

Character Diversification: Rigs of Color

A Major Qualifying Project
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Interactive Media and Game Development (Technical Art Concentration)

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Abstract

The Character Diversification project focuses on developing diverse three-dimensional character models. These models will be available for unrestricted use on the internet, focusing on being a resource for students learning animation. This project centered around developing seven characters of various ethnic backgrounds. Characters were taken from base concept art to fully modeled, clothed, and colored models. This project was created as a Worcester Polytechnic Institute (WPI) Major Qualifying Project, worked on by one interactive Media and Game Development student with a concentration in technical art. This report discusses the considerations that go into a diversity-focused project, the process of building digital characters, and future prospects for this project's continuation at Worcester Polytechnic Institute.

Acknowledgments

I would like to thank my advisor, Professor Farley Chery. His dedication to making a project like this possible is inspiring, and his guidance and feedback were integral to this project. I would also like to thank Professor Ralph Sutter for his continued advice on 3D modeling and his assistance in establishing successful workflows. I also want to thank my fellow students, friends, and family who acted as observers and critics for this project.

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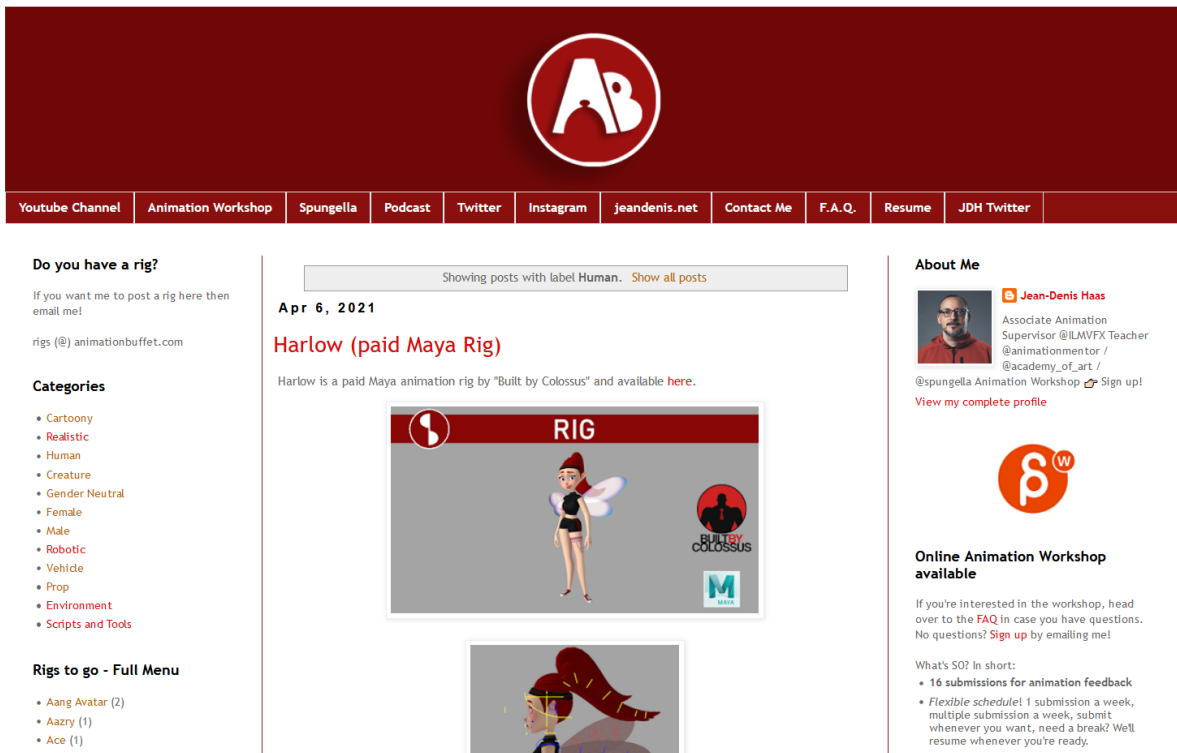
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1 - Introduction

The Character Diversification project focuses on developing diverse three-dimensional character models. This Major Qualifying Project (MQP) was completed by one Worcester Polytechnic Institute Interactive Media And Game Development (WPI IMGD) student. Davina Dawson created almost all 3D assets, textures, and character accessories, except for the Kim model. This project aims to explore the development of more diverse 3D characters and how projects like these may evolve to be a fixture of the WPI IMGD program.

1.1 - Observations of the Current State of Diversity

Our observations of the state of diversity in open-source rigs began through anecdotal experiences of animation students. Students who sought to animate using non-white characters had difficulty finding good representation for people of color. Further, they also often observed that the rigs of characters of color were often less technically functional; their rigs would be missing key features such as foot and hand deformation or facial rigging.



A screenshot of the online rig marketplace: Animation Buffet.¹

One example of online marketplaces that students use to find rigs to work with is Animation Buffet. Out of the over 500 rigs accessible on Animation Buffet currently, I

¹ Haas, J.-D. (1970, January 1). Animation Buffet. <http://animationbuffet.blogspot.com/search/label/Human>. Screenshot by author.

counted seventeen characters of color, including light-skinned non-European characters. There were about nine dark-skinned characters of color. This lack of diversity of character rigs manifests in student animations that lack diversity, and it makes finding diverse characters arduous and frustrating.

1.2 - Planning Considerations

This four-term project sought to create high-quality 3D models of people of color. For the sake of preserving the quality and individuality of characters, my advisor and I scoped the original project to include six characters, three masculine and three feminine. The scope later expanded to seven characters because of extra time. The final product was four feminine character models and three masculine models; additionally, a final feminine model was contributed by another student and edited by me.

Approaching the concept at a high level, a lot of planning goes into developing a fully-fledged 3D model. The process begins with concept selection, where reference art is found or commissioned. Following this, one sculpts the shape of the character. From there, the character's body is refined and given details such as facial design and other more detailed body parts, like hands and feet. Characters also need to be fully clothed, including shoes and accessories. Finally, all characters had to be fully textured. It was essential to keep all of these steps in mind when approaching the project design, as it could have been easy to lose sight of the pre-set scope.

The primary goal, as mentioned, was to explore bringing diverse representation into the open-source rig community. With this in mind, the lineup was to be two Black men, one Asian man, one Middle-Eastern woman, one Hispanic woman, and one Black woman. Later, I added a second Black woman to the project, Desirae. The representation here focused on presenting darker-skinned individuals, as they were vastly underrepresented in sources that were looked at as references.

When approaching this project, a significant point of concern stemmed from its central interest in diversity. Stepping out of one's comfort zone and representing people unlike oneself is challenging, and it takes a high level of research and care. From the beginning, I wanted to make sure that the characters of color that I made felt authentic and representative to the underrepresented groups that they depicted. The following section delves deeper into the planning and consideration behind diversification.

2 - Character Diversification

As this project centers around representing those often underrepresented in media, a large part of the research and consideration that went into the project focused on representing people of color. Whenever working on diversification, it is important to be self-critical. You have to ask yourself if the choices you are making are generalizations or stereotypes, and you have to be careful to represent authentically and avoid an over-emphasis of racial features.

2.1 - Choosing Reference Images

Using reference images is necessary for all artistic work and becomes even more critical when the artist is stepping out of familiar territory; the first step to starting each character's development was finding source material to reference.

2.1.1 - Diya

The first character that I came up with was Diya. I decided that for her, I wanted to start by trying to represent a natural person. This came from a combination of admiration for the subject which I chose to portray; additionally, I felt that the easiest way to be authentic would be to base my work directly upon a person rather than other art which has already made artistic decisions that may or may not help it to represent its subject better. I based Diya after the actor Indya Moore.



Left: Indya Moore, wearing her natural hairstyle with pride.²

Right: Full body image of Indya Moore.³

² Bobb, B. (2020, April 13). *Indya Moore on Giving Back to a Trans Community Most in Need During the Pandemic*. Vogue. <https://www.vogue.com/article/indya-moore-cash-app-trans-community-coronavirus-pandemic>

³ Sullivan, C. (2019, July 9). *32 Times Pose's Indya Moore Truly Swept Us Off Our Feet*. POPSUGAR Celebrity. <https://www.popsugar.com/celebrity/photo-gallery/46350932/image/46351104/Sexy-Indya-Moore-Pictures>

Indya stood out to me as a Black celebrity who wears their natural hair proudly. I was very interested in representing the natural curls of people of color because they are often omitted from art depicting people of color. As a Black and trans actress of color, Indya stood out as a person who is often underrepresented. Indya uses they/them pronouns as well as she/her pronouns because she prefers to identify in a more feminine way.

I quickly learned that it was out of my scope and ability to depict a trans person of color accurately. Not only would I have been going into unfamiliar territory on both counts, but I also learned about some of the other gendered stereotypes that are often attributed to characters of color. I educated myself further on how Black characters are often depicted as gender nonconforming. Black women are characterized as masculine, and Black men are either portrayed as animalistic or effeminate.

My advisor warned me that trying to represent Indya's transness would be too complex for me to depict with justice, and we reached the conclusion that the best way to depict Indya in this project would be to embrace their feminine identity directly and omit their transness from the discussion. It is still authentic to Indya as a feminine non-binary person to focus on depicting their feminine identity, and it lowered the chance that I would misrepresent their transness. Depicting trans characters is a complex topic that deserves a separate character study, and my advisor and I agreed that it would be better to avoid it for now than to do it in a poor or rushed manner.

2.1.2 - Jay

Jay was the first male character that I began, but he went through many iterations before reaching the final version of the character. Initially, the plan was to model him after the character Kilik Rung from the anime Soul Eater (pictured below on the left). This design proved challenging, as my art style does not lend itself well to depicting anime-style characters. The general simplicity of anime character's faces was the last straw towards realizing that Kilik was not suitable for this project.



Left: Kilik Rung from the anime Soul Eater.⁴

Right: Unnamed reference that was used for the final version, found on Pinterest.⁵

Instead, I found the reference on the right above on Pinterest. This character design is much better suited to my art style and allows its portrayed Black character to present more black facial features. The presence of those features was beneficial, as anime styles tend to be facially restrictive enough that diverse characters do not show their full features, such as differentiations in the nose and eye shapes, among others. For all of these reasons, the second reference worked far better for the project - and inspired Jay's design.

2.1.3 - Kaela

Next, I decided that I wanted to depict a Hispanic female character. In looking for references, I found many interesting pieces. I considered doing a similar process as with Diya, in which I could base Kaela off of a living person rather than a character, but my advisor and I eventually decided that using an artistic reference would be better, as it would have more of a stylized artistic body shape upon which to base the character.

⁴ Jackson, O. (n.d.). *Kilik Rung - Soul Eater*. Pinterest. <https://www.pinterest.com/pin/846606429930520790/>

⁵ Tapp, Alex. (2020). *60 Trendy Drawing Simple Anime Character Design*. Pinterest. <https://www.pinterest.com/pin/612841461784307807/>



The character reference used for Kaela.⁶

The primary reference for Kaela was the image above, found on Pinterest. Secondly, I also allowed some of my first-hand experience of having Hispanic heritage and family to influence the character design. I will discuss these changes further in the section on colorism.

2.1.4 - Natsu

Further delving into using pre-existing digital art as a reference, I found many great works depicting Asian characters. Specifically, Natsu is a Japanese character. He is based on the two references below.



Left: Fanart of Chen (Kim Jong Dae) From EXO, posted on Pinterest.⁷

Right: A character art piece more focused on whole aesthetic design.⁸

⁶ Wattpad. (n.d.). Keith X Reader One-Shots. Pinterest. <https://www.pinterest.com/pin/862931978587622616/>

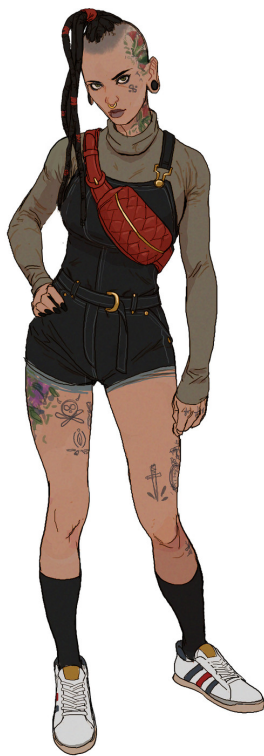
⁷ EXO Cute. (n.d.). Kpop Fanart. Pinterest. <https://www.pinterest.com/pin/14425661289360743/>

⁸ Wattpad. (2020). *The Rumors that makes me change (Haikyuu) Hinata harem*. Pinterest. <https://www.pinterest.com/pin/780389441677695605/>

The first image was the facial reference that I used. It was essential to my advisor and me that we depicted an Asian character with Asian facial features. They are a group that is often white-washed and held to White beauty standards, so the face on the left stood out as refreshingly authentic for an Asian male character. I used the reference on the right for the body and the clothing.

2.1.5 - Sumaira

Sumaira was a character that I had envisioned as an essential character for this project from the beginning. Muslim characters are not only severely underrepresented in media (when shown at all), they are often misrepresented. Finding reference for this character was difficult, as there is not much character art of Muslim women out there. Most of the art that I did find depicted many lighter-skinned women. I thought that it would be essential to represent a darker-skinned Middle Eastern character on this project.



Left: Sumaira's body reference, as found on Artstation.⁹
Right: A photo of a Muslim woman wearing a hijab with style.¹⁰

⁹ Wilkins, A. (2019). Sketches 02. ArtStation. <https://www.artstation.com/artwork/Z5IBlx>

¹⁰ Giyim, L. (2019). Woman Touching Chair. Facebook. <https://www.facebook.com/lamiagiyim/photos/2384759888232727>

Eventually, I concluded that Sumaira would need to be developed more from real-life reference. I used the image on the left above to influence body shape choices. The photo on the right was used as a reference for the character's clothing. My advisor and I wanted to make sure that she presented fashionably, as Muslim characters are often depicted as more traditional.

2.1.6 - Adonis

Adonis came about through more intent to explore the representation of men of color. Specifically, my advisor and I wanted to depict an athletic, attractive Black male character. As Black men are often feminized in the media, we found it essential to include a Black male character that was distinctly masculine in his attractiveness.



