Forging the Mythical
Figurines and Minis Creation

A Major Qualifying Project

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Interactive Media and Game Design

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Abstract

      This Major Qualifying Project explores the process of creating figurines and miniatures of fictional creatures and characters using 3D printing technology. The project begins with a brief history of figure creation and then delves into the modern process of 3D printing. The report details the step-by-step process of modeling the figures using a combination of digital and traditional sculpting techniques. It also covers the 3D printing process, including adding keys, supports, and decimation. Finally, the report discusses the painting process and showcases the progress of the tabletop figures. This project serves as a small guide for anyone interested in creating their own figurines and miniatures.

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Acknowledgments

I would like to express my sincere gratitude to my advisors, Prof. Joshua Rosenstock and Prof. Ralph Sutter, for their guidance, support, and encouragement throughout this project. Their expertise and insights were invaluable in helping me to navigate the various challenges and obstacles that arose during the course of this project.

Executive Summary

This paper provides a comprehensive account of the entire process involved in creating a tabletop figure - right from the inception of the idea to the final product. The project involved using cutting-edge digital sculpting and 3D printing technologies to create a display figure that was then painted to give it a realistic finish.

The paper delves into the critical steps involved in the process, including conducting extensive background research to conceptualize the figure, creating the digital 3D model using advanced software, printing the physical model using a high-quality 3D printer, and finally, painting the figure using a variety of techniques to give it a realistic look and feel.

To gather feedback on the finished product, the author conducted a survey, which is included in the paper. The survey comprised a range of questions that sought to understand the participants' perspectives on various aspects of the figure. The author then analyzed the results of the survey to gain insights that were used to identify the successes and areas of improvement for the project.

In conclusion, the paper provides an in-depth discussion of the project's successes and challenges and outlines recommendations for future projects of this nature. The author emphasizes the importance of a holistic approach that takes into account all elements of the creation process, including research, design, production, and post-production. The paper serves as an excellent resource for anyone interested in the process of creating a tabletop figure, offering valuable insights, tips, and best practices.

1. Introduction

Figurines and Minis Creation MQP or Forging the Mythical is a project that explores the 3D figurine/statue creation process. It allowed me to go through the entire creative process of 3D sculpting, 3D printing, part assembly, part finishing, and painting. I enjoy looking at intricate collector figurines and minis for tabletop games such as Dungeons and Dragons and wanted to learn more about the process that goes into them.

The goal of this project was to create one large display figure. To do this I planned to research how other companies go through this work process, figuring out the subject to model and how to pose it, sculpting it out in a digital program, and finally 3D printing it out and painting it.

This Major Qualifying Project (MQP) was completed by one Worcester Polytechnic Institute (WPI) student. The student Lauren Waddick, majoring in Interactive Media and Game Development (IMGD), created all conceptual pieces and final sculptures.

2. Background

2.1 How this Project Began

This project began as one focused more on minis, tabletop-sized figures usually found in games such as Dungeons and Dragons to represent monsters and players. However, the project was influenced by my love for fantasy creatures, especially dragons. Growing up, I loved media that depicted different creative designs for these creatures from the game series Spyro to the film series How to Train Your Dragon. Dragons have unique proportions, which can make them a lot of fun to bring to life. I loved the idea of being able to bring one to life through the art of figure creation.

Figure 1, Capcom Figure Builder, and First 4 Figures products I've Collected

2.2 History of Figure Creation

A figurine is a small statue or sculpture, usually of a person, animal, or mythological creature. Figurines are typically around a foot in height and are often used as collectibles or as part of various tabletop games. Unlike larger or older museum statues that are hand-carved from bronze, marble, or stone, figurines are often mass-produced and can be made from a variety of materials, such as plastic, metal, or ceramic.

Miniatures and ways to create them have been around for thousands of years. The practice of creating miniatures has been dated back to as early as 2000 BCE by ancient Egyptians, who created small figurines and carvings as offerings and funerary objects. These miniatures were also used in various daily life activities and depicted various scenes, from hunting expeditions as seen in Figure 1 to household chores. The ancient Greeks also created miniature objects, such as clay figurines, which were used in various religious ceremonies. In East Asia, the art of creating miniatures was popularized during the Tang Dynasty in China and the Heian period in Japan (*The art of the tang dynasty*). Miniature objects were often used as toys, and they were also incorporated into various art forms, such as painting and calligraphy.

Figure 2 Model Sporting Boat

While many models created in the past were made for nobles, they are now used all over the world in different ways. From commercial dioramas to toy-filled dollhouses and display collection figurines, model creation just gained more popularity as accessibility to it increased. In the 20th century, miniatures can now be seen for their value in popular culture and advertising (*The Remarkable History of the Miniature*).

Some current-day examples of model creation include architectural models used by builders and real estate developers, scale models of cars and airplanes made by hobbyists, and miniature models of landmarks and tourist attractions sold as souvenirs. Additionally, miniature models of characters from popular movies and TV shows have gained a lot of popularity among collectors and fans alike. Tabletop miniatures and collectible figurines are a popular hobby among gamers and collectors alike. Some notable examples of tabletop miniatures include the Warhammer series, Dungeons and Dragons, and the X-Wing Miniatures Game. These games use miniature figurines to represent characters, vehicles, and other objects within the game world.

Figure 3, Warhammer figurines

In addition to being used for tabletop games, figurines are also popular among collectors. Companies such as Funko and Sideshow Collectibles produce highly detailed collectible figurines based on popular franchises such as Star Wars, Marvel, and DC Comics. These figurines are often sold at conventions, specialty stores, and online retailers.

Figure 4, Funko Pops

Figure 5, Weta Workshop Smaug Statue

The marketplace for works like the Forging the Mythical Project typically consists of hobbyists and collectors who are passionate about tabletop gaming and figurine collecting. These individuals are often willing to pay a premium for high-quality, detailed figurines that are unique and not mass-produced. Online marketplaces such as Etsy and Shapeways provide a platform for creators to sell their 3D printed figurines directly to consumers, while specialty stores and conventions allow creators to showcase their work to a wider audience.

2.3 Digital Sculpting Vs Traditional Sculpting

Being a digital sculptor involves creating three-dimensional models of objects and characters using specialized software. One of these software is ZBrush which is discussed more in depth in section 2.6. The process of sculpting digitally involves using a variety of tools to manipulate virtual clay, metal, or other materials to create the desired shape and texture. Unlike traditional sculpting, digital sculpting allows for greater control and precision, as well as the ability to make changes and corrections quickly. Additionally, digital sculpting can be more cost-effective and less messy than traditional sculpting, making it a popular choice for many artists and designers. While there are costs to both digital and traditional, digital requires less material to work with as you stick to the computer to generate the image rather then traditional were you need to make sure you have enough supplies of materials to sculpt which can add up in costs.

Digital sculpting has become increasingly prominent in the contemporary art scene, particularly as technology continues to advance and evolve. Many artists are embracing this medium as a way to create complex and intricate pieces that would be difficult or impossible to achieve using traditional sculpting methods. Some of the artists who have embraced this medium are Joshua Harker, Bathsheba Grossman, and Nick Ervinck.

Figure 6, Examples of Pieces by Joshua Harker and Bathsheba Grossman

2.4 Modern Process of Figure Creation

The process of creating figurines typically starts with a concept or idea. This could come from a designer, an artist, or even an existing intellectual property. Once the idea is established, a team of professionals works together to bring it to life. This team could include conceptual designers, sculptors, engineers, mold-makers, factories, painters, and other skilled professionals.

The conceptual designer creates the initial design of the figurine, taking into account the theme, style, and other details. Once the design is approved, the sculptors use specialized software such as Zbrush to sculpt the model digitally. They then use 3D printing technology to create a prototype of the figurine. The engineers then analyze the prototype and break it down into machineable and reproducible production parts. This helps to ensure that the final product will be easy to produce and assemble. The mold-makers then create molds for the production process. By using molds, manufacturers can ensure that their products are uniform in size, shape, and quality. The factory then produces the figurines using these molds (*Behind the scenes: How weta workshop made the kitava statue.*).

Finally, a team of painters adds color and detail to the figurines, bringing them to life (*Painting the poison ivy premium format figure | behind the scenes)*. This is typical done with airburshes filled with arylic paint for broader features and then smaller detail brushes are used to paint smaller details of the figure. The final product is a high-quality figurine that is ready to be sold and enjoyed by both collectors and fans. The number of people involved in this process can vary depending on the size and complexity of the project. In a professional environment, there could be a team of several dozen skilled professionals working on a single figurine.

2.5 Stereolithography vs. Fused Deposition Modeling

SLA (Stereolithography) and FDM (Fused Deposition Modeling) are two different types of 3D printing processes. SLA uses a laser to cure a liquid resin, layer by layer, in order to create the final object. The printed object ends up being printed upside in the process so it can be dipped into the transparent resin tray with each layer hardening onto the print bed through the laser at the bottom of the tray. On the other hand, FDM uses a heated nozzle to melt and extrude filament, layer by layer, to create the final object.

SLA printing is better for highly detailed prints because it can produce finer details and smoother surfaces compared to FDM printing. SLA printing uses a bath of resin through which a targeted light source (most often a laser or LCD screen) cures precise layers of resin. This results in much smaller build layers, which typically can be 0.01mm to 0.02mm high; resulting in prints with much greater detail than what is possible with filament-based printers. In contrast, FDM printing relies on melting and extruding filament, which can leave visible layer lines and rougher surfaces. I ended up choosing SLA printing with our Form 2 printer by formlabs because of its better finishes and it was available on campus with not as many people using it compared to the FDM printers due to its secluded location.
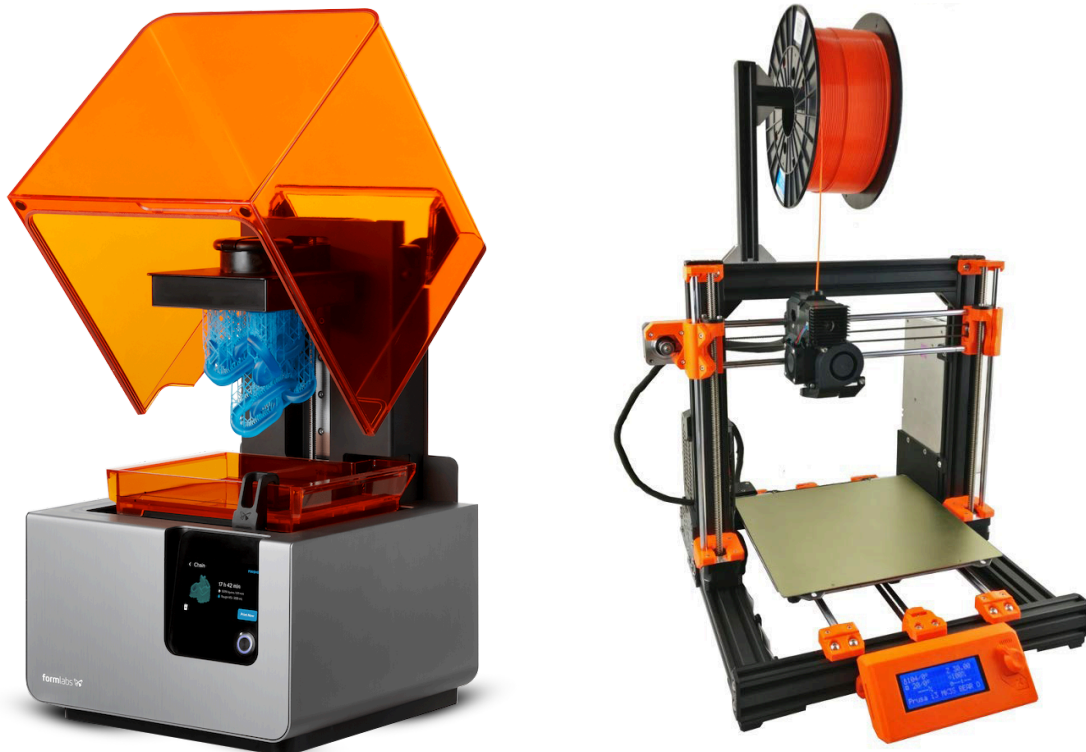

Figure 7, SLA Printer Compared to FDM Printer

2.6 Software Used and Why Zbrush

I used ZBrush for digital sculpting because it is widely regarded as the industry standard software for figurines and miniatures. ZBrush provides a range of tools, features, and workflows that make it an ideal software for creating highly detailed and complex 3D models. One of the

key features of ZBrush is its ability to sculpt organic shapes and add intricate details to models. It provides a range of brushes that can be used to sculpt, build up, and refine the shapes of models. The software also has advanced dynamesh and ZRemesher features that allow for the creation of smooth surfaces and clean topology.

