjoyable and I was able to pick up the basics and produce stunning renders within an hour of use.



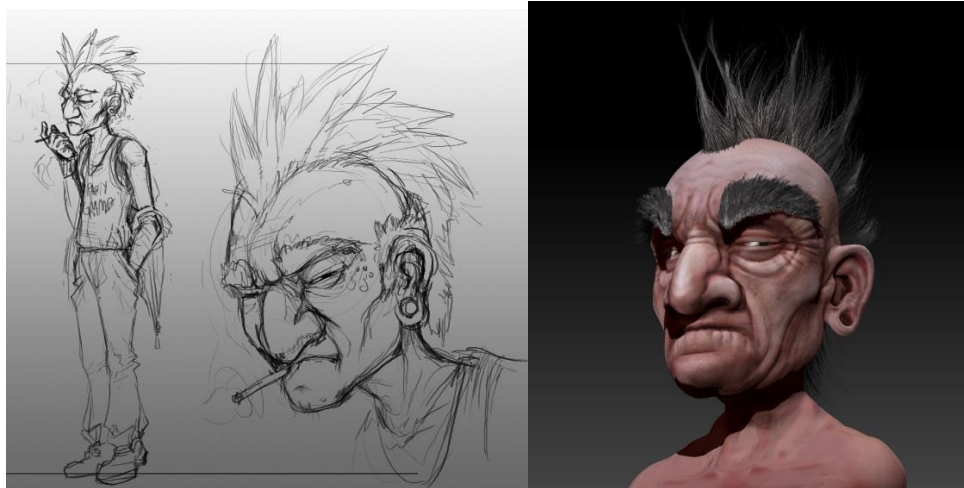
(Fig 15. Left, Model rendered in Marmoset Toolkit. Right, same model rendered in Sketchfab.)

Another popular choice among modelers is Sketchfab which allows for not only real-time rendering but also is fully intractable. Sketchfab models give users the option to freely rotate the model in the browser, and have roughly the same editing interface as Marmoset. The only catch I found while using Sketchfab is that their program relies heavily on a having a steady internet connection as models may take a while to load in the browser. Also, Sketchfab currently offers no offline viewing options which makes it difficult to show interested companies while at conferences. I preferred the Marmoset Toolkit over Sketchfab, only because of the offline capability. Sketchfab can retain some cache memory allowing the user to load a model while connected to the internet and display it later offline with the browser still

open. I don't recommend this method necessarily, because while at the East Coast Game Conference, my preloaded models were subject to crash or disconnect if the device I was displaying them on fell asleep. Overall, I found both options are entirely viable and are inevitably up to the artist's preference.

CONCLUSION

I have always craved more from the single 3D modeling course offered during my stay at East Tennessee State University. Within four years, the industry completely shifted to focus on an entirely new workflow and I wasn't going to let it leave me behind. This thesis illustrates my trials teaching myself new software and keeping my dream of becoming a character artist alive. 3D character artists are one of the most competitive fields in the industry, and for a time, I was afraid the role was too prestigious for me. This burning doubt drove me to learn everything I could about the industry I was stepping into and became the foundation of my thesis. I set out on this journey to learn how the entertainment industry was changing so that I could evolve with it.



(Fig 16. Translation of Old Man Jazz-Hands 2D concept to 3D model bust.)

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