A piece of fanart, depicting Lucio from *Overwatch*, found on Tumblr.¹¹

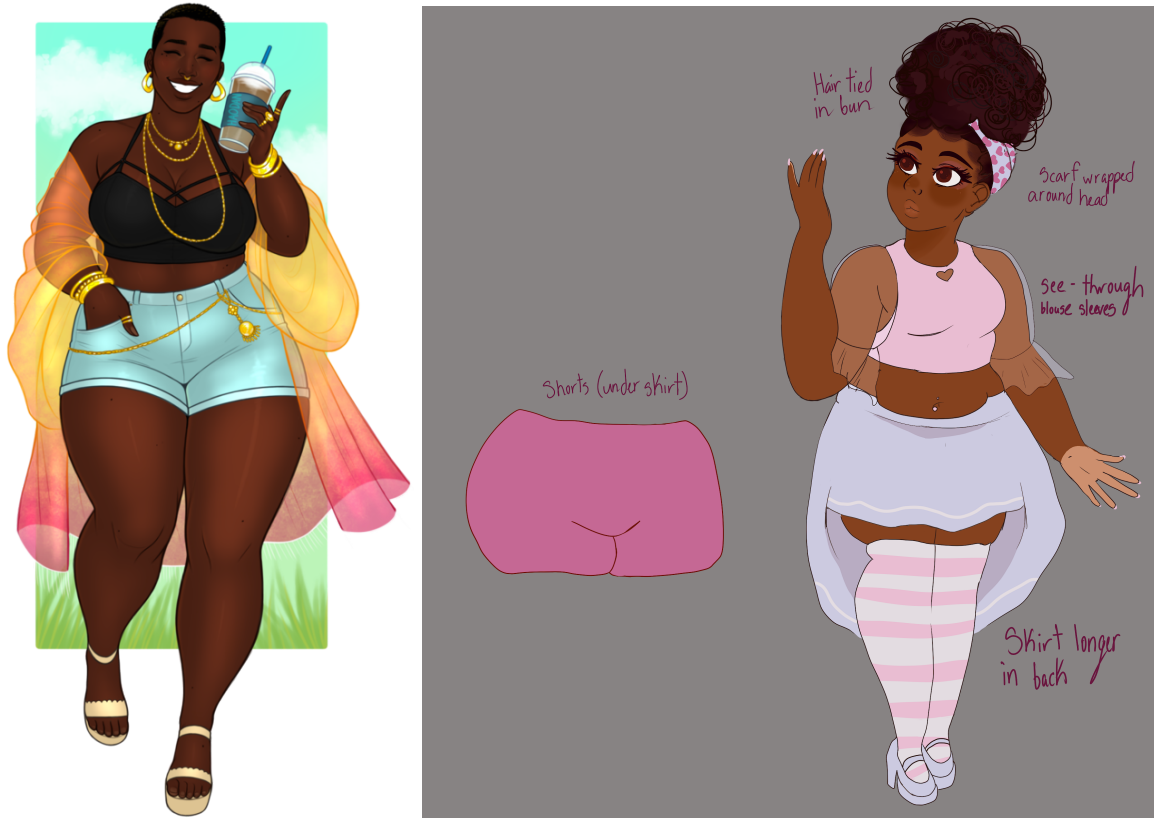
I found the reference above on Pinterest. Upon further investigation, I found that this digital painting depicts the *Overwatch* character Lucio. I accepted it, though, as the character is different enough from Lucio that he can be presented very differently.

2.1.7 - Desirae

Desirae was a late addition to the lineup. Upon discussing the project's progression, my advisor and I noticed that we had not included representation of any fat characters. We both agreed that adding a fat character would help express the diverse body positivity central to this project. Upon further discussion, we decided that she would be Black. Further, we discussed how fat Black women are often sexualized in

¹¹ wakaju. (2017). Tumblr.
<https://sugawara-kkoushi.tumblr.com/post/161617829900/some-overwatch-fanart-i-did-mostly-lucio-and>

their depictions; because of this, we realized that we wanted more control over her character. We decided to commission her design from an artist that my advisor knows. Having the input of another artist on the process was extremely helpful, leading to a very individual character.



Left: Reference of a fat black lady, found on Pinterest.¹²

Right: Commissioned reference, drawn by Mackenzie Ensley (ig: peachbunnii_).¹³

The reference on the left above was the closest thing that we could find on the internet to depict what we would want for this character. I then provided it to the commissioned artist (Mackenzie Ensley) that drew the image on the right. There will be more discussion of this process in the following section.

2.1.7.1 - Commissioning Reference for Desirae

The final character that I developed for this project was developed from reference art commissioned directly. We did this to choose the design of the character's appearance deliberately for this project. My advisor put me in contact with a student artist from a different school, and she and I collaborated on coming up with the character design. The artist, Mackenzie Ensley, specializes in character concept art such as this one. More of her work can be found on her Instagram @peachbunnii_.

¹² BOSSES OF CURVES MODEL. (n.d.). Black and Curvy. Pinterest. <https://pl.pinterest.com/pin/550635491933764873/>.

¹³ Ensley, M (2021). Desirae (digital sketch). Commissioned for this project.

2.1.7.2 - Working With Mackenzie Ensley

The first part of our collaboration was conducted over email, where I sent the artist references that the character was supposed to emulate. The character concept began with keywords that defined features that we wanted in the character (primarily: fat, cute, and Black). It was important to my advisor and me that we were very deliberate with this character, as representing larger bodies can be challenging in any situation, let alone a project primarily focused on considering racial diversity.

The artist and I proceeded to have a Zoom meeting to discuss creative decisions further. These spanned from decisions on hair color and body build to further discussion of clothing, shoes, and accessories. We also discussed the issue around "cutesy" characters, wherein they are often depicted in an overly childlike way. One of the most significant identified challenges here was to develop a character that would be received as cutesy without being infantilized. On the other hand, we also wanted to avoid over-sexualizing her.

Eventually, we decided on a cutout top with a lace shirt underneath and some sort of skirt. We themed the colors around soft pink shades and agreed on long socks and platform shoes. Finally, the character was to have natural hair.

2.2 - Representing Groups of People

One of the main challenges of this project is providing thoughtful and positive representation. There can be a fine line between authentic representation and caricature when representing different races. The risk of caricaturing groups is also elevated when using a stylized artistic approach, as artists often exaggerate predominant character features as part of their stylization method, leading to an overemphasis of stereotypical characteristics. This section details the considerations that made sure that the characters represented their groups without being caricatures or exaggerations.

2.2.1 - Colorism In Minority Groups

My professor and I took great interest in how colorism contributed to the characters' designs. Colorism is a form of discrimination that presents mainly within minority communities. Colorism is the favorable treatment of lighter-skinned individuals over darker individuals within the same racial group. Colorism can also influence non-white individuals to shun their more natural appearance and make an effort to present themselves as lighter. This can influence individuals to hide their natural hair textures, use lighter makeup, or even go through the drastic and dangerous skin lightening process.

Colorism is a self-fulfilling prophecy of sorts, in which minorities are more accepted in media if they perform to minimize their non-white features. As a result of this, the minority representation that exists is often unrealistic and diluted by efforts to appear lighter-skinned. In this project, colorism was carefully considered when choosing

references and deciding when to vary. For example, we passed over any Black characters who did not have naturally Black hairstyles. Further, we had to make many changes to Kaela's design to avoid depicting her as a nearly White Hispanic character.

Kaela's design considerations hit close to home for me, as she is our representation of the Latinx community. As a mixed Hispanic woman myself, I've had many direct experiences with colorism, where I was encouraged to try to pass as closely for White as I could. Kaela's character art looks like a colorist depiction of a Hispanic woman, from her light skin to her green eyes and loosely wavy hair.

To avoid reinforcing that, we reworked her character form in some ways. We darkened her skin significantly and gave her a more natural hair appearance by using inverted French braids and the presentation of curled baby hairs. Similar considerations were also made with Natsu, as light-skinned Asian characters are often white-washed. My advisor and I put in every effort to show the features that distinguish him as Asian.

3 - Modeling Process

The process of creating a 3D modeled character is complex. A lot of planning, effort, and review goes into developing these sorts of characters. The process can be broken into some steps, as discussed here.

3.1 - Observing Other Works

When working on a project like this, it is important to observe other successful art in the style used. The primary artist referenced for this project is Dylan Ekren. Ekren depicts his characters in a stylized art style that was perfect for this project. Further, he also has many available online works depicting various ethnicities and body types. I referenced his work for finding the proper line between realistic body proportion and stylized exaggeration.



Left: Jane, a piece by Dylan Ekren, which was referenced for appealing shape work.¹⁴

Right: Another Dylan Ekren piece which was referenced to get a handle on stylized character art.¹⁵

3.2 - Blocking

The first step to making the models is the block-out phase. Blocking out a character begins with identifying the shapes used to form the character's body; this was done by repeatedly annotating the reference to observe and define how the character's body shape was being shown. This way, the blocking can start with a thorough understanding of how the character is represented.

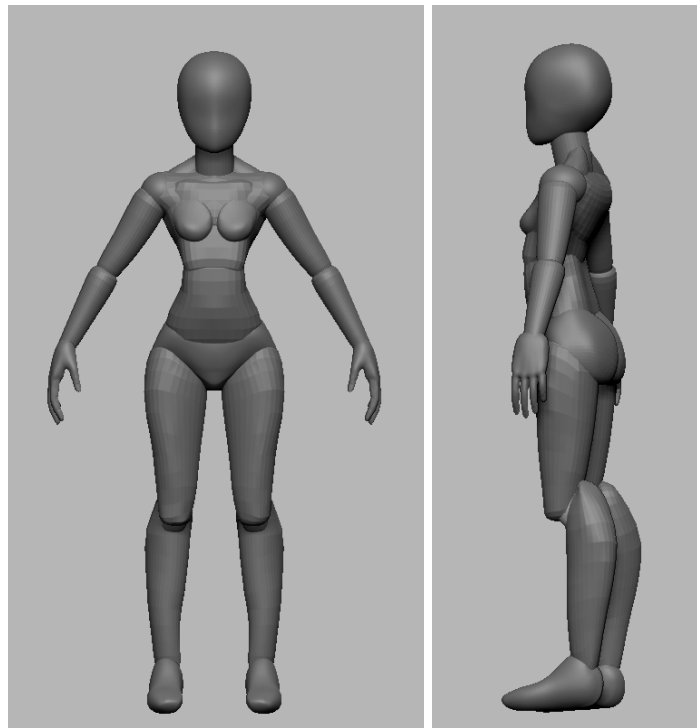
¹⁴ Ekren, D. (2016). Jane. ArtStation. <https://www.artstation.com/artwork/kmvPA>

¹⁵ Ekren, D. [@dekren] (2018). [Photo of 3D model of woman of color in business attire]. Retrieved from <https://www.instagram.com/p/Bokt65MAoK5/?hl=en&epik=dj0yJnU9Z3d6ZHo3VF9oWGwtT04xaGRveWxJdWJGbFp5ZWZQTlmcD0wJm49S1d4Mk8wdEFRM2ItWEpkSFpzdnpqQSZ0PUFBQUFBR0lxMlI0>



Kaela's art reference with annotation that shows form and shape breakdown.

From here, after a few iterations of sketching, I would move onto basic character blocking. Blocking is done in ZBrush by using various primitive shapes such as spheres, cubes, and cylinders. Further, I also used various tapers to achieve the common tapered shape used on the arms and legs of many characters. These shapes would be deliberately kept separate within the program to make early form editing easier.



Sumaira shape work phase, from multiple angles.

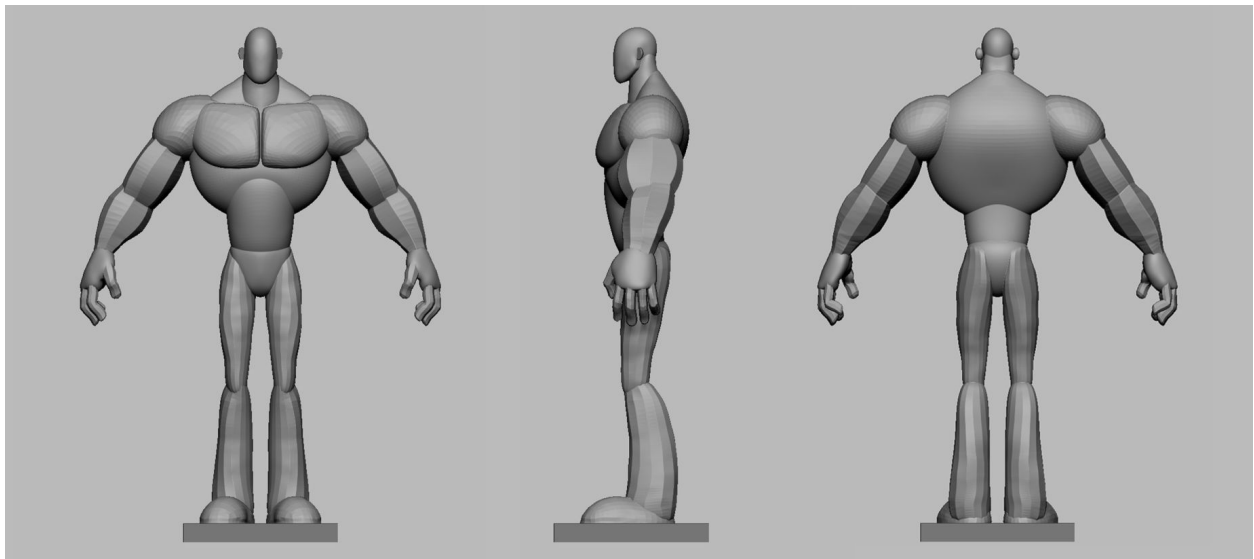
These blocked-out forms were ideal for making base shape changes. Once I brought them to a place where the shape and proportions were ideal, they were merged, and the sculpting could start. See the Figure Appendix section A for more photos of the blocking process.