Another key feature of ZBrush is its ability to add high-resolution textures and materials to models. This is particularly important for the figurine and miniatures industry as it allows for the creation of highly detailed and realistic models. ZBrush also has a range of tools for painting textures and materials onto models, which can be used to create intricate designs and patterns. Some other features that ZBrush offers that are useful for this field are:

"Anchor Brush – Apply anchors onto a mesh and perform actions with or without symmetry.
DecoBrush – DecoCurve brushes use Stroke >> Curve Mode functionality to simulate the application of an alpha projection onto a surface.
Dragstamp – Move and alter surface detail in real time.
Gizmo/Transpose Masking – Control how you apply, manipulate, and transpose assets and masks.
Knife Brush Split to Parts – Slice parts from existing parts while keeping sliced parts active"
(Lexi, *ZBrush vs. Blender)*.

2.5 3D Printing Process

In the past, figurines and miniatures were typically created using traditional sculpting and mold-making techniques. An artist would first create a physical sculpture of the character or object they wanted to create a figurine of, usually using materials such as clay or wax. This sculpture would then be used to create a mold, which would be filled with a material such as resin or metal to create the final figurine. While this method allowed for a lot of creativity and artistic expression, it was also time-consuming and expensive. Each figurine had to be created individually, and any mistakes or changes required starting the whole process over again.

In recent years, however, 3D printing technology has become more accessible and affordable. This has allowed for a more streamlined and efficient process of figurine creation. With 3D printing, artists can create digital models of their designs using software, which can

then be printed out as physical objects layer by layer. This allows for greater flexibility and precision in the design process, as well as faster and more cost-effective production. The adoption of 3D printing technology has revolutionized the world of figurine and miniature creation, making it easier and more accessible for artists and enthusiasts alike to bring their ideas to life.

Once a model has been finalized, with 3D printing it must be supported correctly to avoid the print failing. Whether the full model is printed all at once or in parts to be assembled, ensuring there are no stray islands that form unsupported is essential to ensuring the print succeeds. Resin printing can fail due to a variety of reasons. Some common reasons for resin print failure include incorrect exposure time, insufficient supports, poor resin quality, and improper cleaning of the print bed.

Figure 8, Examples of My Print Failures

Incorrect exposure time can result in under-cured or over-cured resin, leading to a print that is either too soft or too brittle. Insufficient supports can cause the print to collapse or deform during printing, while poor resin quality can result in a print that is not strong or durable enough. Improper cleaning of the print bed can also cause adhesion issues, resulting in prints that do not stick properly to the bed or become warped during printing.

To avoid resin print failure, it is important to carefully follow the manufacturer's instructions for exposure time and use high-quality resin. Additionally, ensuring that the print bed is properly cleaned and supports are placed correctly can greatly improve the success rate of

resin prints. It is also good to keep supports away from very detailed areas of the model like the face, as removing the supports can often leave marks that need to be filed down.
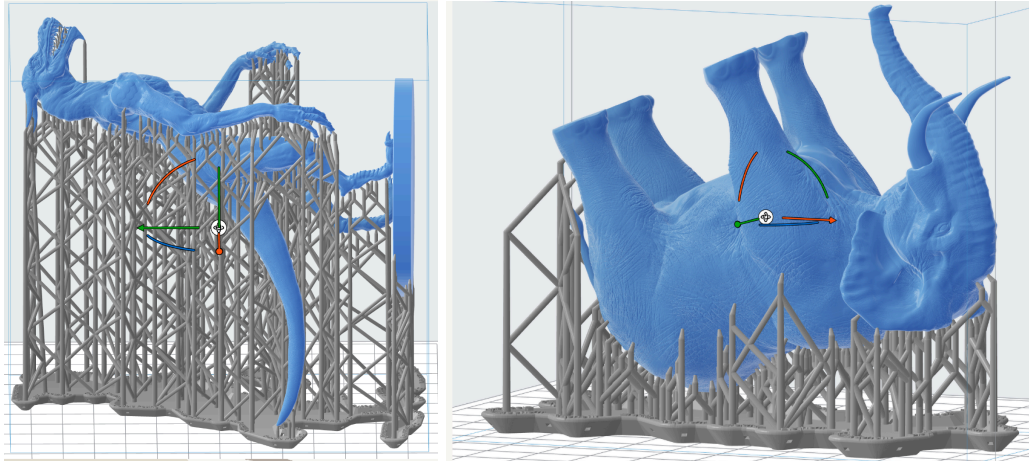

Figure 9, Example of what supports look like in Preform, a 3D printing program

Perform is a very useful tool for supporting your models. It has a very good automated process for figuring out the best rotation and where to place the supports. In my experience using the program, it has yielded very few print fails and will often warn you when part of the model is unsupported by highlighting that part in red.

2.6 Painting Process

Painting models have many paths and techniques to get a nice end result for your model. While some artists may follow a specific set of steps like prime, basecoat, wash, and highlights, others may use a more layered approach with multiple colors and techniques. Ultimately, the process an artist uses will depend on their personal style and preferences, as well as the specific needs of the piece they are working on. Priming the figures means putting a substance on it so the paint will stick better to the model and be less likely to chip away. Basecoat is putting on the flat colors through two or more passovers of the model. Wash is putting in the shadows through a more liquid paint that can get into crevices and add a nice contrast. Finally, highlighting helps certain places where you put accents on the figure to stand out more and create a more realistic

look. Highlighting can be done through dry brushing where you remove as much paint as possible from a brush before going into areas you want to highlight repeatedly.

2.7 Timeline

To achieve the goal of creating one larger display figure print and two smaller tabletop game mini prints I made production scedule. During the first couple weeks of the project, I planned to research other figure-creation companies such as Slideshow Toys and Wētā Workshop to see what I could learn from their work. Also during these starting weeks, I decided on what to base my model on and study how it looks and how to transfer those details to sculpt. Figuring out the posing of the model is important as well and doing so early is good as it can help to know how its weight might translate into the real world.

The most significant chunk of time for this project was to be spent sculpting and painting. I used Zbrush as the program to sculpt for the reasons stated in section 2.6. Then, moving that model from the digital to the physical by 3D printing it and adding a coat of paint that fits will also take some time, so I made sure to scedule some weeks to that. In Figure 2, you can see a rough timeline I planned to try to stick to. This will helped keep the project on track and let me know when I was falling behind on deliverables.

Task	B Term	C Term	D Term
Research			
Find Subjects to Model			
Posing			
Sculpting			
Painting			

Figure 10, Project Timeline

3. Tabletop Figures Progress

3.1 The Test Figures

Before doing the big figure, I first practiced the process of some smaller figures. They ultimately helped me figure out the process which was sculpting, adding supports, printing and making sure the print didn't fail while cleaning it up, and then painting. Practicing the process of creating smaller tabletop figures helped me in several ways. Firstly, it allowed me to get a better understanding of the sculpting process and how it differed from sculpting larger figures. Additionally, it helped me learn how to add supports to the prints to ensure that they did not fail during the printing process. For example, when printing a figure with lots of overhangs I made sure each overhang had generated a least a couple of supports stretch across the surface to make sure it would have something to print from. And thus the print didn't fail and went though without issue. This was a crucial lesson that I later applied while creating the bigger figure to ensure that the print didn't fail while cleaning it up.
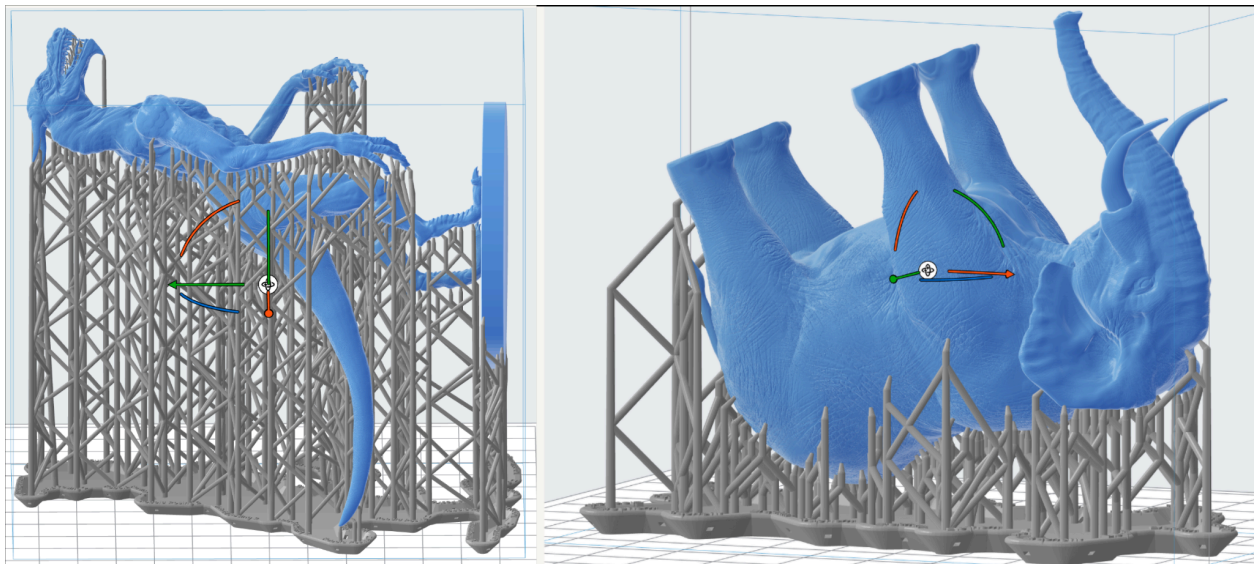
Figure 11, Support Generation in Preform and Print Outcome

Moreover, the smaller-scale prints helped me understand the level of detail that could be achieved with smaller prints. This insight allowed me to plan better for the bigger figure. I was able to identify the areas where I needed to add more detail and the areas where I could be more restrained. Finally, practicing painting techniques on the smaller figures helped me get a sense of the techniques that I later applied to the bigger figure. All in all, the smaller tabletop figures played a crucial role in helping me create the bigger figure successfully.