3.3 - Form Work

The next step in making a 3D character is somewhat abstract, but I have summarized it with the name 'form work.' Form work includes all of the edits that happen after blocking to define a good form. The form is essential for 3D modeling, so this process should not be overlooked.

This part of the process also included the most back and forth with my advisor. There were countless messages about negative space, S-curves, C-curves, and just generally appealing visual form. In this step, all of the shapes that made the characters would have to come together to form something visually appealing that communicated the desired human features.

We discussed and explored what makes a form masculine or feminine during this phase. I learned that one of my artistic shortcomings is that I tend to project a feminine form onto all of my characters. Because of this, there was a lot of form work that went into simply researching and reviewing what makes us perceive gender in stylized art.



An image from an interview on CGMA Academy, which spoke on developing the male form¹⁶

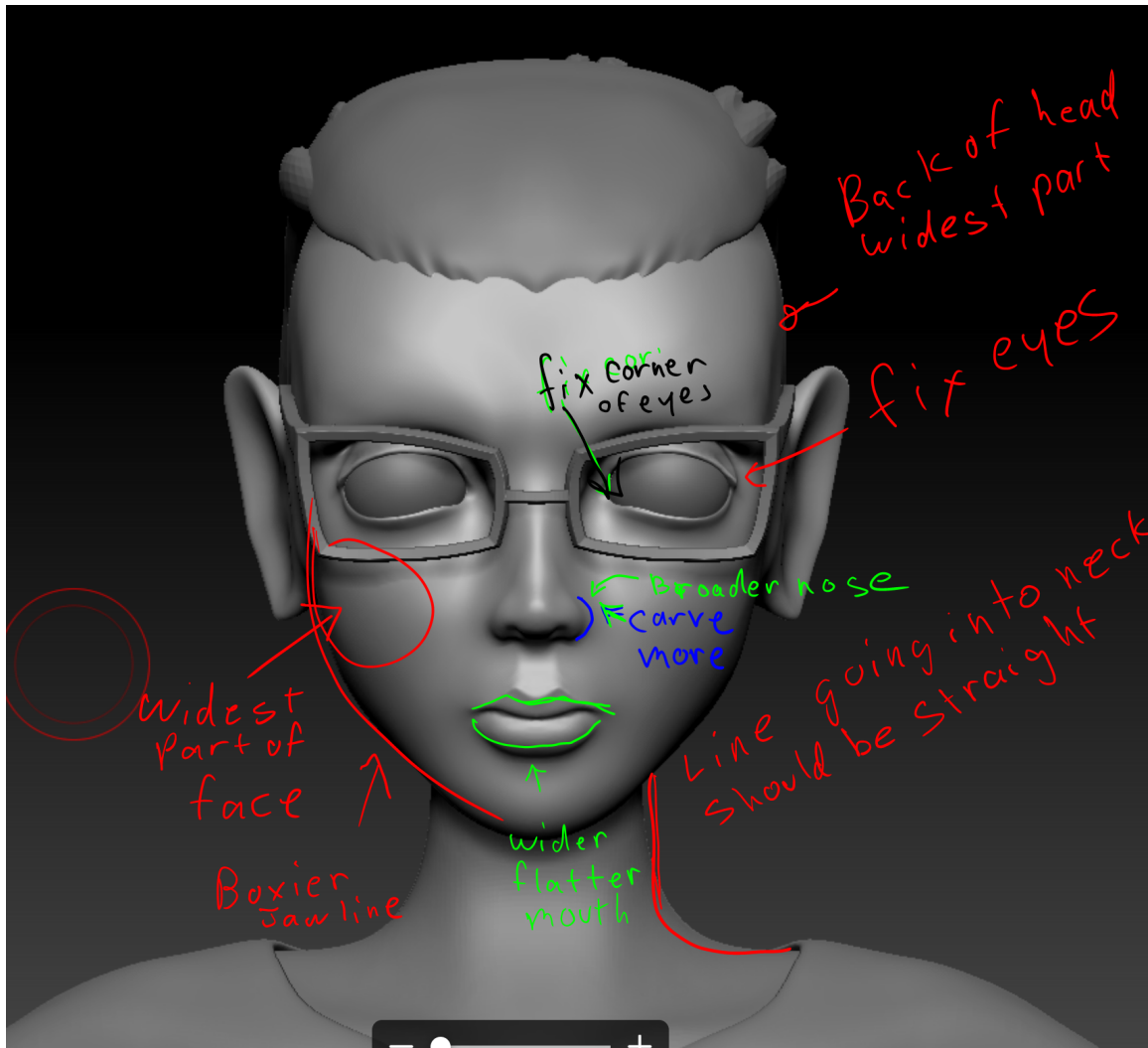
As shown in the image above, it does not take a detailed sculpt to make a character seem masculine or feminine. The overall shapes of the body define how we perceive a character's gender. This also connected back to referencing concept art and making sure that the characters that were being developed matched the concept given.

¹⁶ Gonzalez, C. (n.d.). CGMA Academy. CGMA.
https://www.cgmasteracademy.com/courses/109-stylized-characters-in-3d#tab_interview_98

3.4 - Critique Process

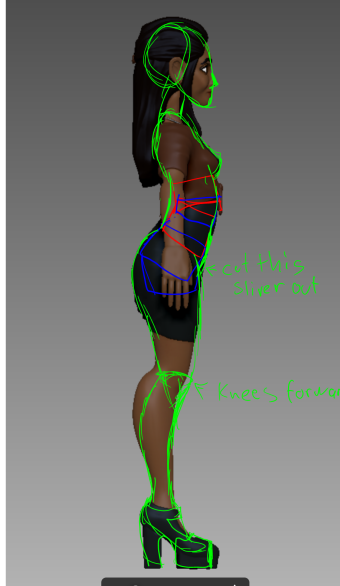
While there is no phase of the 3D modeling pipeline in which critique happens all at once, it is covered here because the form work stage is probably the most heavily critiqued part of the project.

The critique was most heavily concentrated during form establishment. My primary source of critique was my project advisor: Professor Farley Chery. Essentially, I photographed each major landmark of my work and sent the photos to him, which was often met with many comments on what needed to be improved. Critique is a vital part of any artistic process; even the most well-seasoned artists can get too close to their work and require an outside perspective.



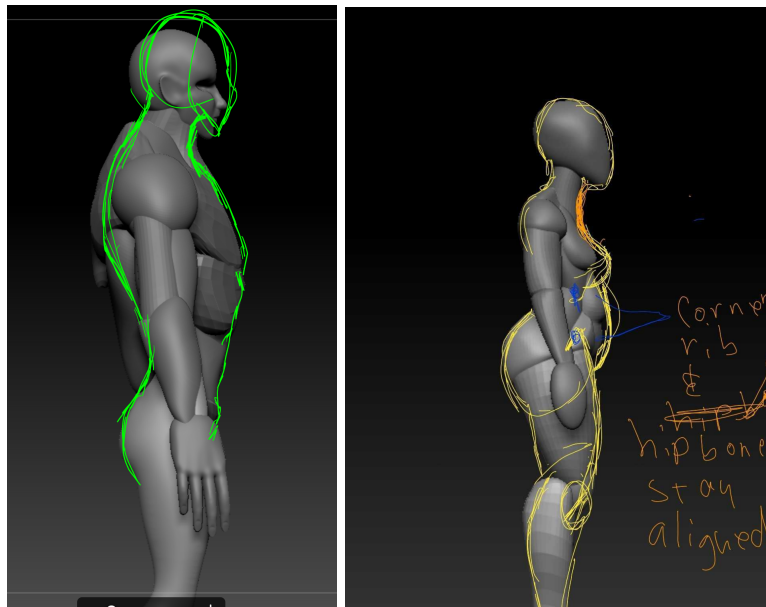
Some face critique given on Jay from when he was still based off of Kilik Rung. Here we can see the main method used for communicating critique.

Going for Professor Chery for advice, I would send him pictures of my work as it was from basic angles. We used a critique method of drawing on the images directly to show where problem areas were as well as how they could be improved.



While working on earlier iterations of Kaela, I often had trouble getting the posture and scale to work in an appealing way.

Our form of critique was incredibly helpful. Using the drawings made up for the fact that we could not meet in person this year. It also gave me references to look back on while making future characters. I found that observing these concrete drawings helped me form my artistic eye. It was a lot more helpful than any written or verbal advice could have been.



Left: Annotated critique from my professor, where he advised me to change the head location and back shape on a character.

Right: Critique on Desirae's shape phase, where my professor guided me on choosing appealing shapes and forms.

When I was not getting my critique from Professor Chery, I was instead getting it from those around me: my friends and family. This form of critique cannot be overlooked. It often happened less eloquently: While my professor would have told me precisely what was not working, my mother might say, "there's something wrong with the shape of the shoulders," but that does not make her critique any less valuable. As human beings, we are hardwired to know what humans look like. To acquire this feedback, I presented my work to some of my less artistically-minded peers.

While the project progressed, my advisor also made it clear that he was planning on scaling back his direct critique. He explained that by later points in the project, I should have developed my artistic eye enough that perhaps instead of telling me how to fix the head, he would instead inform me of a problem with the head and trust me to solve the problem myself.

This change was to ensure that I formed a better technique for self-critiquing. In the process of self-critiquing, Professor Chery encouraged me to sketch over my work as he had (shown above). Doing this can make it easier to see where the art deviates from our expectations.

3.5 - Developing Clothing and Hair

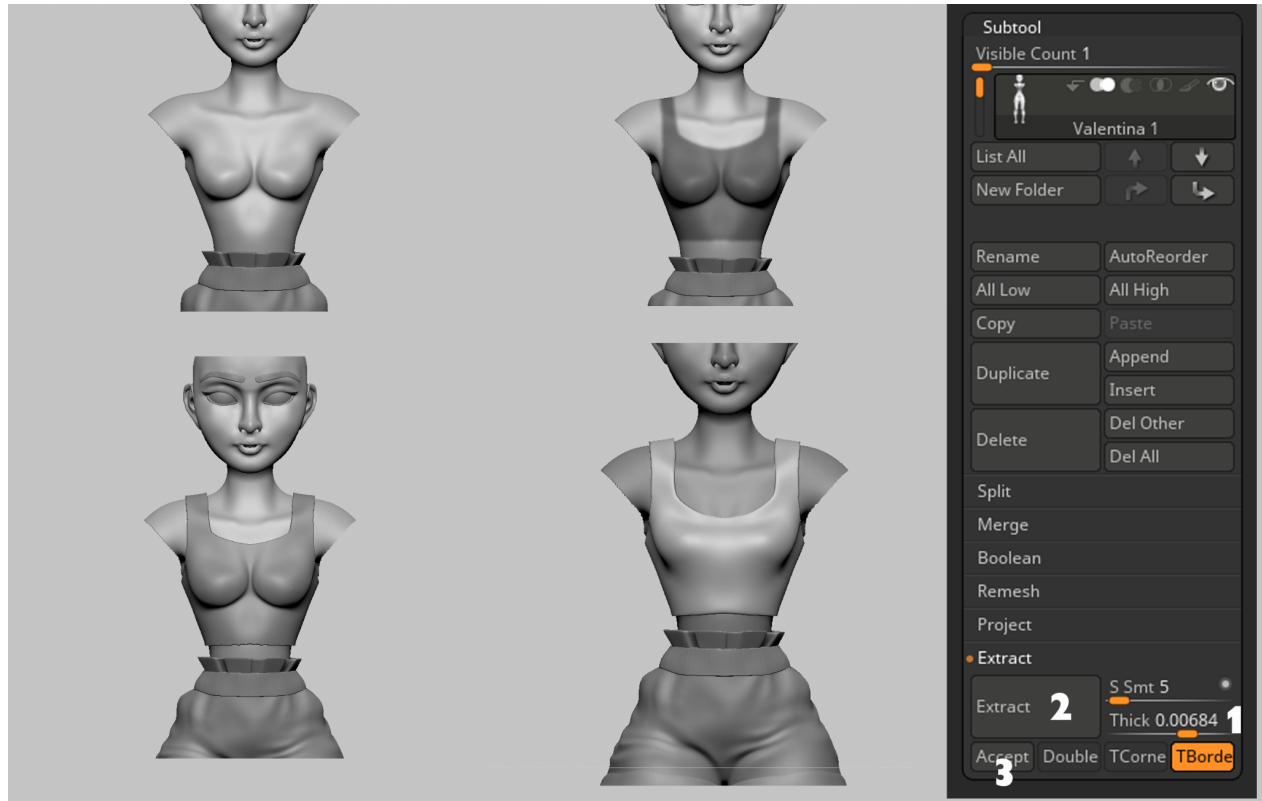
Once the characters had properly sculpted bodies, it was time to move on to clothing development. For most characters, clothing concepts had been well established during the concept phase, barring some last-minute choices such as shoe design and extra accessories. With that in mind, the clothing-making process can be divided into a few categories of items.

3.5.1 - Tight-Fitting Clothes



Kaela's clothing in early development, made by extracting her body in ZBrush.

This clothing category includes items fitted to the body, such as shirts, pants, shorts, and other fabric items that are wrapped around the body. These clothing items take on the form of whatever body part they cover, and as such, it is best to develop them based on the body part for which they are being designed.



The ZBrush Extracting process, as shown on Kaela's shirt.

The extracting process is done in ZBrush by using the extract tool and begins by masking off the area of the body that the clothing should cover. Next, within the subtool area, expand the extract menu, then choose a thickness for the mesh to be generated with and press extract. Finally, you must press accept to initiate the mesh creation. Next, on the new mesh, make the clothing less skin-tight by using the ClayBuildUp brush and the Smooth brush, thereby establishing the base form of a clothing item. Details such as wrinkles can then be added through classic sculpting methods.

3.5.2 - Hair

There are a lot of methods for creating stylized hair for 3D characters. As the focus of this project is diversity, I focused my efforts on creating hair models that represented that diversity. As such, I often took different approaches for each hairstyle.



Left: Kaela's hairstyle was chosen as twin braids, sculpted in a chunky and stylized way.

Right: Desirae's hair, a curly updo that features a natural hair texture.

As shown above, I often approached feminine hairstyles with large chunky blocks modeled and textured to look like hair. As shown on the left, I reimagined Kaela's hair to be twin braids with visible baby hair. Baby hair is important in many underrepresented spaces, as it is a common phenomenon for people of color; as such, I felt it essential to include. I showed that with her small tresses visible next to her ear.

For establishing the rest of Kaela's hair, I used three main pieces. Each braid began as a soft-edged cube that I slowly pushed into the proper shape. I then transformed a sphere into the base of the hair, where it attaches to the head. I then sculpted these pieces with the Damian Standard brush to form strands with directionality, as seen above.

Desirae's hair, seen on the right above, was designed to show an everyday natural hairstyle. To maintain the stylization, I made her hair by sculpting individual curls formed on the top of her hair. Along with this, there was a second piece that formed the hair below the hairband.



Left: Adonis' hair, made with chunky pieces that fell from the head as strands of hair.

Right: Jay's hair, designed with chunky spheres shaped to look like locs.

For the male models, I observed the hairstyles used in the references. As seen on the left, Adonis has an updo with a short trimmed undercut on the sides and back. This was created using one piece for the undercut hair and a separate for the rows on the top. Finally, each strand falling out of the hair tie is another individually modeled piece. These were eventually merged to optimize the mesh.

Pictured on the right, Jay's hair was shown with short locs in the reference art. Showing this was relatively simple, as I could simply develop the base shape for a dread, and I then populated the head with duplicates of that base mesh. Finally, I stylized them to add different lengths and different amounts of weight and gravity to each of them.



Left: Diya's hair early process, where I was defining the shape and placing curls that would be separate from the general hair piece.

Right: Diya's hair later in the process, where some more curls have been added, and sculpting has been done to make the base and the curls more cohesive together.

Diya's hair was a massive undertaking. I chose her inspiration, Indya Moore, primarily based on how Indya embraces her natural hair. As such, I wanted to translate those natural curls to a 3D model accurately. As such, I approached the development of this hair with two factors in mind: I had to make naturally curly hair, and I had to develop

those curls to still show when used in a low-poly context. As natural curls tend to have many separate strands, the poly count was a genuine concern.

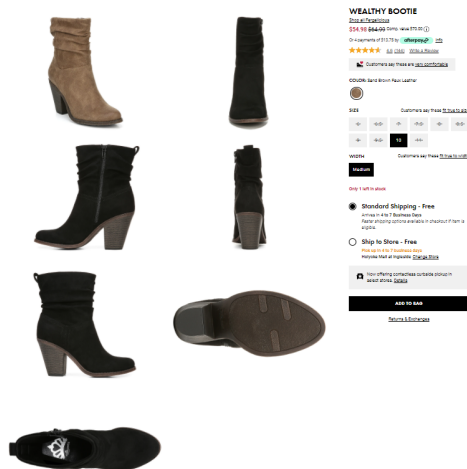
I eventually decided to develop Diya's hair by using one large chunk that would be carved and styled to establish the appearance of corkscrew curls. Then I used a separate mesh to develop a standard curl end. Finally, I duplicated that curl end and applied it to the end of each corkscrew. I also applied some to the top of the hair to show baby hair. Finally, I sculpted one large stylized curl on her forehead. These base meshes are shown on the left above.

Next, I sculpted the base hair mesh to show the corkscrew hair appearance. Once all these lines were carved using the Damian Standard brush, the hair began to read as curly. Finally, I merged and retopologized the hair by hand to accurately show the hair. More on the retopology process can be seen in section 3.9.

There is no one way to model diverse hair. I approached each hairstyle with an open mind and then formed my model planning around how I believed I could represent that hair best. I encourage anyone reading this to portray diverse hairstyles with a similarly open mind.

3.6 - Shoes and Other Accessories

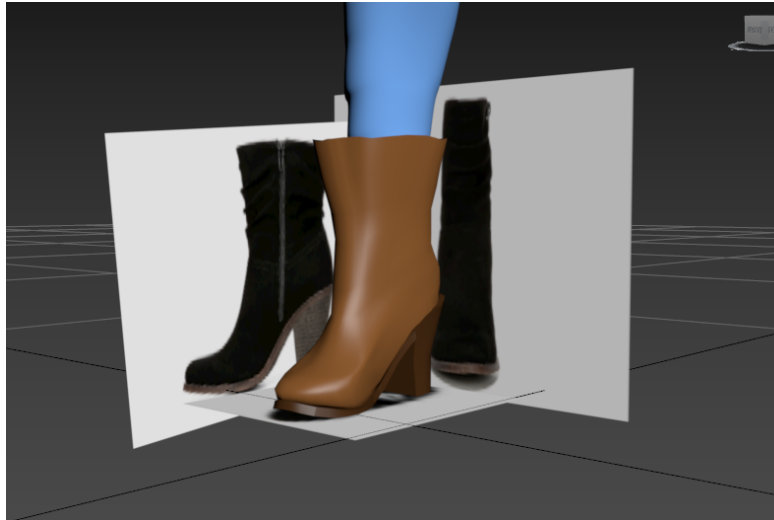
Shoes can be a challenging part of the modeling process for some sculptors. This is because shoes are a combination of organic and geometric shapes. Because of this, it is better to design the shoes in a different program than ZBrush. For this project, I used 3DS Max. Before starting the shoe modeling process, I always find a reference on an online shoe retailer page. This is very useful because shoe retailers take many photos of the shoes they are selling, and they usually have one photo from each cardinal angle, as seen below.



Pictured: Fergalicious Wealthy Bootie from DSW.¹⁷

¹⁷ Fergalicious Wealthy Bootie. DSW. (n.d.). <https://www.dsw.com/en/us/product/fergalicious-wealthy-bootie/466608?activeColor=250>.

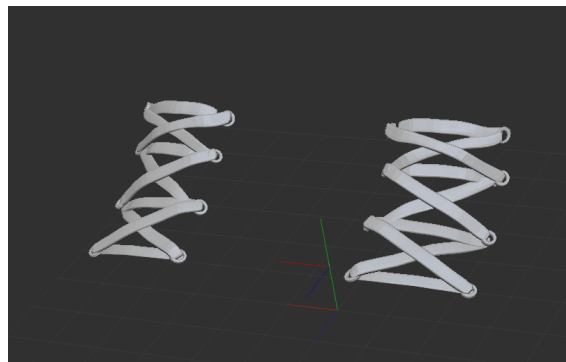
Using these photos, I can get a better idea of the shoe's shape from multiple angles. From here, I download the most useful photos, and I import them into 3DS Max directly. This way, I can work on the shoes with a visible indicator of the silhouette that I am trying to match.



Making Sumaira's shoe based off of the orthographic shoe images found on the DSW website.

Using the silhouette photos, I start with the hard-surface pieces, such as the base platform that supports the shoe. Usually, I make pieces like that out of a cube, as they handle the thickness of the shoe base well. I often use an edited sphere to make the body of the shoe. I alternate between pulling points to where they belong and relaxing points to make them look more natural. In this way, I can make shoes that feel organic and solid.

For shoes with laces, such as sneakers and combat boots, I faced the problem of depicting them in a clean and low-poly way. I decided to make a 1000-poly set of laces in 3DS Max that could be applied to any pair of shoes that would only take a few tweaks on the individual pairs. The laces made all of the sneakers look a lot more polished (tied loops were omitted as an artistic choice).



One size fits all shoelaces that can be combined with any shoes and then pushed into place.

3.7 - Color

One essential aspect of 3D character development is color. Adding color to the characters initially happens in ZBrush. I start the process by considering the colors that are most present in my reference. In this observational step, I ensure that my character accurately represents the reference art.



Left shows Diya with flat color fill layers applied, in contrast with the right photo where color variation has been painted on.

Following that, I add base color fills to each object, as shown in the image on the left above. We can observe that flat colors look very bland on 3D models. 3D character models look better with color variation added to the skin through underpainting. For this process, it is crucial to ensure that all models are polygon-heavy enough to support polypaint in detail.

Underpainting is the process by which a character is set to a neutral skin color, and then the artist draws small patches of red, yellow, and blue onto certain areas of the body. The general rule is that largely fleshy or cartilage areas such as the nose, cheeks, and thighs are painted with a dark red underpainting layer, while areas with a large concentration of veins, like wrists and necks, are painted blue. I also use blue on chins, as I find that it helps that area. Finally, areas where the bone presses directly on the flesh, such as the forehead, shins, and cheekbones, are painted with a light yellow shade.



Sumaira's face with a flat color fill (left) in contrast with her skin painted version (right).

Following the underpainting process, an artist uses a color fill with low RGB intensity and slowly covers the underpaint layer with the character's skin shade. After this point, I usually add some touch-ups where I add some highlights and makeup. As seen in the before and after images above, the process of underpainting, highlighting, and adding makeup and skin differentiation is fundamental to make characters that feel real. Without these critical steps, characters feel flat and bizarre.

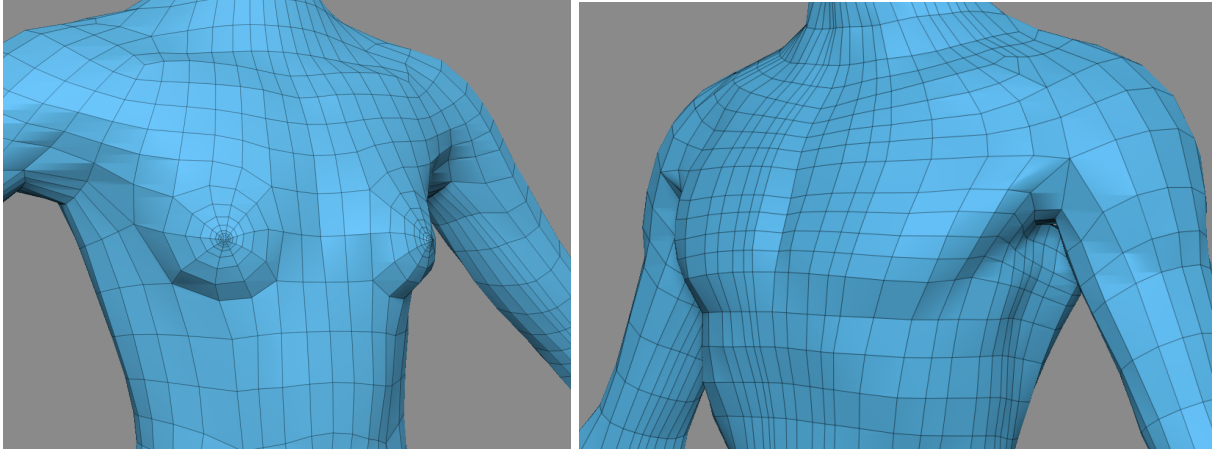
3.8 - Retopologizing, Unwrap, and Export

Once characters are painted and accessorized, the next step in the process is editing the character topology. Within ZBrush, these characters all had 12-20 million polygons. Naturally, they cannot have that many polygons if they are to function in any capacity for animation. For low-poly characters to deform correctly, it is important to manually create a new topology for the models. This process was initially done in Maya on one male and one female character (Adonis and Diya, respectively).

To retopologize, I lower character body poly counts to somewhere around 200 thousand; I then export out the model and use Maya to make a new topology. After importing the character model into Maya, I make the model "live," meaning that new models added will shrink wrap onto the form of my live model. I then use quad draw to start the retopo process.

The retopology process is performed by making large boxes that cover a lot of the character and then going back and adding loops to divide the initial boxes into smaller and smaller "quads" (four-sided polygons). So arms and legs were initially two connected cubes, differentiated at the elbow and knee, respectively. These connected

to a few base cubes that made up the torso. The next step is to slowly add loops to make the poly count higher and the character image more detailed.



Wireframe of the male and female meshes, showing that they both have been hand retopologized.

Loops are set up somewhat differently for male and female characters. This is most obvious in the breast area; as seen above, feminine chests use circular loops to best reflect the form shown; meanwhile, masculine chests continue with loops straight across the chest as they are anywhere else on the body.

On items of lesser deformation importance, such as shirts, pants, and other clothing, it is adequate to use ZBrush's built-in ZRemesher to handle a low topology version. To do this, you navigate to the model's geometry and then set a target polygon count within ZRemesher. It is often helpful to select KeepGroups as well, as this preserves polygroups and uses them to influence edge flow design.

Following the retopo process, all 3D models must be unwrapped to support textures. This process can be done in most of the software used for this project, but I did most of my unwrapping in ZBrush. This is done by using the UV Master tool within the ZPlugin section. I can use this tool to create unwrap maps and imbed them into the .obj files that are exported.

Using the UV Master tool, an artist can control paint for both polygon density and seam placement. First, polygon density can be control painted so areas that require more texture detail (such as faces and shirt decals) can have more texture space. On the other hand, areas that do not require much texture space (such as the back of the head, internals of clothing, and anything else covered by other models) can be painted to take up less texture space; this allows more room for the parts of the mesh that need higher resolution texturing.

Finally, an artist can control paint for where seams should be. Texture seams can sometimes be visible in the engine, so it is essential to try to place these seams in less visible places on the object. On characters, seams are best hidden under clothes, on the back of the head, and on the inside of the arms and legs where they are least visible from natural positions. Within ZBrush, an artist can control paint for areas where no seams should go, such as the face and other highly visible body parts. In contrast, an

artist can also control paint to attract seams to some low-visibility regions such as the inner thighs and calves.

Finally, the UV Master can be activated directly to create an unwrap of its own, using the information provided, which can then be edited within ZBrush. Once the characters are retopologized and unwrapped, they can be exported from ZBrush. This is done by using the Multi Map Exporter tool. This tool exports meshes and maps from ZBrush and into a folder chosen by the user. In this case, I exported texture maps, normal maps, and meshes.