Figure 12, Tabletop Figure Paint Results

4. Modeling the Display Figure

4.1 The Character

It's crucial to research and gather information about the subject you plan to sculpt to ensure that you have a clear vision of what you want to create as it provides a foundation for your proportions and textures. Finding references is especially important when sculpting something that doesn't exist in real life. In my case, I spent a significant amount of time researching dragons in general, looking at various depictions of them in different cultures and media. I also looked specifically at the dragons in House of the Dragon, which was the inspiration for my sculpture.

Figure 13, Diablos from Monster Hunter

I considered several different dragons before ultimately settling on Caraxes. I considered dragons such as Diablos from the series Monster Hunter for their bulky build and interesting scale pattern. However, I chose Caraxes because of its unique appearance, impressive size, and distinctive features. Its distinctive anatomy, with its long snake-like neck, puffed-out chest, little horns, and massive wings, sets it apart from many other dragons. I also found that it had a lot of dynamic potential for posing and composition. The details of the smaller scale patterns and spikes would come out a lot better on a larger scale figure as well.
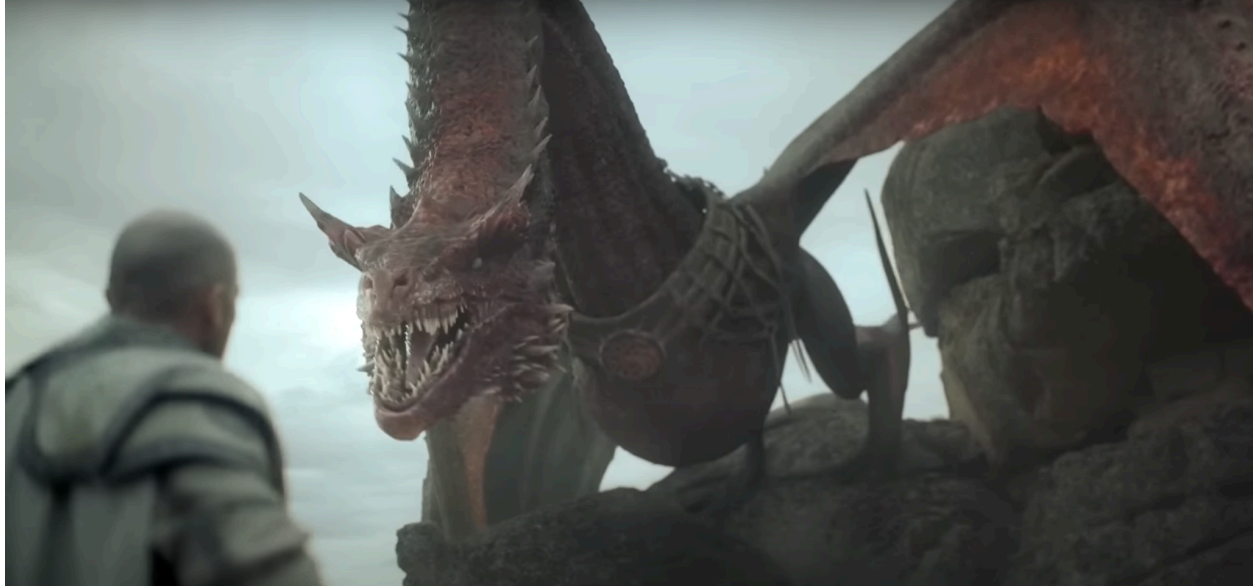
Figure 14, In Show Reference of Caraxes

I also looked at other figures to inform my choices, particularly in terms of pose and size. I wanted my sculpture to have a sense of movement and power, so I studied the anatomy and movements of animals like birds and reptiles. This helped me to create a pose that felt natural and dynamic. After gathering all of this research and information, I was able to come up with a clear concept for my sculpture. I knew what I wanted to create, how I wanted it to look, and how I wanted it to feel. This allowed me to approach the actual sculpting process with confidence and clarity (*The Art of Star Wars poster collecting: 70s to modern)*.

One of the key aspects of sculpting is anatomy. In order to create a believable and visually appealing figure, it is important to have a good understanding of human anatomy. For dragons I did looked up references of bats for their wings as a means to understand the skeletal structure of them. I aslo looked into lizard heads for the shape of the head. This means understanding the proportions of the body, the placement of muscles and bones, and how they all work together to create movement and form. This knowledge can be applied to the creation of humanoid and animal figures, as well as creatures and monsters.
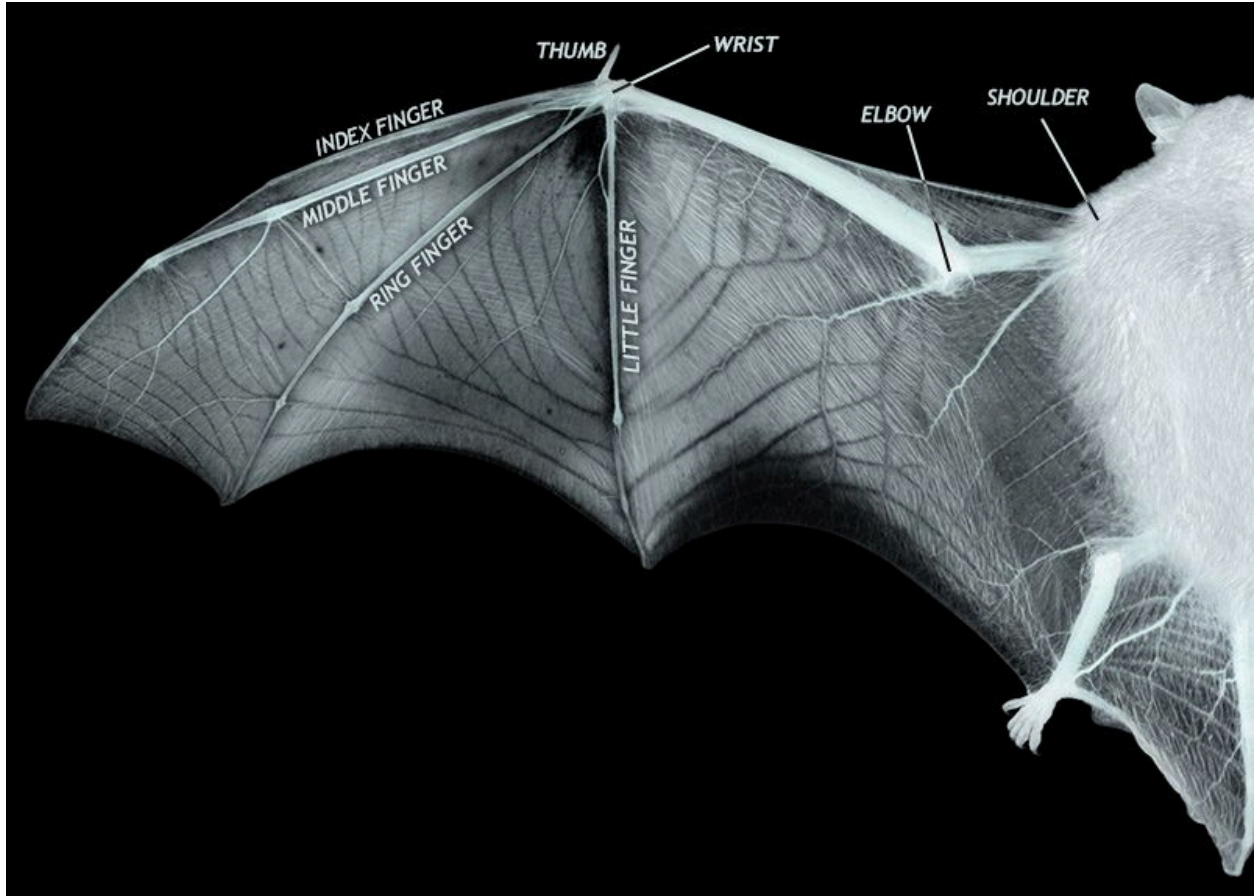
Figure 15, Wing Reference

Another important aspect of sculpting is silhouette. Silhouette refers to the outline or shape of a figure, and it is important because it is often the first thing that is noticed about a character or creature. A strong and recognizable silhouette can make a figure stand out and be more memorable. This is why it is important to consider the silhouette at every stage of the sculpting process, from the initial block out to the final detailing. The reason why all of the most iconic designs are almost immediately recognizable just based off of their silhouette is that the human brain is wired to recognize shapes and patterns quickly. When we see a recognizable silhouette, our brain can quickly associate it with a certain character or creature, even if we only see it for a split second. This is why a strong and memorable silhouette is crucial for characters or creatures in movies, video games, animations, and other forms of media. It helps viewers to quickly identify and remember the character, even if they only see it briefly. A well-designed silhouette can convey a lot of information about a character's personality, mood, and attitude, which in turn helps to create a more immersive and engaging experience for the viewer