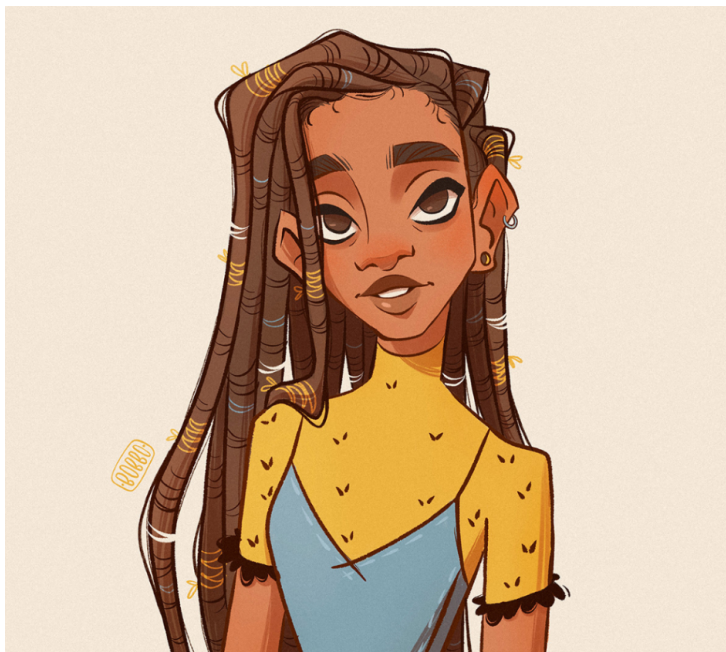
Normal maps are created during this process; these are essential for making a low poly 3D character look detailed. The computer uses color codes to imbed information on how the character is deformed past its lowest subdivision level. This can then be loaded into a game engine, so the deformation encoded into the map is decoded and applied to the character mesh.

4 - Future Expansion

4.1 - The Continuation of Rigs of Color

My professor and I initially imagined Rigs of Color to be a more extensive collection of 3D modeled rigs. For this project, I've made a first sample of what Rigs of Color can be, but ideally, it can be further developed by future WPI students. With work from more students, Rigs of Color could reach or even surpass what we had initially imagined for it. This would be an incredible result for the WPI IMGD community and people of color who want to see themselves in 3D modeled characters.

4.2 - Kimberly's Case



Kimberly's chosen reference (left)¹⁸ and her 3D model (right).

Another WPI student, Kimberly Coudrey, made the character Kim as an Independent Study Project (ISP). We believe that she is an excellent example of how Rigs of Color could have contributors who play a less active role. Kimberly found the reference and did the base modeling, clothing, and coloring of her model. Following this, it was handed over to me for editing, further texturing, retopologizing, and exporting. I also made Kim's shoes, which were somewhat out of Kimberly's skillset. Our collaboration was very successful, and we were also able to critique each other's work

¹⁸ Andonova, B. (2020). [Untitled Character Drawing]. ArtStation. <https://www.artstation.com/artwork/6a9e6V>

during the art process. By following a working model like this, there could be different levels of involvement from different students, from students performing a full MQP to expand the project's model library to several individuals conducting parallel ISPs to create single, more minor single-model additions.

4.3 - Methods

Rigs of Color could be continued in many different project formats; primarily, it could exist as a recurring Major Qualifying Project (MQP). We considered its potential as an Interactive Qualifying Project (IQP), but one drawback for Rigs of Color as an IQP is that IQPs tend to be more interdisciplinary. It is unclear whether or not this would work, given the fact that students in the IQP may potentially have no 3D modeling or artistic experience upon entering the project. Finally, as mentioned above, it could also involve different levels of involvement, ranging from independent study projects to personal input from students who want to be involved.

5 - Conclusion/Postmortem

5.1 - Finished Product

As of the end of this project, eight fully completed models are ready. Seven of these were modeled entirely by me, while the eighth was modeled by Kimberly Coudrey and edited by me. There are three male characters and five female characters in the group.

The following are some rendered images of each completed character:







Each character, as shown above, is fully clothed, including shoes. They are also set up with a clean topology, so each can be in the poly range of 20-40 thousand polys.

5.2 - Successes

This project felt majorly successful. Generally, the further along that I got in the modeling process, the higher quality models I could produce. To make the most of this self-growth, I retouched the older models to bring them more in line with the newer, higher-quality models at the end of the project. This was very helpful and meant a world of difference for some of the earlier characters, such as Diya.

Another success that my advisor and I achieved was realizing that this project is best done while working on multiple characters in parallel. It sped up my artistic process and gave me something to work on while a character was waiting for critique. Anyone continuing this project after me should consider working on three or more characters at a time.

I found that another great success was the project's representation of a range of natural hairstyles. I would encourage others to also focus on depicting natural hairstyles well, as hair is often white-washed for 3D models of color.

My collaborations were both very successful. Working with Mackenzie Ensley on the reference for Desirae resulted in a beautiful and well-planned character reference. It also allowed me to receive direct artistic opinions from a person from the racial group being represented. Similarly, working with Kimberly Coudrey was very successful. Her

character model was refreshingly different from mine, adding some much-needed style variation. The collaboration also proved that continued collaborations in that format could succeed in the future.

5.3 - What I Would Have Done Differently

The first change that I would make would be to change the order in which I made the models. I started with a challenging character to represent, and by starting with a person as my reference rather than an art piece, I was forced to make a lot of style decisions immediately, even when I was not on the stylized art workflow. If I were doing this project again, I would have started with a character with a more concrete visualization and whose scope was closer to my abilities at the start of the project.

Another change that I would make is coming up with a dedicated deliverable goal from the start. I retopologized two characters before my professor and I agreed that we should give all of the characters actual feet (they were initially just given blunt ends to their legs hidden by the shoes). This meant that I had to go back and make topological changes after finishing my beginning topology, which was challenging and cost valuable time. If I were doing this again, I would come up with a list of models to be produced and a list of required details to include to prevent having to re-do work.

Another noticeable change that I would make in different circumstances would be getting more opinions on the characters than I did. As I spent the entire year working remotely, I did not show the models to as many people as I usually would have. I still tried to share them and get opinions, but I would recommend building this sort of critique into the schedule in the future.

5.4 - Takeaways

This project has been very personally important to my advisor and me, and we both spent a lot of time making sure it was as high quality as possible. But, surprisingly, I also found that the project spoke to a lot of people I told about it. People of all sorts look at the representation that media fails to give them and feel ignored. It was amazing to see other people's excitement at the idea of a project like this. I think that Rigs of Color can inspire a lot of people who have felt invisible or unrepresented in the past.

Another takeaway that I have experienced from this project is that diversity takes research. Even with the best intentions, proper representation cannot happen without research into the diverse groups being represented. This project was more about seeing and listening than it was about showing.

6 - Bibliography

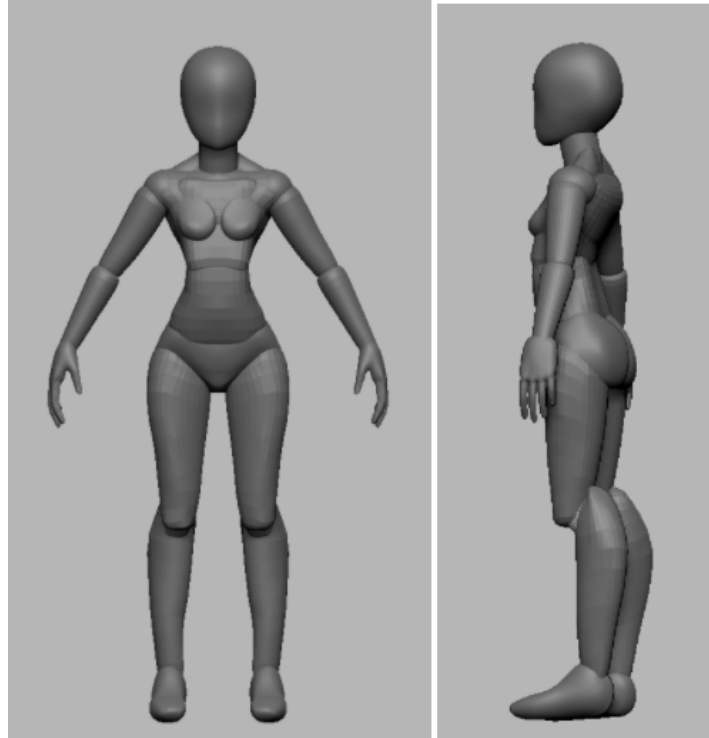
- 3d art with javad. (2020, Jan 21). *how to sculpt ear in ZBrush* [Video]. YouTube.
<https://www.youtube.com/watch?v=RR1WVMvWgKo>
- 3d art with javad. (2020, Jan 15). *how to sculpt lips in ZBrush* [Video]. YouTube.
<https://www.youtube.com/watch?v=0SJsbBXTceU>
- Akira 3DCG channel. (2021, Mar 1). *How to make pleated skirts and hakama in ZBrush* [Video]. YouTube.
<https://www.youtube.com/watch?v=0FyQRAHKZIs>
- Andonova, B. (2020). [Untitled Character Drawing]. ArtStation. <https://www.artstation.com/artwork/6a9e6V>
- Animation Blaster. (2019, Mar 15). *How to use Mirror Mesh in maya* [Video]. YouTube.
<https://www.youtube.com/watch?v=fCOSKAJqsts>
- Autodesk. (2020, December 7). *Manually create or retopologize a mesh with Quad Draw*. Manually create or retopologize a mesh with Quad Draw | Maya 2020 | Autodesk Knowledge Network.
<https://knowledge.autodesk.com/support/maya/learn-explore/caas/CloudHelp/cloudhelp/2020/ENU/Maya-Modeling/files/GUID-5B9A94A4-1019-49C9-B9F9-9A2ACBB66E1F-htm.html>
- Bobb, B. (2020, April 13). *Indya Moore on Giving Back to a Trans Community Most in Need During the Pandemic*. Vogue.
<https://www.vogue.com/article/indya-moore-cash-app-trans-community-coronavirus-pandemic>
- BOSES OF CURVES MODEL. (n.d.). Black and Curvy. Pinterest.
<https://pl.pinterest.com/pin/550635491933764873/>
- CG Cookie. (2012, Nov 9). *Blender Topology Collection: Male and Female Torso* [Video]. YouTube.
https://www.youtube.com/watch?v=a_2hN0_zHvA
- Danny Mac 3D. (2020, Dec 11). *How to Sculpt Sexy Lips* [Video]. YouTube.
<https://www.youtube.com/watch?v=Ms1vX1qi8Pg>
- Dew Diehard. (2019, May 6). *Intro To 3D Art - Lesson 3 - The Body, Pixar Style Topology* [Video]. YouTube. <https://www.youtube.com/watch?v=5G9ziFbJJmM>
- Dew Diehard. (2020, Jan 28). *Intro To 3D Art Pixar Style Topology Part 2 Patches* [Video]. YouTube.
<https://www.youtube.com/watch?v=X5Jksu5Z8AA>
- Fergalicious Wealthy Bootie. DSW. (n.d.).
<https://www.dsw.com/en/us/product/fergalicious-wealthy-bootie/466608?activeColor=250>
- Ekren, D. (2016). Jane. ArtStation. <https://www.artstation.com/artwork/kmvPA>
- Ekren, D. [@dekren] (2018). [Photo of 3D model of woman of color in business attire]. Retrieved from <https://www.instagram.com/p/Bokt65MAoK5/?hl=en&epik=dj0yJnU9Z3d6ZH03VF9oWGwtT04xaGRveWxJdWJGbfP5ZWZQTlomcD0wJm49S1d4Mk8wdEFRM2ItWEpkSFpzdnpqQSZ0PUFBQUFBR0IxMlI0>
- Ensley, M (2021). Desirae (digital sketch). Commissioned for this project.
- EXO Cute. (n.d.). Kpop Fanart. Pinterest. <https://www.pinterest.com/pin/14425661289360743/>
- FlippedNormals. (2018, Jan 29). *Retopology for Beginners in Maya*. YouTube.
<https://www.youtube.com/watch?v=xpDWta5O3n8>
- Giyim, L. (2019). Woman Touching Chair. Facebook.
<https://www.facebook.com/lamiagiyim/photos/2384759888232727>
- Gonzalez, C. (n.d.). CGMA Academy. CGMA.
https://www.cgmasteracademy.com/courses/109-stylized-characters-in-3d#tab_interview_98
- Haas, J.-D. (1970, January 1). Animation Buffet. <http://animationbuffet.blogspot.com/search/label/Human>.
Screenshot by author.
- Jackson, O. (n.d.). Kilik Rung - Soul Eater. Pinterest.
<https://www.pinterest.com/pin/846606429930520790/>
- Martin, A. (2020). *Stylized Basemesh Collection*. FlippedNormals.
<https://flippednormals.com/downloads/stylized-basemesh-collection/>

- Martins Costa, K. (2009, December 9). *Realistic Ear Modelling*. 3dtotal.
<https://3dtotal.com/tutorials/t/realistic-ear-modelling-krishnamurti-martins-costa-modeling>
- Pavlovich, Michael. (2017, Sep 7). *PavWork 21: Creating a Mouthbag with ZRemesher* [Video]. YouTube.
<https://www.youtube.com/watch?v=GDlyPFhI4dw>
- Sullivan, C. (2019, July 9). 32 Times Pose's Indya Moore Truly Swept Us Off Our Feet. POPSUGAR Celebrity.
<https://www.popsugar.com/celebrity/photo-gallery/46350932/image/46351104/Sexy-Indya-Moore-Pictures>
- Tapp, Alex. (2020). 60 Trendy Drawing Simple Anime Character Design. Pinterest.
<https://www.pinterest.com/pin/612841461784307807/>
- Urdinov, D. (2019, July 22). *Female Character Production Guide*. 80lv.
<https://80.lv/articles/female-character-production-guide/>
- wakaju. (2017). Tumblr.
<https://sugawara-kkoushi.tumblr.com/post/161617829900/some-overwatch-fanart-i-did-mostly-lucio-and>
- Wattpad. (n.d.). Keith X Reader One-Shots. Pinterest.
<https://www.pinterest.com/pin/862931978587622616/>
- Wattpad. (2020). The Rumors that makes me change (Haikyuu) Hinata harem. Pinterest.
<https://www.pinterest.com/pin/780389441677695605/>
- Wilkins, A. (2019). Sketches 02. ArtStation. <https://www.artstation.com/artwork/Z5IBlx>
- yolo3d. (2020, Apr 12). *Using R3DS Wrap - Never retopo again* [Video]. YouTube.
<https://www.youtube.com/watch?v=r6NXHLL08Fg>

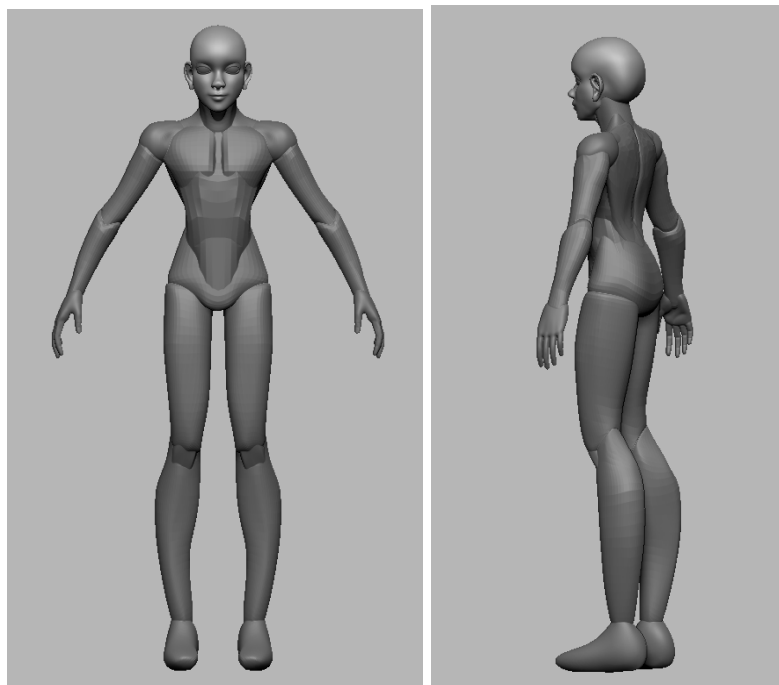
7 - Figure Appendix

7.1 - Blocking

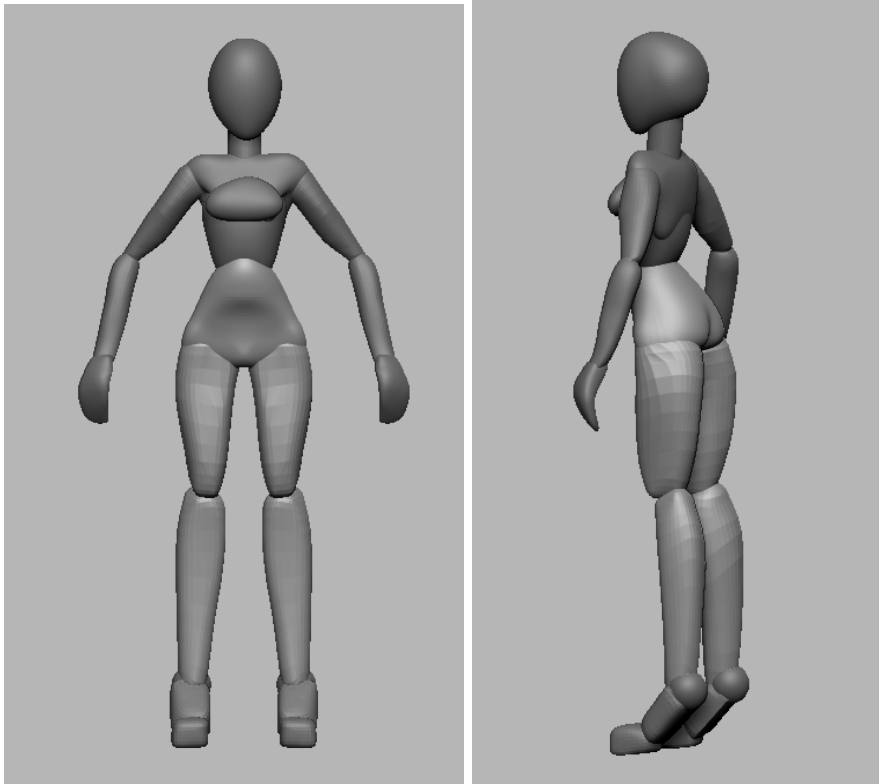
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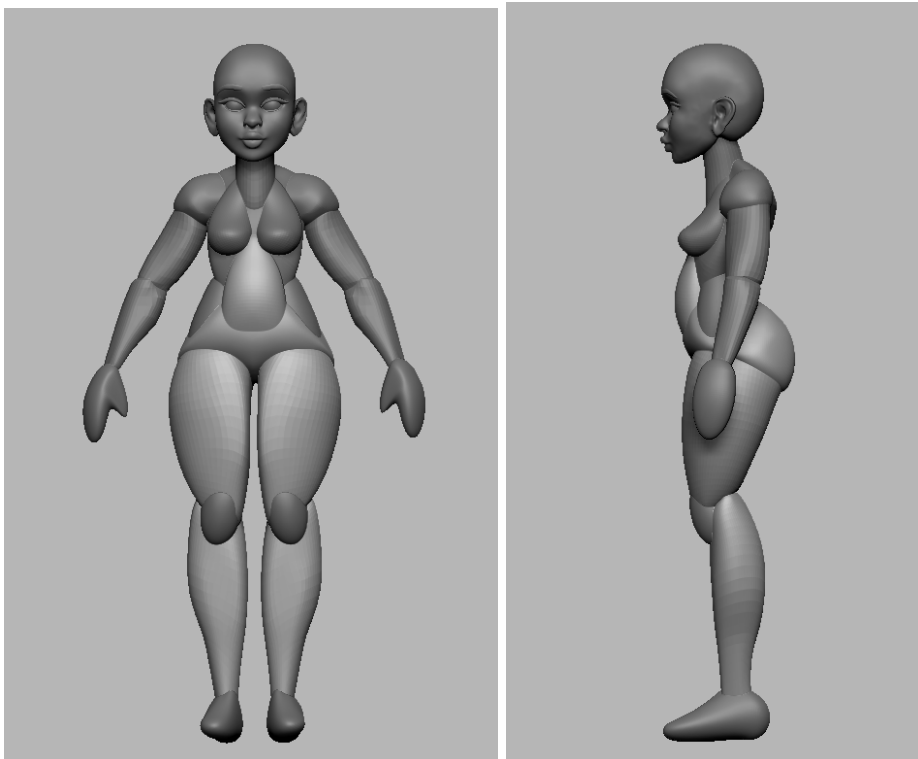
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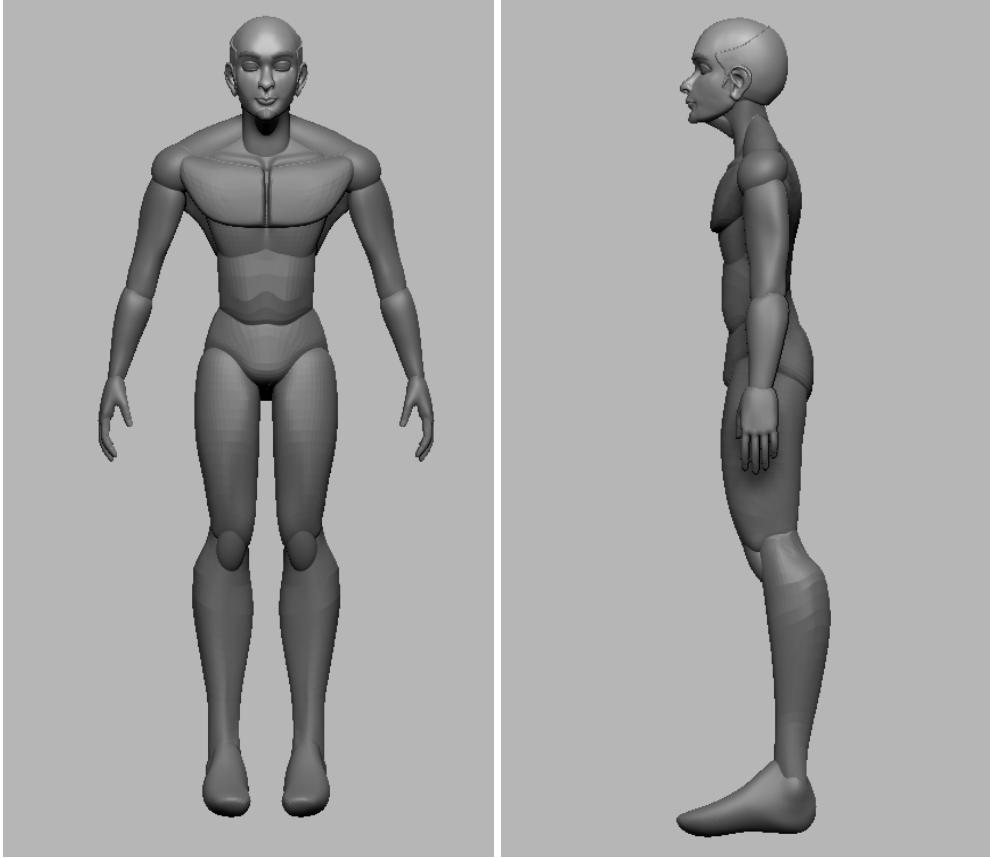
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Desirae:



Adonis:



7.2 - Form Work

Diya:



Jay:

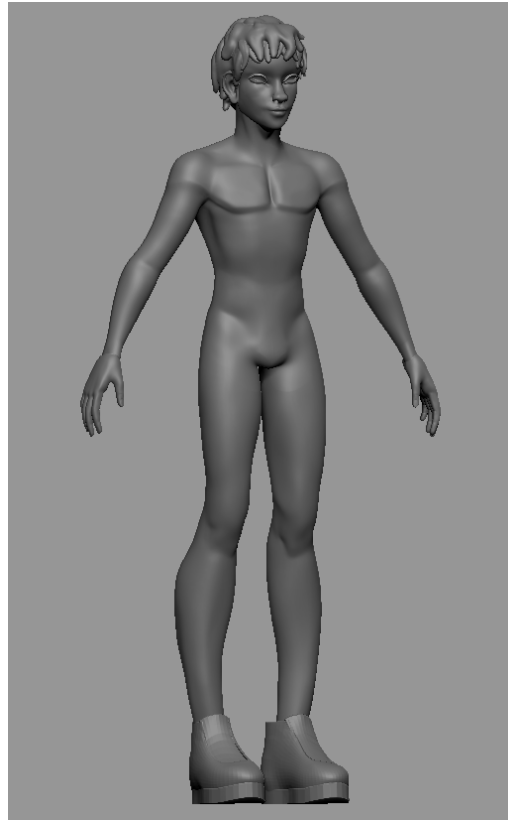
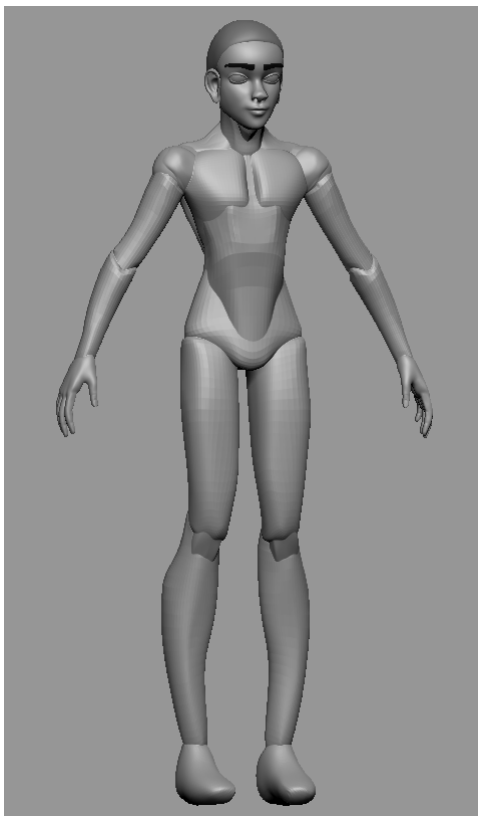