Weight is another important consideration when sculpting figurines and miniatures. Weight refers to the sense of mass and gravity that a figure conveys. A well-sculpted figure has a sense of weight that makes it feel grounded and believable. Achieving a sense of weight digitally can be a challenge, as it requires careful attention to the placement and shape of each element of the figure. Figure 16 of Michelangelo's David shows how weight can be shown even in a still statue as his posture shows how he is leaning to one side.
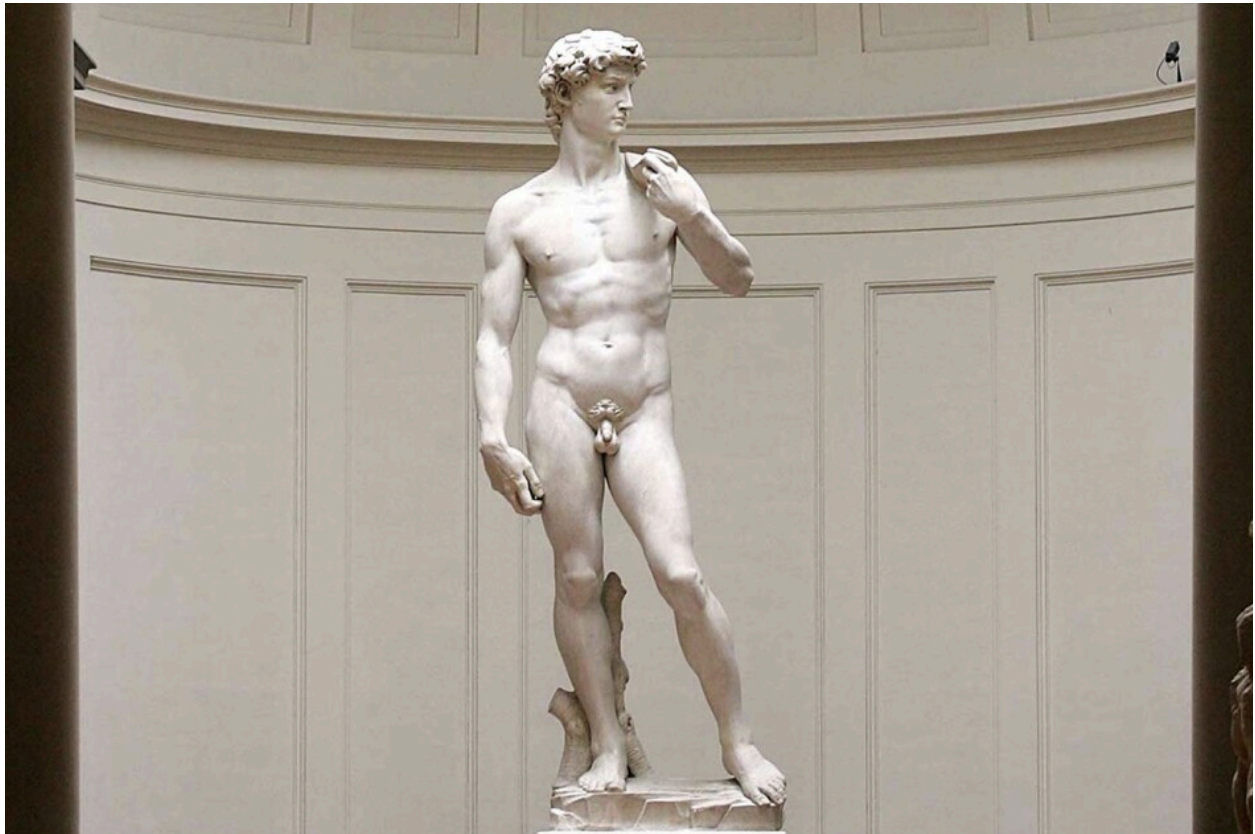
Figure 16, Michelangelo's David

Successfully achieving the above aspects digitally can be challenging, as it requires a combination of technical skill, artistic intuition, reasearch and expiramentation. It takes practice and experience to develop a good sense of form, anatomy, and weight, as well as an understanding of how to use digital tools to achieve the desired result. However, with dedication and practice, it is possible to create beautiful and compelling figurines and miniatures using digital sculpting tools like ZBrush.

4.2 The Blockout

Once the concept was chosen, the next step is blocking out the model's pose. This phase creates a rough, simplified version of the model before adding finer details. I chose to use ZBrush for the sculpting portion of this project because of its versatility and ability to create highly detailed models. ZBrush is a digital sculpting software that allows artists to create intricate 3D models using a combination of sculpting, painting, and texturing tools. It is widely used in the entertainment industry for creating characters, creatures, and props for movies, video games, and other forms of media. When blocking out the figure, I used spheres and other primitive shapes to help build the foundational design. Blockout helps define the overall scale of the piece and helps to figure out the overall proportions. It can also show how a model's weight might have to be edited in certain places to keep the figure balanced so it doesn't fall over to one side due to weight issues.
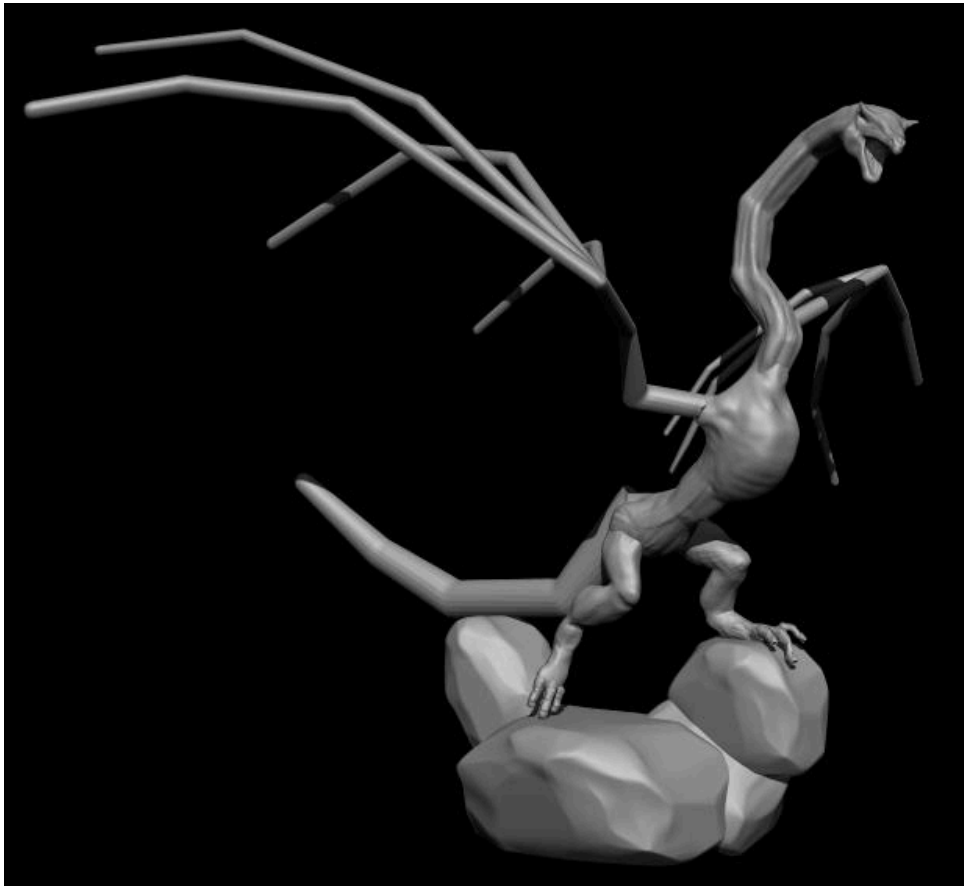

Figure 17, Blockout of Caraxes

At first, I tried blocking out the dragon in a pose that would make it look like it was about to take flight with rocks at the base forming a weight that would make sure the figure was steady and not fall over. After some tweaking by rotating parts in different directions I thought it was time to start refining the details starting with the head and going from there to the rest of the body.

4.3 Breaking it Down to Parts

From the head, I went on to the torso next making sure they were on different layers at first. After the torso, I attached a wing and decided to duplicate it and mirror it to the other side when it was finished to save on time.

Separating the sculpture into parts may seem weird but it has its advantages. For one, it helps organize the workflow to help focus on each part without getting overwhelmed by the big picture. For even larger sculptures than what I did, it's useful for keeping track of projects with many components in the scene. It's also easier to manipulate a sculpt in parts rather than all attached together as it becomes simpler to move parts like limbs independently from the main body in case the pose ends up changing. Separating parts makes applying masks, selections, and other sculpting operations easier to specific areas of the model.

4.4 Sculpting the Head

When it comes to the process of sculpting figurines and miniatures, ZBrush is a popular choice among digital sculptors. This is because ZBrush provides a lot of tools and features that make the sculpting process more intuitive and efficient. For example, ZBrush offers various brushes that can be used to create different types of textures and details, such as wrinkles, scales, and hair. It also offers features like DynaMesh, which allows the user to create and manipulate geometry in real time.

When I was sculpting early on I was focused on adding structures to the form of the head to give it some sense of skeletal structure and prominent silhouette. The best tool to use for this step is the move brush and clay buildup brush. Refining those shapes and adding definitions becomes easier once you have sketched out a layout with these brushes. This process can be seen

in Figure 18, where the jawline, snout, and neck shape get more refined with each pass. Adding on details like eyeballs, spikes, and a tongue usually became their own separate subtools in case they needed to be manipulated separately from the head shape.
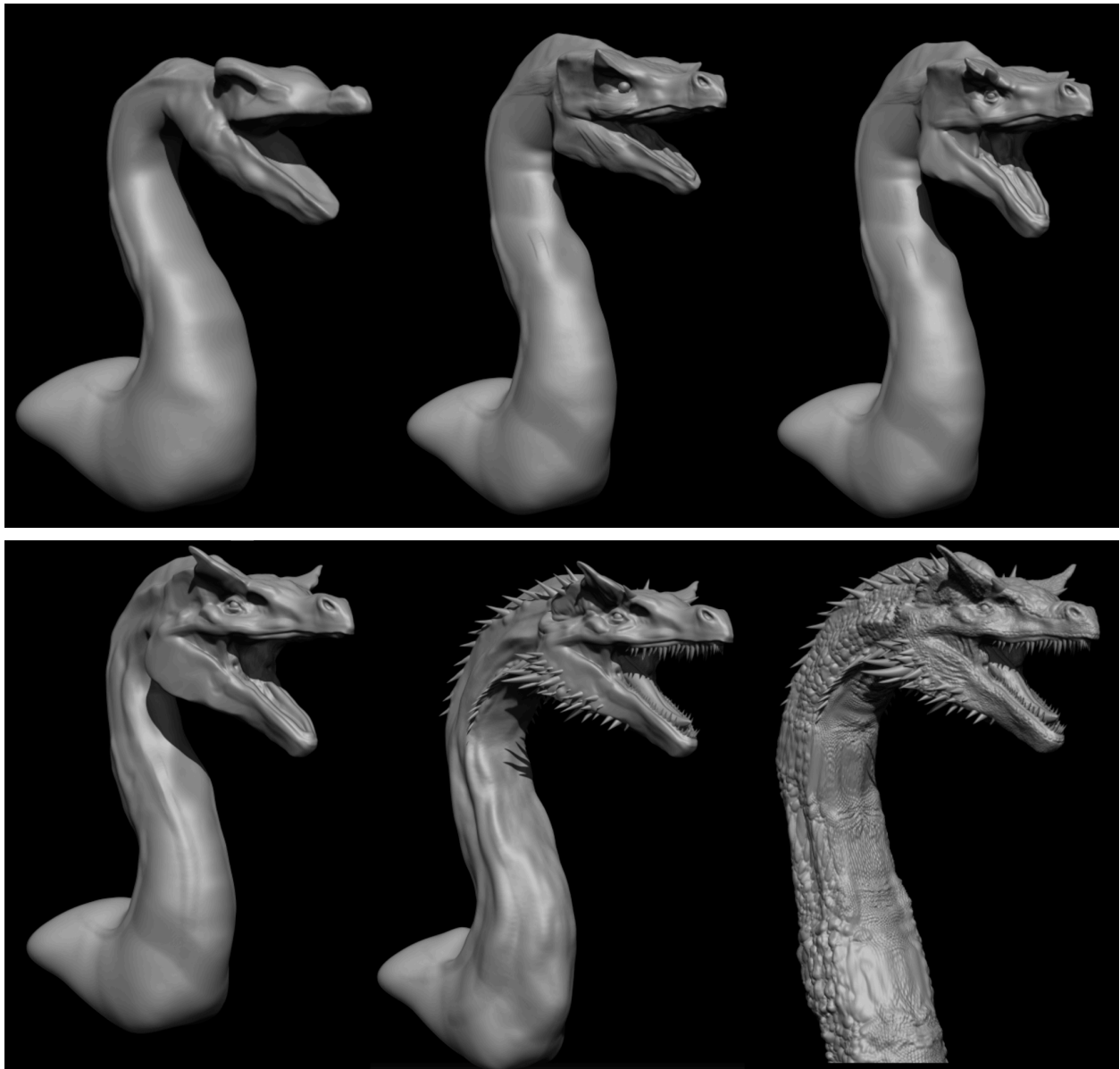

Figure 18, Dragon Head Initial to Final Iteration

Once everything was in a good stage, I moved to sculpting and using alphas to add textures. As seen in Figure x, the fifth iteration shows the before textures were applied, and the fifth shows after. This part of the process truly makes the sculpture come alive and gives you an idea of what it would feel like to touch.

For texturing, I got my references mostly from lizard scales such as the Komodo dragon for its rounder bumpy scales and crocodiles for their larger more rectangular scales. I used a variety of brushes and tools in ZBrush to sculpt the various parts of the model, paying close attention to the details and proportions. I created the textures through the dam standard brush, and Alphas which are grayscale intensity maps used to represent height or depth and can help create repeating patterns. Another important tool were VDM (Vector Displacement Map) brushes which are similar to Alphas but operate more like brushes. VDM brushes work by using a grayscale image to create a 3D displacement map, which is then applied to the surface of the model.
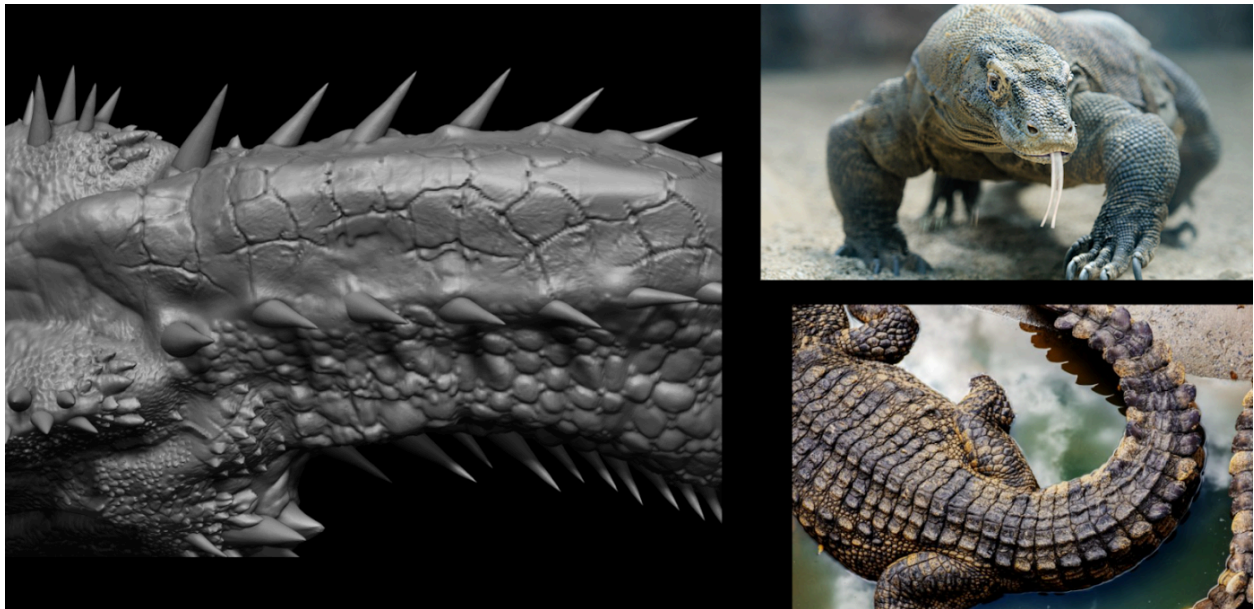
Figure 19, texture example

4.5 Sculpting the Torso and Wings

Making the Torso and Wings had a similar workflow of making the head. First making them two separate parts of simpler shapes, then refining them over the course of many iterations of building up anatomical structures and finally adding details through texturing. Texturing the chest of this character was a strange time because in the show model he has very little in terms of anatomical detail there, not even a collar bone or anything. I tried to add a bit more definition to his chest in terms of pecs but decided to stick to being as show-accurate as possible.

The wings were especially interesting to work on as adding skin between the wing membranes finally got the piece to start looking finalized. The wrinkles on the wings help it stand out from all the scales elsewhere on the piece and ultimately gave way to a better idea of how it would look.

As I got to this phase in the project, I realized I was running out of time and couldn't complete the whole body as I had originally planned. This change of plans got me thinking of how I could still make a figure with only half a dragon and still make it look dynamic. I eventually came up with the idea of having the creature look like it was emerging from a caged cave entrance. That way, it could be implied that the other half of its body was in the cave's base and also allow for new ways the figure could be displayed.
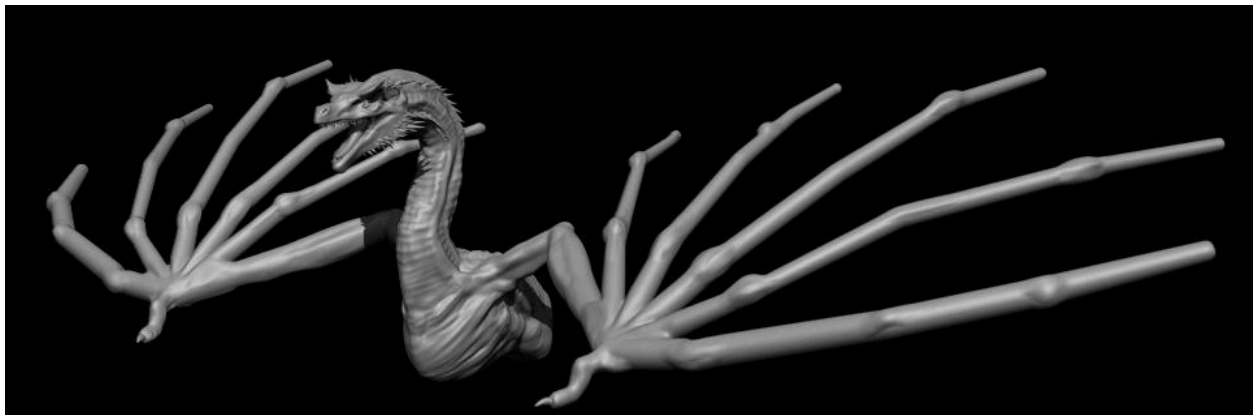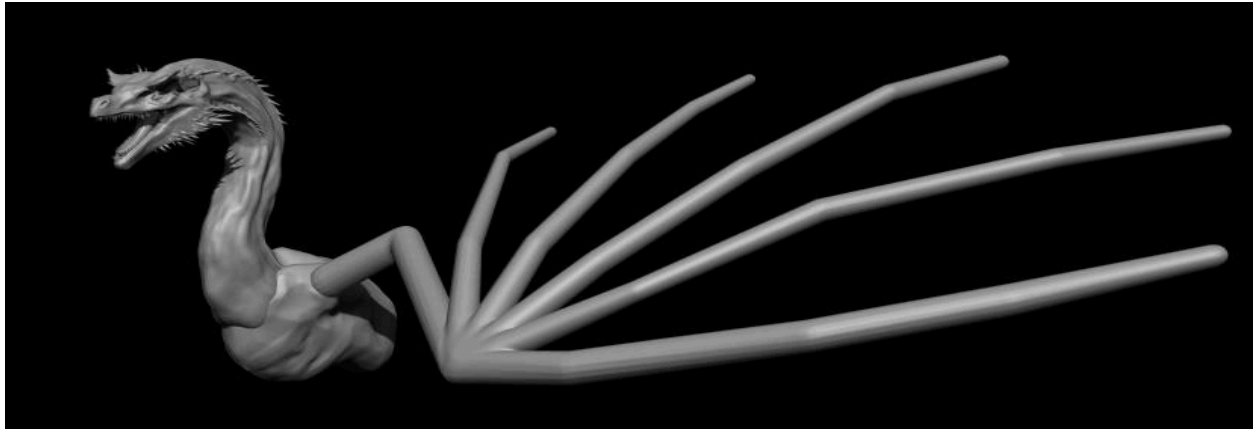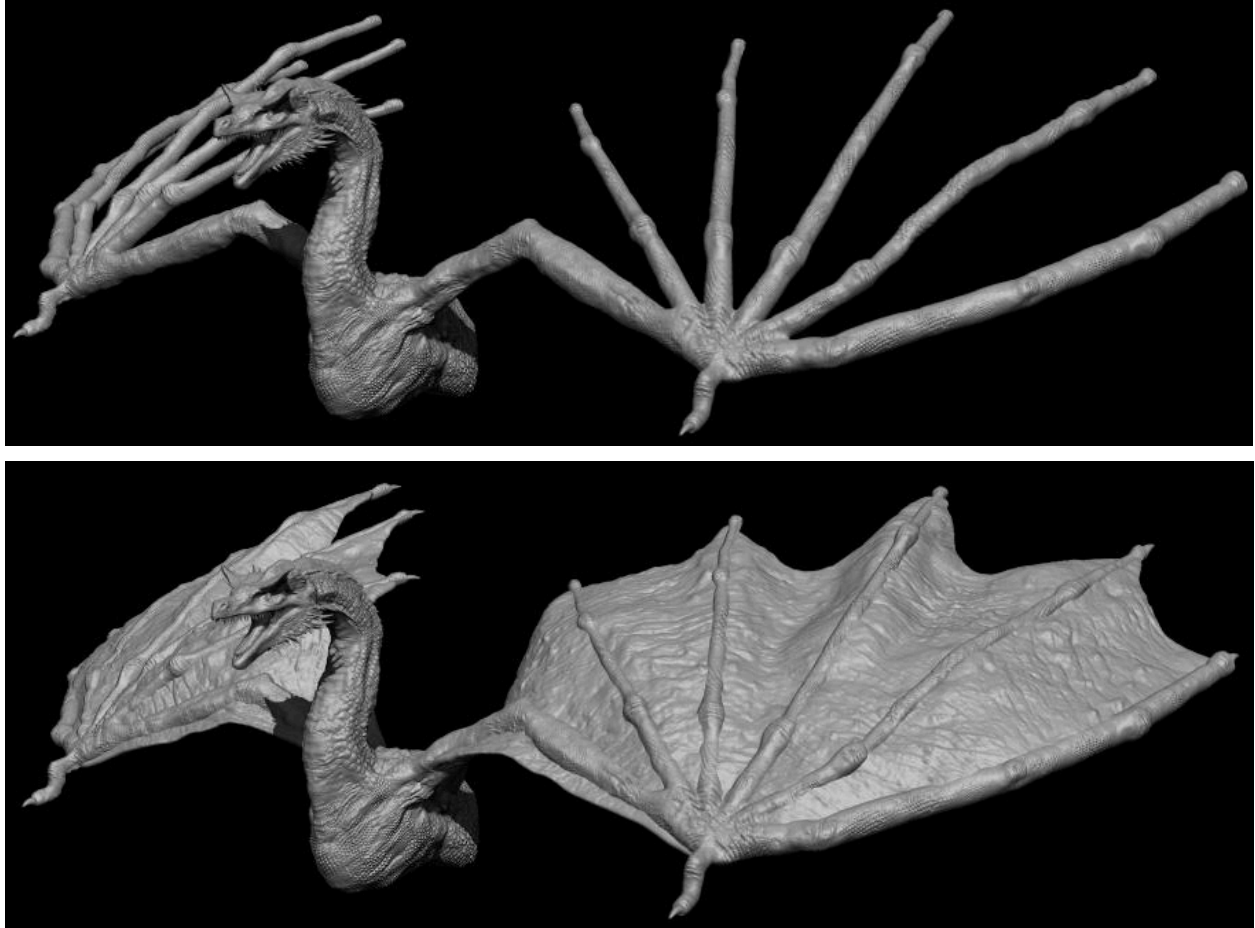
Figure 20, Torso and Wings Initial to Final Iteration

4.6 Sculpting the Base

To make a base that accommodated only half the dragon being sculpted, I made the first iteration of a low poly cave gate that the dragon would be coming out of as seen in Figure X. When I first test printed the first base design out I found the wings went behind where the base ended and thus couldn't be put against the wall to make it look like it was almost coming out of it. I edited the dragon's pose and the length of the tunnel it was emerging from so its wings were more forward. This allowed the figure to be rested against a wall, bringing a new depth to the original pose.
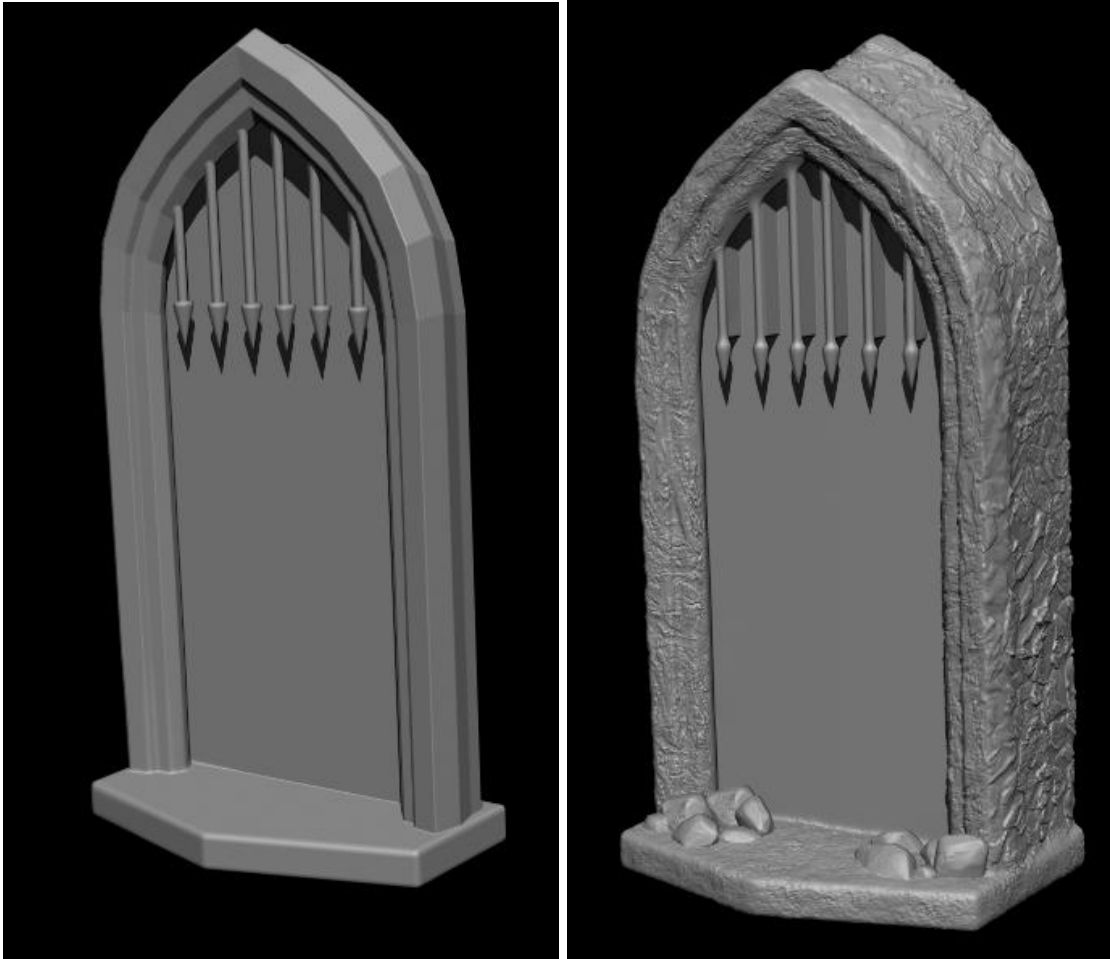
Figure 21, Base Iteration

Once the base shape was in a spot I wanted it to be I added the stone texture and some rocks at the bottom to add more detail and potentially hide lights in the future if I were to consider adding them. I also added built-in supports to the gate bars as in the test print those snapped off very easily. One last addition to the base was hook hangers on the back to add the potential of the figure being hung up. These can be seen in Figure x and run pretty deep into the base. Though hanging hasn't been tested much regarding this figure, I thought it would be a nice feature to include.
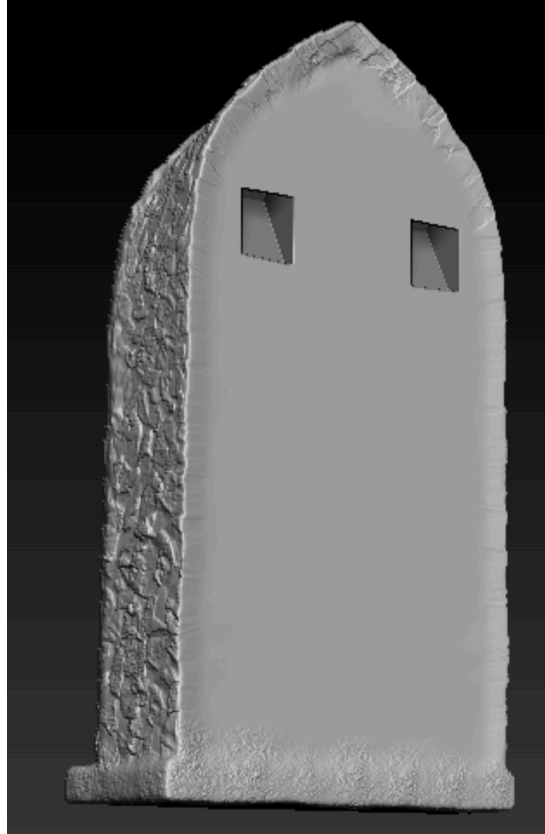
Figure 22, Idea for Hook Hangers

5. Printing the Display Figure

5.1 Adding Keys and Decimation

Once the sculpture was in the spot I wanted it to be, I moved on to adding keys to the model. Keys exist because it is hard to 3D print everything in one go. Especially for bigger pieces as you'd need a massive printer to print everything in one go which can lead to higher chances of the print failing halfway through. Keys allow you to separate pieces that can't be done in one print and then correctly align and reassemble it so you can have a good-sized print even if the printer is not big enough. They also make replicating parts easier. Since you can then mold and cast them, without the need to reprint a piece every single time. Using the slice tool in Zbrush I was able to make clean cuts to split the figure into parts to effectively add the keys.
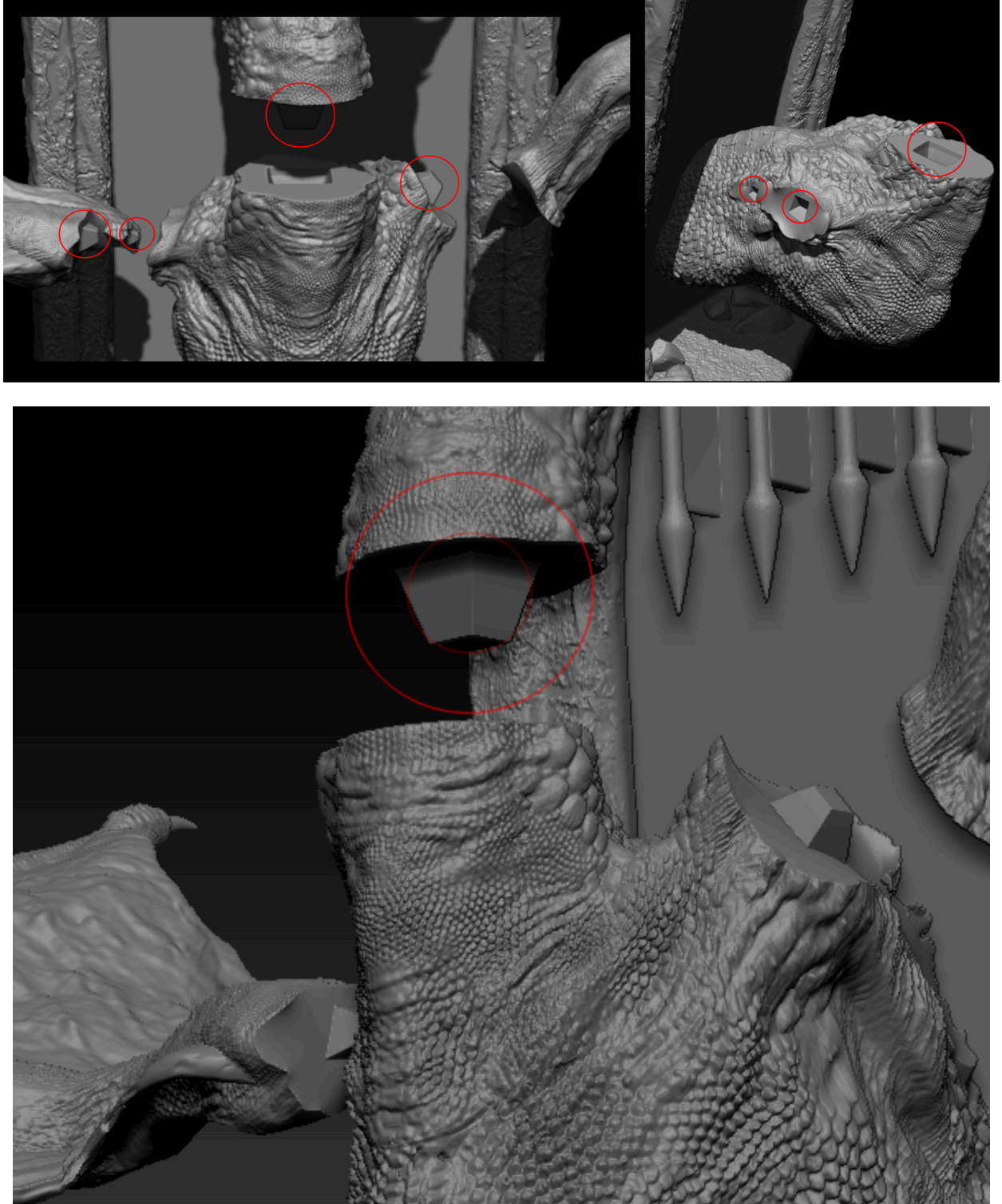
Figure 23, Example of How Keys on the Models Look

Figure 24, Keys and parts for a Weta Warhammer Figure

Once all the details on the model were complete and the keys where I wanted them to be I used the decimation tool in Zbrush to reduce the polygon count of the model, making it easier to 3D print. This ultimately ruins the typology of the model making it very hard to sculpt on once it's decimated so this step should only be done when your positive you won't need to make any more changes and the model is ready for printing.

5.2 Adding Supports

When preparing the model to be printed, I used auto support generation in the software PreForm but edited it a bit to ensure the supports were on sides that wouldn't be as noticeable on the figure. This is because when removing supports, they can leave behind little indents and bumps that show they were there, and the more you have, the more work that goes into filing them down. It's easier overall if you just put them in places that would be less likely to be seen in the first place.
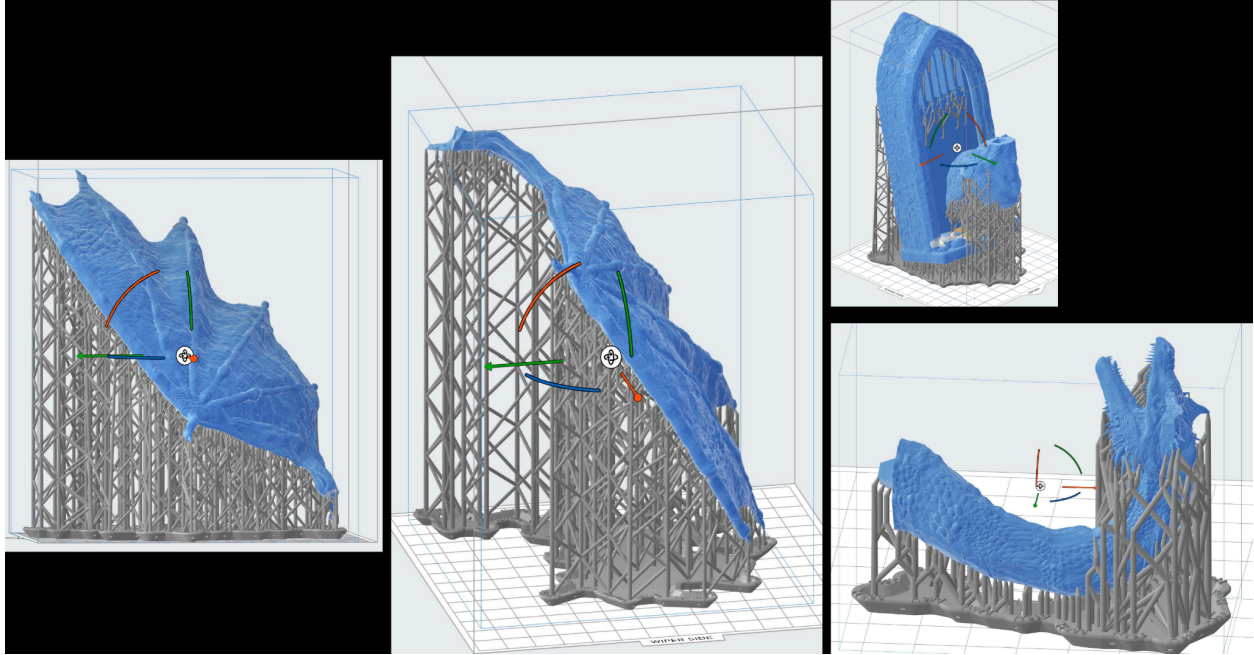
Figure 25, Supports for Each Part

5.3 Removing From Print Bed and Cleaning Aftermath

Removing the print from the bed and removing the supports from the figure is a very precarious time as you want to make sure you use enough force to remove the supports, but not so much that you break off a thinner piece of the figure in the process. Using tools such as tweezers to pick away at hard to reach supports and scrapers for areas with clusters of supports can make the job a lot easier. Once all the parts were printed out and the supports were removed I used a dremel to smooth down areas in which indents were very apparent.

Figure 26, Print of the Head and Wing

One of the challenges faced during the assembly of the figure was the keys that were printed to fit the different pieces together. The keys needed to be precise and fit just right, otherwise they would not hold the pieces together properly. For two parts the keys did not properly align. The head key was misaligned leading to part of the neck hanging off and the right wing key was a bit too big to fit in its proper hole. This problem was solved by using the Dremel again to make keys fit better into their holes by drilling them to be bigger or deeper.

When I first printed out the pieces, I ran into scaling issues, as PreForm did not scale each part the same. To fix this, I used the Meshmixer program to make sure each part was scaled to the correct size for the printer I was using. It was a shame to lose time to this mistake but eventually, the scaling came out so each piece would be printed as big as the printer could produce the largest piece which was the wings. The overall size of the figure came out to be about 15.75 in for length, 4.5 in for width and 4.75 in for height. A size comparison compared to some everyday objects can be seen in Figure x.

Figure 27, Final Scale of Everything

6. Painting the Display Figure

6.1 Painting Techniques

In my research, I found that companies and individuals who create figurines and miniatures use a variety of painting techniques. Some of the most popular techniques include dry brushing, washes, layering, and glazes. Dry brushing involves using a dry brush to apply paint to the raised areas of a figure, leaving the recessed areas untouched. This creates a highlighting effect and adds depth to the figure. Washes are used to darken recessed areas and create shadows. Layering involves building up thin layers of paint to create smooth transitions between colors. Glazes are used to add a transparent layer of color over an existing layer to change its hue or add depth.

I also researched the specific painting techniques used for dragons and other mythical creatures. Many artists use a technique called "color shifting," where they paint the figure in a base color and then use a different color for the highlights and shadows. This creates a shifting effect, where the colors appear to change depending on the angle and lighting.

Figure x shows the result of about 20 mins of work through just using the two techniques of wash and drybrushing. In a short amount of time doing only one layer of wash and dry brushing has made it easier to see areas where layering can be used. It also illustrates how quickly things can pop on the figure through just a coat of dark and light colors. Before when everything was one color it was hard to make out certain details but with these techniques, details like wrinkles and muscles start standing out more.

Figure 28, Wash and DryBrushing Quick Results

In my own approach, I experimented with a combination of these techniques to create a unique look for the figures I painted. I started with a base coat of paint and then used dry brushing and washes to add depth and texture. While I didn't use glazes, I did end up using gloss and matt varnish to add light scattering to the figures when in the sun. Overall, my research helped inform my approach toward the display figure.

Ultimately, this is the process I used to paint the bigger figure. I used a red spray-painted primer and as red was the main color of the dragon this helped me save time base coating it the same color. I then went over it with a wash to see where the shadows would land. Building up the color from dark to light I found was the easiest as highlighting through dry brushing is easier when things start off dark and in the end, it led to this result as shown in the figures below.

Figure 29, The Painting Process

7. Survey Results

7.1 Preparation of Survey

In the last couple weeks of this project, I did a survey. The survey section of this project was conducted to gather feedback on the progress of the tabletop figures. As this project was completed independently, I wanted to get an outside perspective on the quality of the work and any areas that could be improved. By conducting a survey, I hoped to gain insight into the opinions and preferences of potential customers for the final product should I decide to pursue this commercially. The survey was designed to be short and straightforward, focusing on the appearance and quality of the figures, as well as pricing and interest in purchasing. I used the

data collected from the survey to make adjustments to the final product and ensure that it met the needs and expectations of potential customers.

One of the questions I asked was things like how obvious were the seam lines between parts. I asked this because it is important to hide the seams of a figure as well as possible to give it a better finish and quality. Another question I asked was how well the details came out on the sculpture as it could be rendered into an STL file and printed out. An STL file a universal file formate for 3D printing so the customer would be buying the file instead of a physical product. This would give the, the ability to print it out as many times as they want was long as they have a printer. I asked this question to get a better idea of how others thought the sculpture came out. One other question I asked was how much money people would spend on a figure like this out of curiosity for if I were to sell this project in the future what people would be willing to spend. The full survey can be seen in Figure x.

Figure 30, Survey Questions

7.2 Analysis of Feedback

Although I was only able to survey a handful of campus students, the findings of the survey indicate that the majority of the participants had a favorable view of both the painted figure and the STL file. However, when it came to the question of whether the respondents would be interested in purchasing the product, the results were mixed. This could be due to the fact that the survey was conducted among students who are either not interested in collecting figures or do not own a 3D printer themselves.

It is worth noting that although the overall response to purchasing was mixed, a significant number of respondents still expressed positive feelings about the outcome and looked at the product. This suggests that there could be potential market opportunities outside of the student demographic. Further research would be needed to determine the interest of this figure outside of the student body.
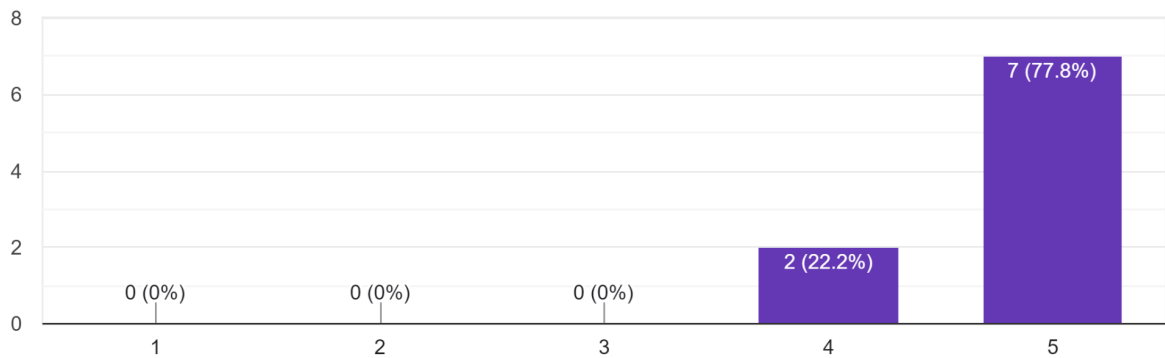
Do you like buying figures or minis for tabletop games or display purposes?

9 responses

- ● Yes
- ● No

77.8%

22.2%
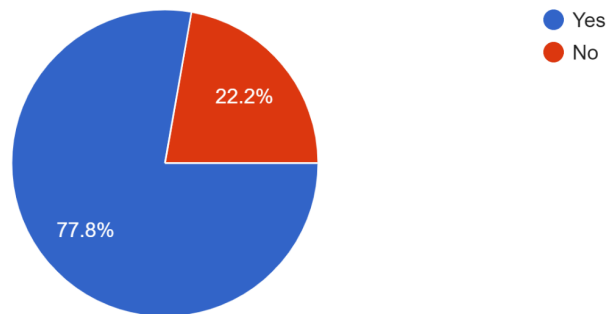
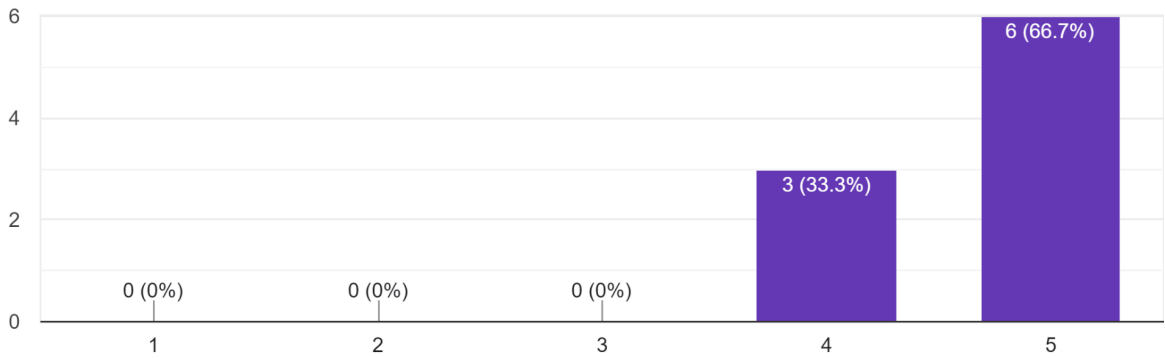Regarding the pictures above, how obvious are the seam lines where parts of the figure have been connected?
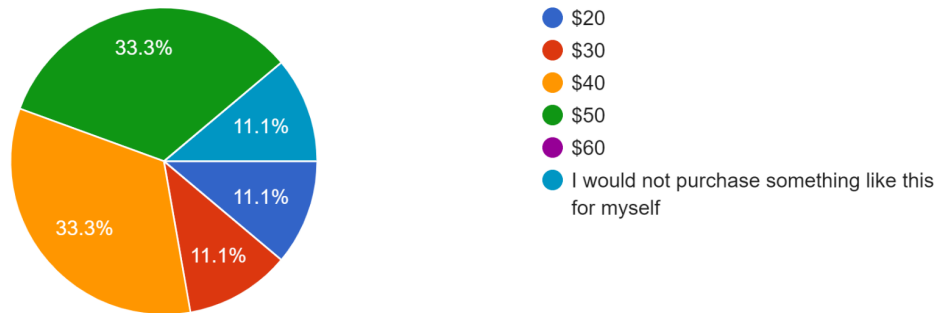
9 responses

How would you rate the paint job on the figure?

9 responses

Would you be interested in purchasing a fully printed and painted figure like this for yourself? If so, how much would you usually spend?
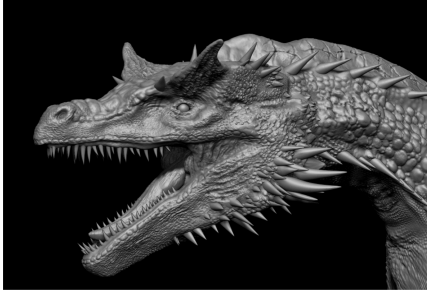
9 responses

- $20
- $30
- $40
- $50
- $60
- I would not purchase something like this for myself

Above are renders of the model that can be converted to an STL file and able to be 3D printed out.
How would you rate the overall look of the sculpture?

9 responses
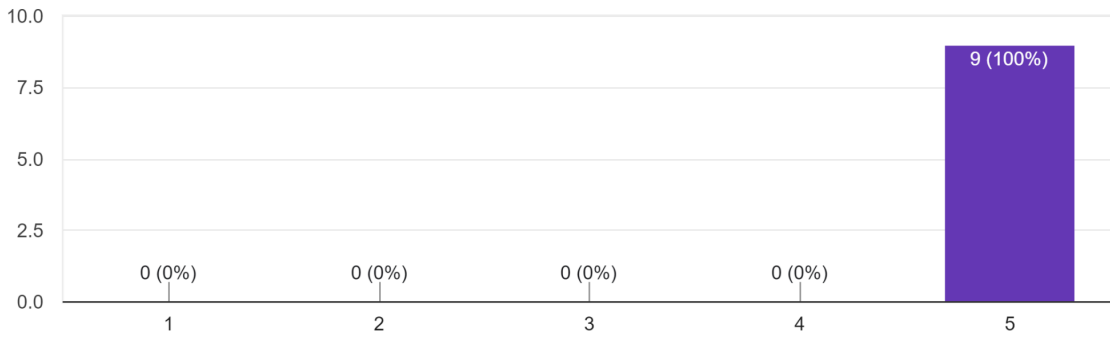
Is the pose dynamic enough?

9 responses
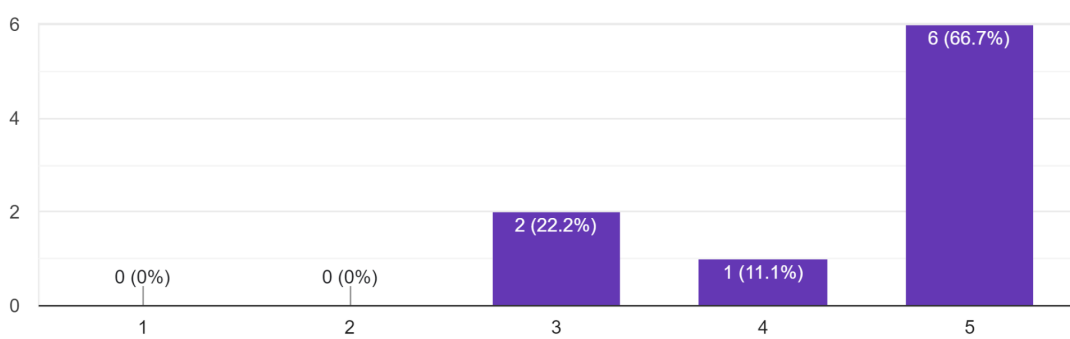
Would you be interested in purchasing the STL file to use? If so, how much would you usually spend?

9 responses

- $5
- $10
- $15
- $20
- $25
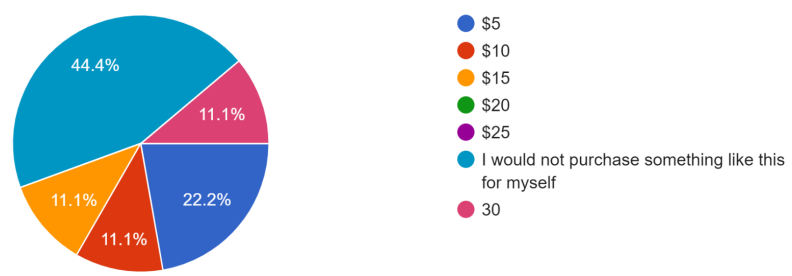- I would not purchase something like this for myself
- 30

Figure 31, Survey Results

7.3 Targeted Research

While I conducted a survey to gather feedback on the finished product, I also wanted to conduct more targeted research by surveying those who actively 3D print or collect statues/figurines. However, due to time constraints, I was not able to conduct this research. In future projects, I would like to allocate more time to targeted research, as I believe it would provide valuable insights into the preferences and opinions of those who are most invested in this field.

8. Conclusion

8.1- Challenges Faced During the Project:

Throughout the duration of this project, I had to face several challenges that made the journey a bit difficult. Initially, my focus was solely on creating miniature models, but as I progressed, I found myself drawn to the challenge of creating larger, more complex display figures. However, this presented several challenges that I had to overcome.

One of the main setbacks I faced was running out of time. I had initially set a timeline for myself, but due to the complexity of the figures, I had to extend the timeline. This resulted in a bit of frustration, but I remained committed to the project and continued to work diligently to achieve my goals.

Another challenge I faced was struggling to push the paint job to its full potential. I found myself getting stuck and unable to create the desired effect I had in mind. It took several attempts, but with perseverance, I was able to eventually get to the desired outcome.

I also had issues related to keys and scaling, which were a bit of a struggle to overcome. This required me to take a step back and re-evaluate my approach. I had to make several adjustments to ensure that everything was proportional and aligned correctly.

Looking back, I realized that the best place to start sculpting would've been the torso as it is the center of the creature and therefore a good point in which to keep the proportions and details consistent throughout the piece and not hyperfixate on one area for too long. I instead started at the head as it was the part I was most excited to get to work on. Despite these

challenges, I remained committed to the project and continued to work diligently to achieve my goals.

8.2 Positive Experiences and Growth

Despite the challenges I faced, there were also many positive experiences that came out of this project. One of the things I am most proud of is the level of detail I was able to achieve in the model. It was a true labor of love, and I was thrilled to see how well it was received by others once it was completed.

Along the way, I had the opportunity to learn a great deal about the process of figure creation, which was incredibly meaningful to me. This project was a valuable learning experience that I will carry with me for years to come. It taught me the importance of perseverance and the value of hard work.

I also learned that taking a step back and re-evaluating my approach can lead to better outcomes. It is essential to remain flexible and adaptable in the face of challenges. This project helped me develop a greater sense of self-awareness and taught me the importance of self-reflection.

In conclusion, this project was an incredible journey that presented several challenges, but also allowed me to grow and learn in many ways. The positive experiences and growth I gained from this project will stay with me for years to come.

8.2 Surprises I Encountered

During my involvement in this project, I was taken aback by a few things that I didn't expect. Firstly, I realized just how much time and effort goes into each step of the process, from planning and designing to molding and casting. It truly requires a great deal of patience and dedication to create a high-quality figure.

Secondly, I was surprised by the strength of the adhesives used to keep certain parts of the figure suspended in the air. It's amazing to see how a small amount of glue can hold up a seemingly weighty piece.

Lastly, I learned that some parts of the figure made from brittle resin can be quite delicate and prone to breaking. It's important to handle them with care to avoid any accidental damage.

All in all, it was a fascinating experience that taught me a lot about the intricate world of figure-making.

8.3 What's Next

I am very pleased with the outcome of this project. It was a great learning experience and I feel like I have gained a lot of new skills. I am planning to showcase this project in my portfolio as a testament to my abilities. Additionally, I am considering the possibility of setting up an online shop where people can order custom 3D-printed figures. Perhaps, I could even offer custom painting services to add a unique touch to each order. This would be a great opportunity to turn my passion for 3D printing into a business venture and share the creativity I've gained from this project with others.

Due to time constraints, I wasn't able to delve into the lighting aspect of the project as much as I would have liked. However, lighting is a crucial part of the display of any figurine or miniature, and it can make a significant difference in how the final product looks. Proper lighting can highlight the details of the figure and enhance the overall appearance. Lighting requires a lot of foresight into where to place the lights be it on the base or inside the model itself. You also need to design pathways for the wire to go through and place the outlet in a place that won't be too noticeable. In the future, I would love to explore lighting techniques and how they can be used to bring out the best in 3D-printed figurines and miniatures.

For other students attempting a similar project, I would say that it's essential to have a clear plan and timeline in place. It can be easy to get lost in the details of 3D modeling and lose track of time, so setting goals and deadlines can help keep you on track and ensure that you complete the project on time. Additionally, having a good understanding of the software and hardware you will be using can also be beneficial.

As for things I would do differently next time, I think I would focus more on the planning and research phases of the project. While I was able to create a successful display figure, I think I could have made the process smoother by doing more research on the workflow and techniques used by other companies and artists in the industry. Additionally, I would have liked to have more time to experiment with different painting techniques and finishes to see how they would affect the final look of the figure.

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