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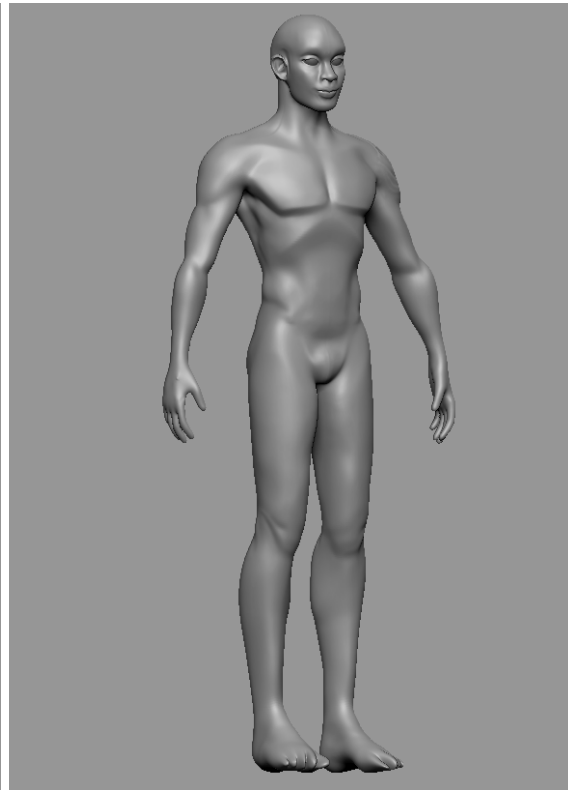
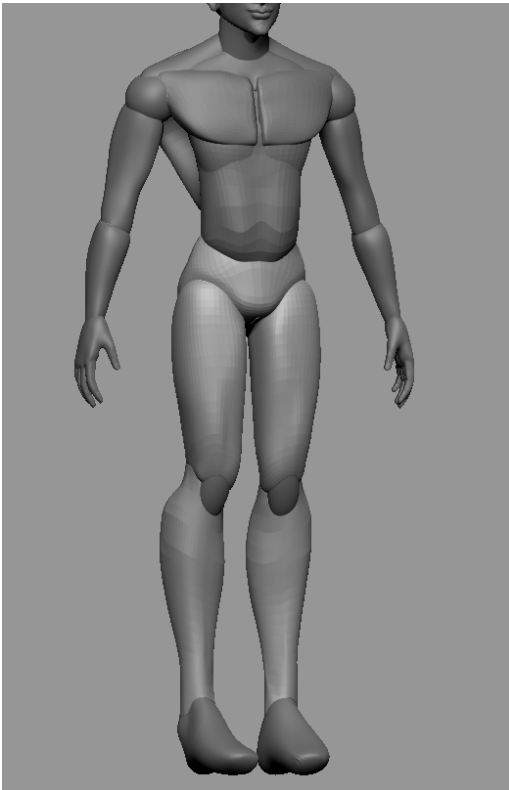
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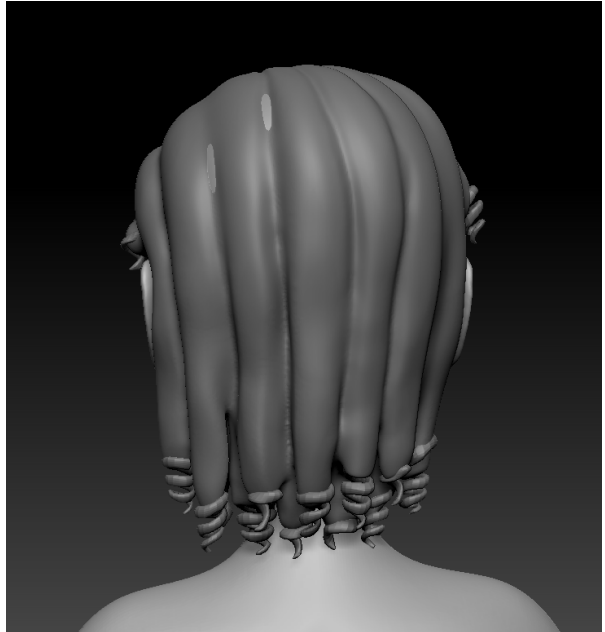


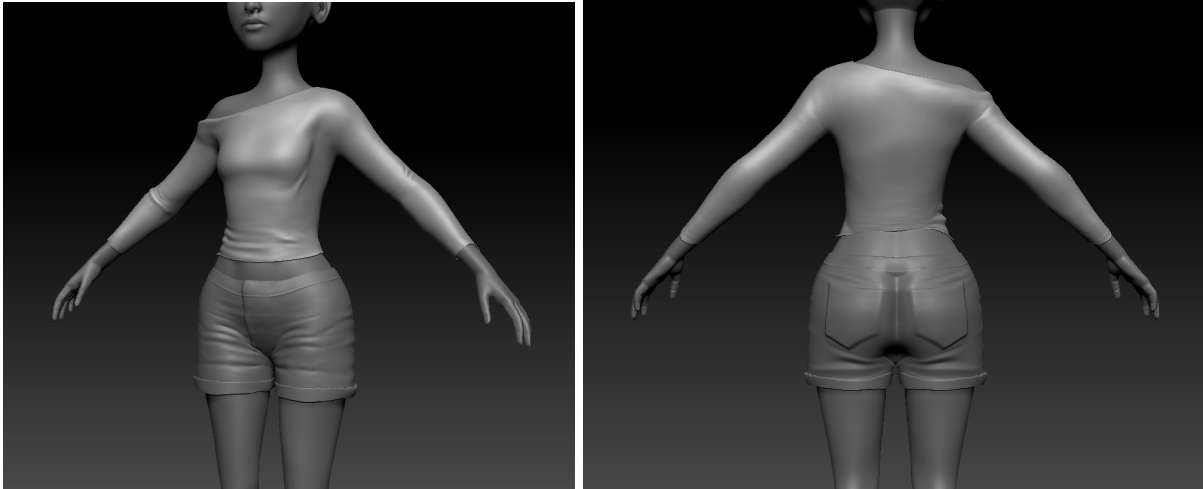
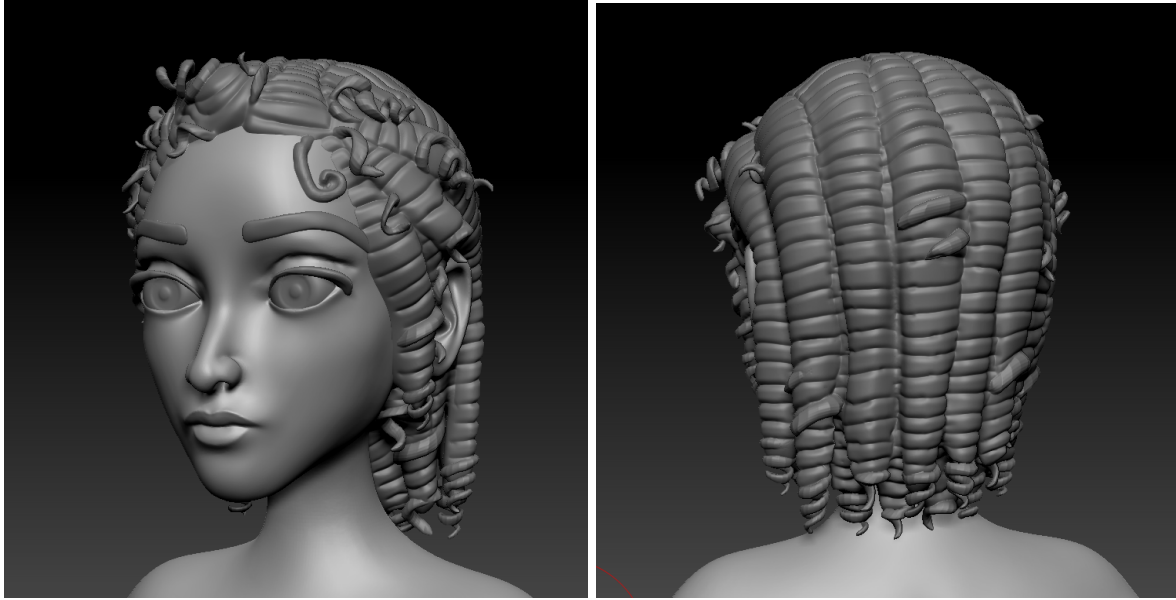
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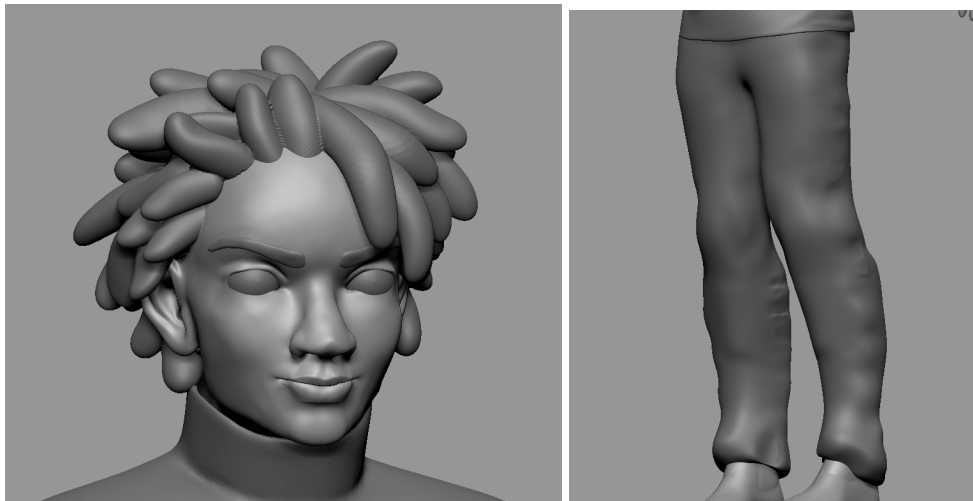
7.3 - Developing Clothing and Hair

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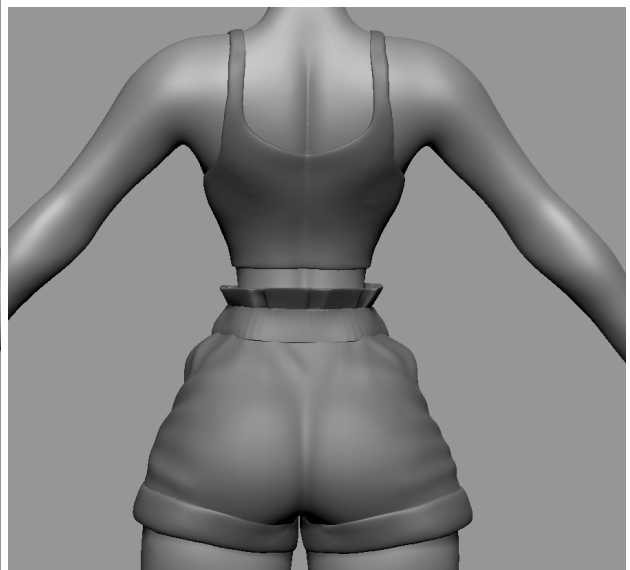
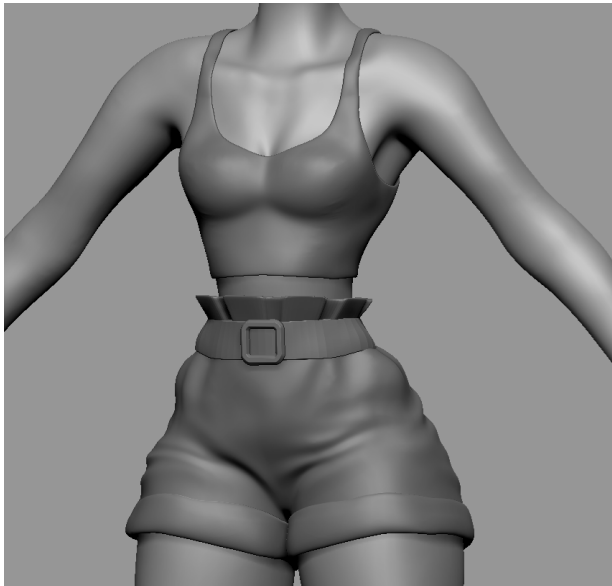


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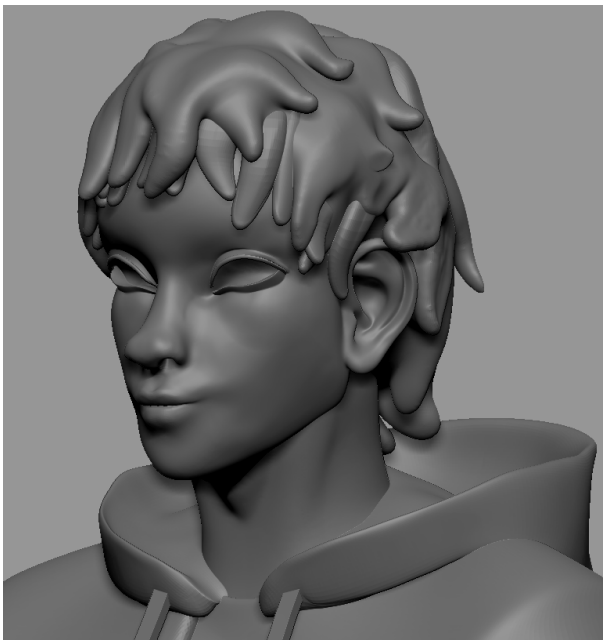




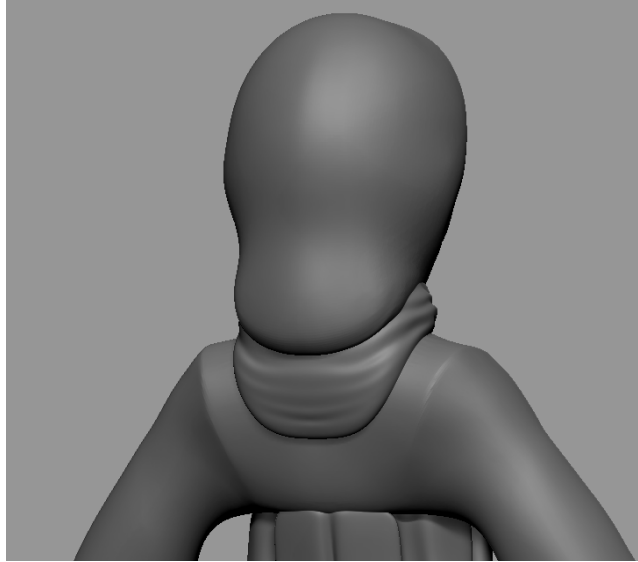
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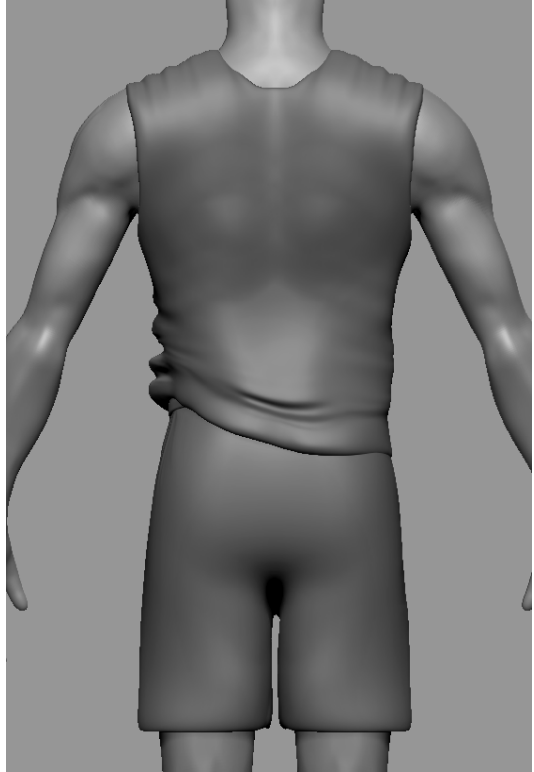
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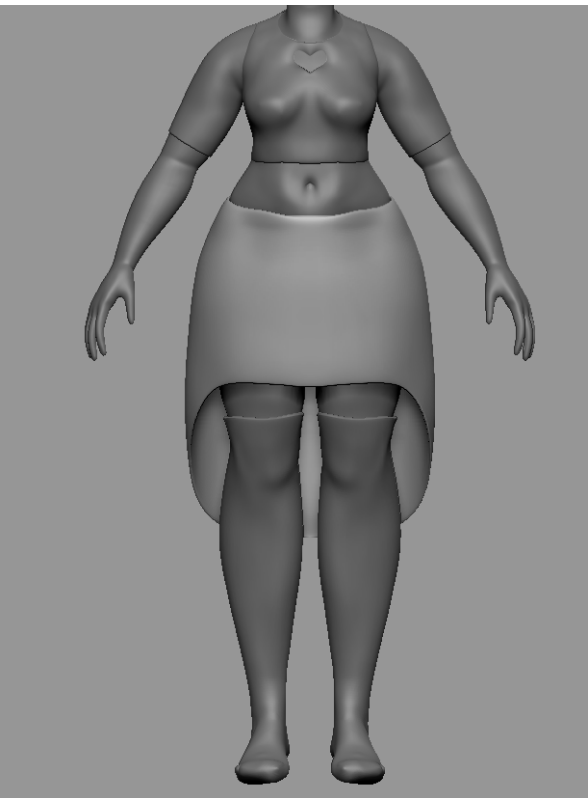
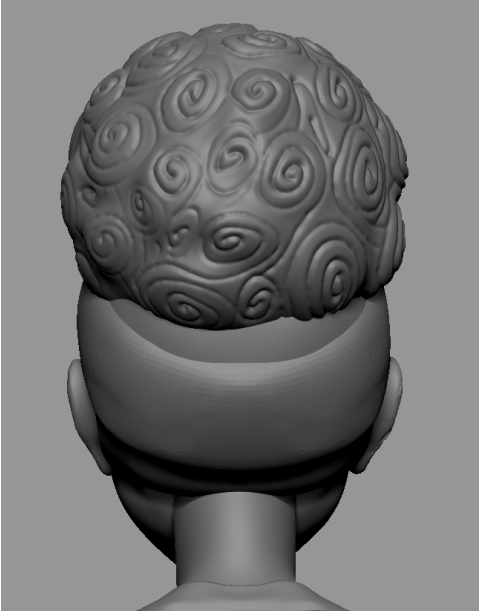
Sumaira:

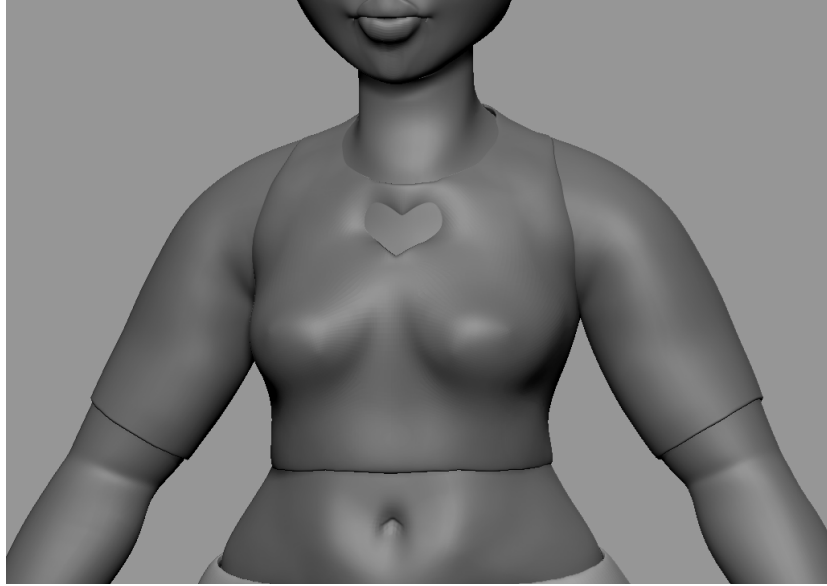


Adonis:

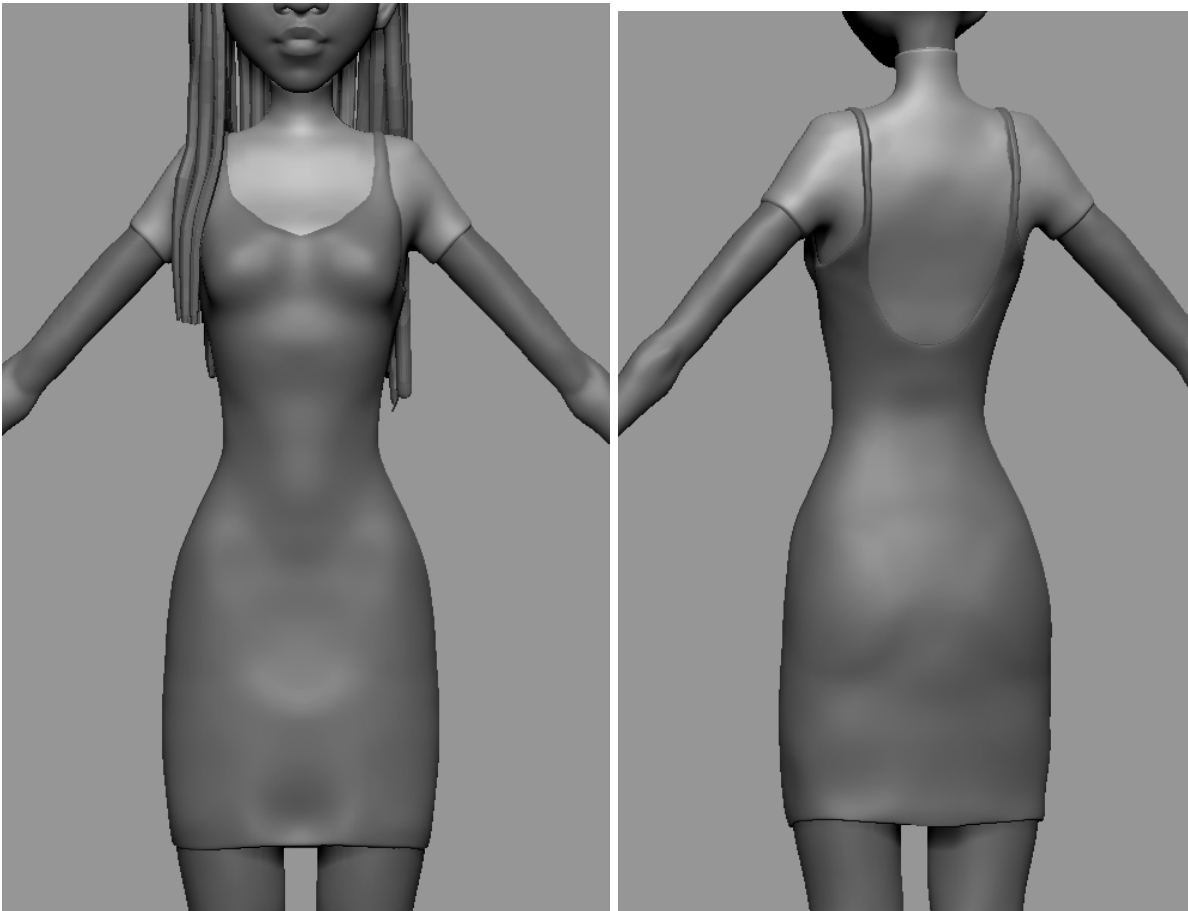


Desirae:





Kim:



7.4 - Shoes and Other Accessories

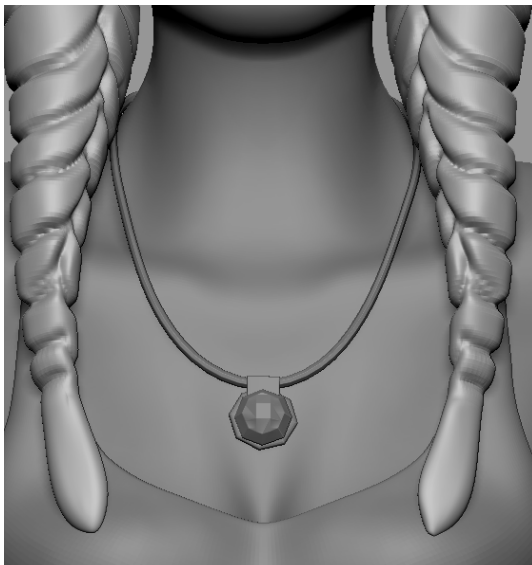
Diya:



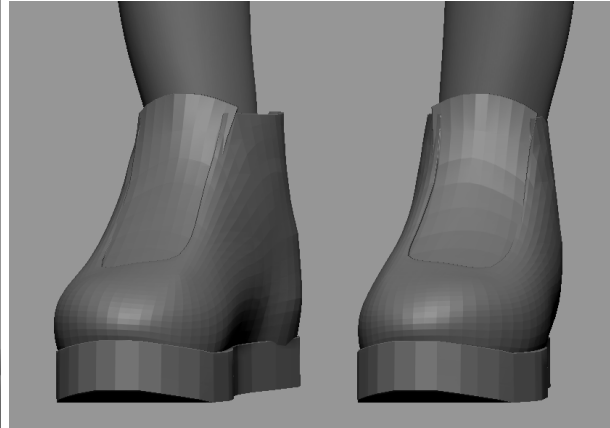
Jay:



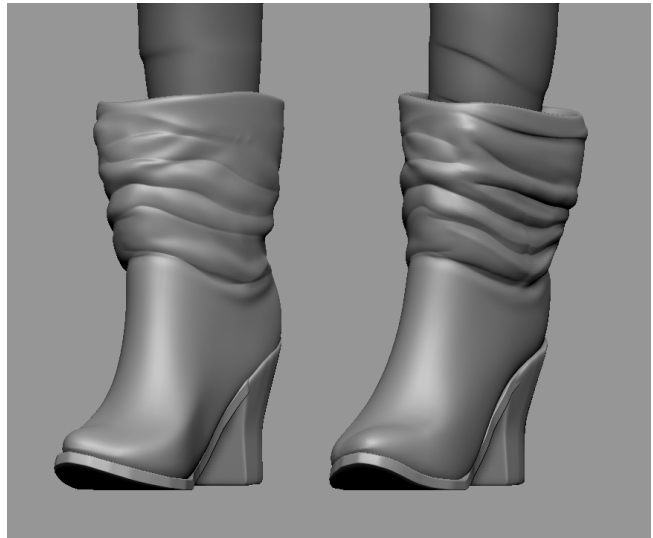
Kaela:



Natsu:



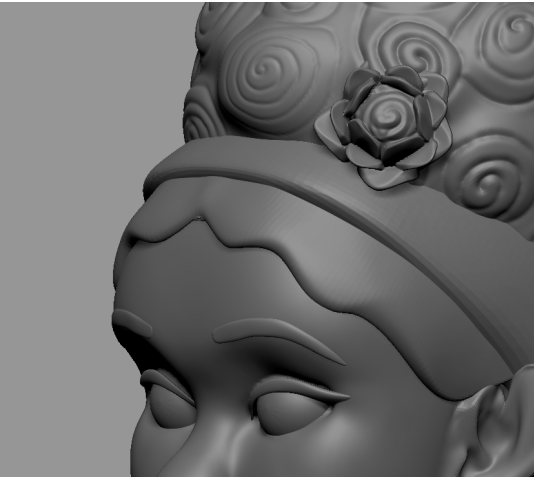
Sumaira:



Adonis:



Desirae

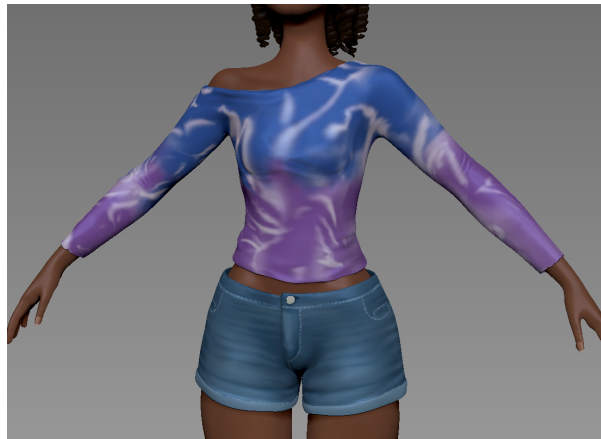


Kim:



7.5 - Color

Diya:



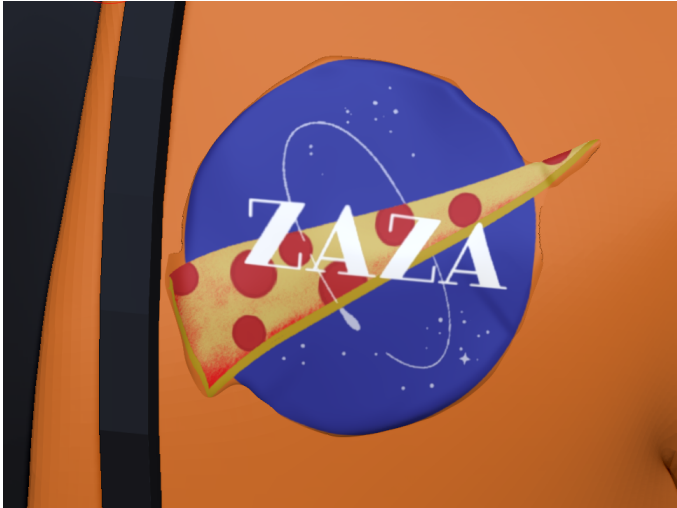
Jay:



Kaela:



Natsu:



Sumaira:



Adonis:



Desirae:



Kim:

