MILO

Bachelor Thesis

Bachelor of Science

MILO - 3D CHARACTER CREATION WITH A FOCUS ON CLOTH DESIGN AND TEXTURING

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Abstract

This bachelor thesis revolves around the development of a 3D character with a special focus on clothing simulation, high quality texture creation and rendering.

The approach includes creating a concept using Moods and realising it in Blender. The character's clothing is designed in Marvelous Designer and the textures are hand-painted in Krita. The character is rendered at high resolution in Blender, and the final renders are enhanced with frame-by-frame animations in Krita.

The result is a 3D character wearing three outfits with intricate detail achieved with minimal geometry. This production-ready character is suitable for animation, video games, and clothing advertisements due to the emphasis on clothing design. The thesis serves as a comprehensive guide to 3D character development, demonstrating the effective use of various tools and techniques to achieve impressive results.

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Introduction

01

In this thesis I am taking on the challenge of 3D character development. My motivation comes from my exploration of character design in previous semesters. I find the process of transforming a 2D concept into a visually stunning 3D model to be extremely impressive and captivating. I would also like to expand my skills by learning new programs such as Marvelous Designer and delving deeper into the character creation process.

A big source of inspiration for this project is the Netflix series "Arcane" [1]. The show's unique art style showcases the variety of character creation possibilities and drives me to create a unique character.

The primary goal of this project is to create a distinctive, production-ready 3D character. Three outfits will be created to explore cloth design. Stylized texturing will also be used to add to the uniqueness of the character.

In order to achieve my goals, I will follow a specific workflow, which is described below. It's important to note that there are different approaches to character creation, but for this project I'll be focusing on the following steps: modelling in Blender, cloth simulation in Marvelous Designer, texture creation in Krita, rendering in Blender and polishing in Krita.

02

References and Moods

The first step in creating my character is to gather references and explore different moods. This will give me a better idea and inspiration for how my character will look.

While the moods help me get a general sense of the desired aesthetic, the references provide a deeper understanding of real-world objects and body parts, allowing me to achieve a realistic model. Therefore, I incorporate references and moods throughout the project, especially when I need clarity on specific shapes. I use PureRef [2] to collect and organise the images. My PureRef document (Figure 1) contains most of the references used throughout the project. I also look up additional references on the go for minor details.

Figure 1 References and moods in PureRef

Figure 2 Face moodboard

Since my plan is to design a character with three different outfits, I need to gather moods for both the outfits and the character itself. My focus is on the character's face, as the rest of the body will be covered by clothing. Considering the overall look of the outfits, I choose my inspiration for the face (Figure 2) accordingly.






Figure 3 Techwear outfit moodboard

Once I have all the necessary references for the character's face, I look for inspiration for the clothing. Three mood boards are created, each representing a specific outfit. I make sure that they capture my vision, while maintaining distinctiveness between them.
For the first outfit, I want to create a techwear-inspired casual look.
To achieve this, I gather a collection of images (Figure 3) that capture the essence of the desired style.

The concept of the second outfit tends towards a more elegant look, but still fits with the overall feel of my character.
The moodboard (Figure 4) shows the images that represent the vision for this particular outfit.






Figure 4 Elegant outfit moodboard

For the third outfit, I want to create a streetwear-inspired look that combines comfort and coolness.
To bring this vision to life, I collect a series of images (Figure 5) that capture the essence of the desired aesthetic.

Figure 5 Casual outfit moodboard

Concept

03

Creating a well-defined concept for the character is an essential step in the character creation process, as it sets the foundation for the overall design [3]. With a clear understanding of my creative direction, established through the moods, I work on sketching the character and the three outfits. I use Krita [4], a free drawing software that provides all the essential tools I need. Krita offers a wide range of brushes and efficient layer and mask management.

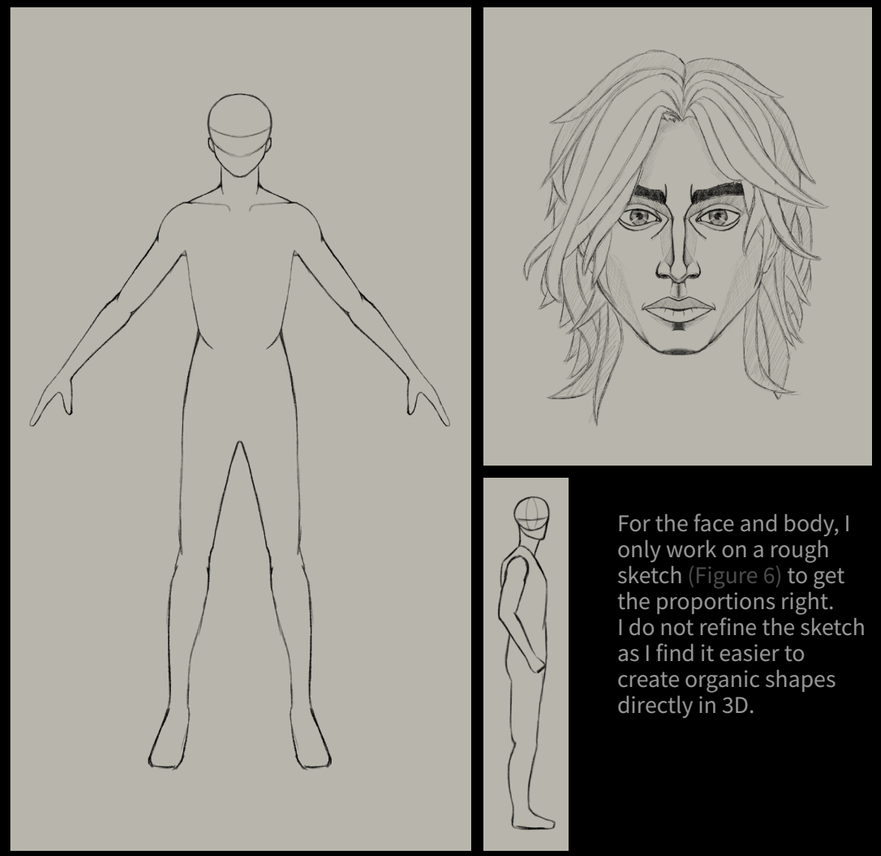

Figure 6 Face and body sketch

For the face and body, I only work on a rough sketch (Figure 6) to get the proportions right. I do not refine the sketch as I find it easier to create organic shapes directly in 3D.

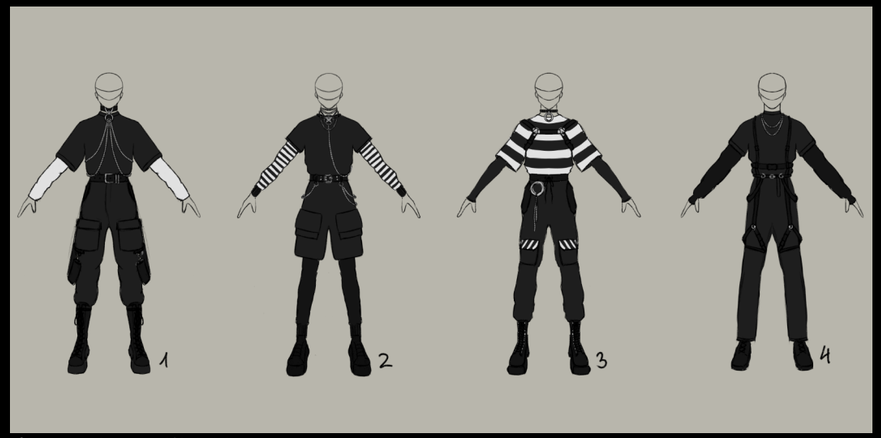

Figure 7 Techwear outfit sketches

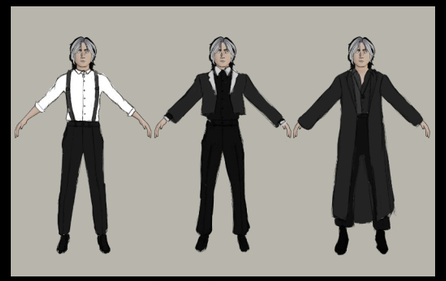

Figure 8 Elegant outfit sketches

Figure 9 Casual outfit sketches

To create a concept for the outfits, I like to work by drawing different versions of my vision.

Using the mood board, I create several sketches for each outfit (Figure 7-9).

Figure 10 Final techwear outfit sketch

Figure 11 Final elegant outfit sketch

Figure 12 Final casual outfit sketch

I then combine them into one final sketch (Figure 10-12). I use a grey block shading technique to get a general idea of the desired final look while keeping it simple. The sketches mainly serve as a guide for simulating clothing and detailing.

Modelling

04

With the concept in place, the next phase of the character creation process is modelling. I begin to shape the 3D character and lay the groundwork for the cloth simulation that follows. For this I rely on the powerful capabilities of Blender [5], a widely used 3D modelling software.

4.1 SETUP

To begin the modelling process, it is necessary to set up the scene.
One important aspect is to ensure the correct scale, especially if you plan to use the model in a software such as Marvelous Designer. In Blender, the scale is equivalent to real-life measurements. For example, you can add a cube with the dimensions 1x1x1 metre to provide an accurate scale reference.

Once the scale is set, the previously drawn references are added to the scene. These references act as a rough guide and assist the modelling process by providing visual guidance.

4.2 FACE

With the scene set, I move on to modelling the face. I focus on the right side and use the mirror modifier [6] to mirror the changes on the left side (Figure 13).
To make the face appear smoother, I use a subdivision modifier. I set the parameters at two as it adds geometry and I want to keep it low.

While modelling, I pay attention to detail, working with loops around the eyes and mouth to maintain proper geometry.
Once the face modelling is complete, I apply the Mirror modifier and make adjustments to individual vertices to create a natural and realistic asymmetrical appearance (Figure 14) [7].

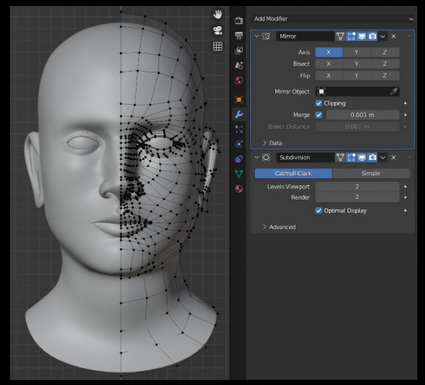

Figure 13 Symmetrically modelled face

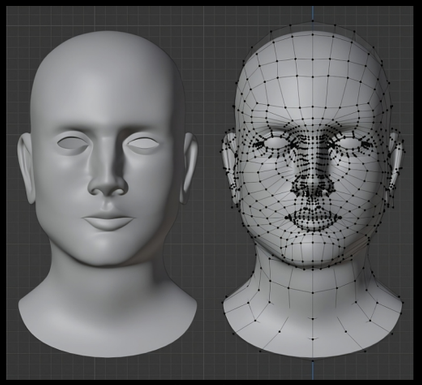

Figure 14 Asymmetrically modelled face

4.3 BODY

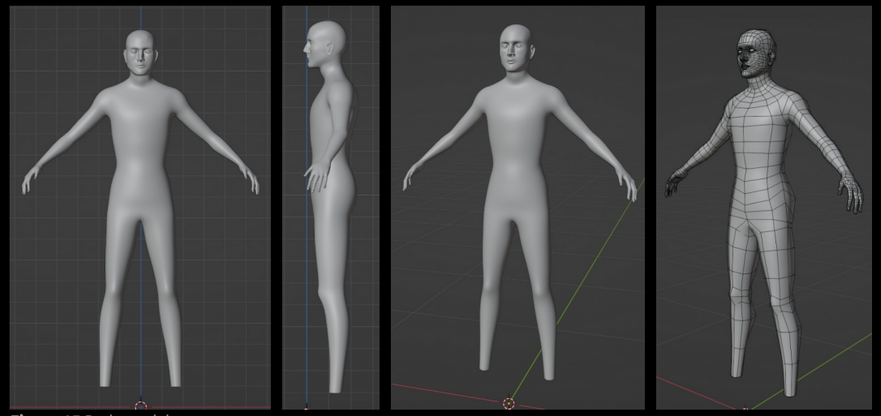

Figure 15 Body model

Once I have finished modelling the face, I use similar techniques to model the body. The mirror and subdivision modifiers are used in this process as before. However, I focus less on detail as the body will be covered by clothing. My primary goal is to create a well modelled body that will serve as a base for the cloth simulation.

I start by working on the upper body and then move on to the lower body. Arms, hands and legs are added accordingly. I do not model the feet as they are hidden by shoes, which are modelled separately. I work with loops consisting of eight vertices as this allows for smoother and more rounded shapes.

Once the body modelling is complete, I apply the mirror modifier and continue to attach the body to the previously modelled head (Figure 15).

4.4 HAIR

The next step in modelling my character is to add hair using a particle system. To achieve a stylised look, I refer to a tutorial on stylised hair modelling [8].

To begin, I add a plane to the scene and apply a new particle system to it, changing it from an Emitter to Hair (Figure 16).

I then start tweaking the settings to get the look I want.

The first step is to change the hair shape type in the render properties tab from strand to strip (Figure 17). This improves visibility during the process. I then focus on the particle system itself.

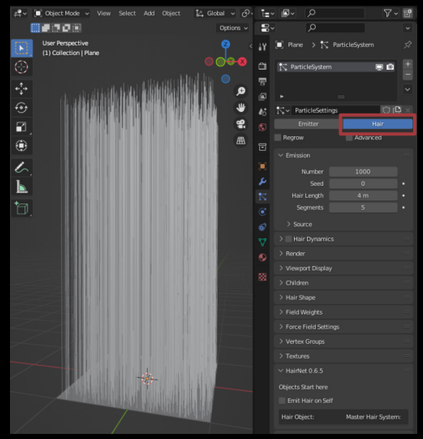

Figure 16 Hair particle system on a plane

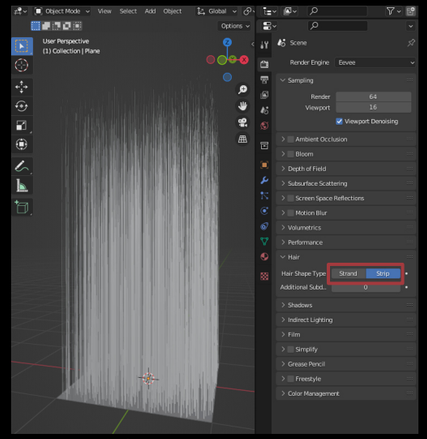

Figure 17 Hair shape type strip

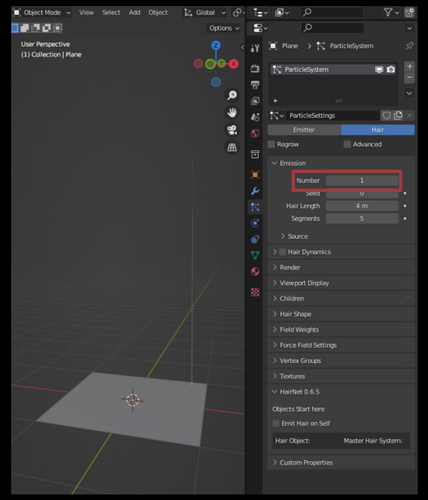

Figure 18 Number of hairs set to one

I reduce the number of hairs to one (Figure 18). This hair will act as a guide for the other hairs.

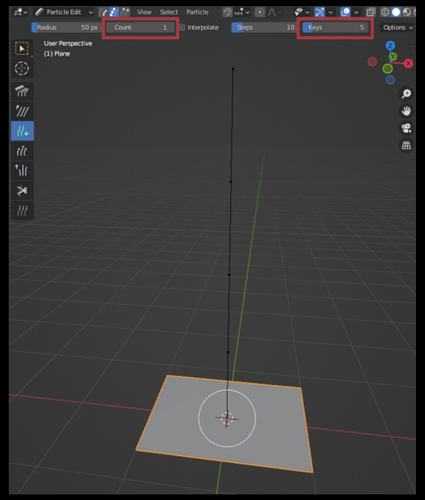

Figure 19 New hair

To place the hair in the centre, I go into particle edit mode, use the cut tool to remove the hair and the add tool to place a single hair in the centre of the plane. It is important to set the settings of adding a hair correctly: I set the count of hairs to one and the number of keys to five (Figure 19).

Next, I add more hair to the simulation by setting the children to interpolated and adjusting the display and render amounts as needed (Figure 20).

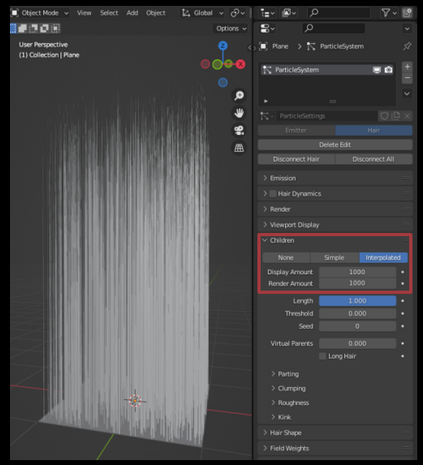

Figure 20 Children set to interpolated

I change the shape of the hair using the Clump Curve (Figure 21).

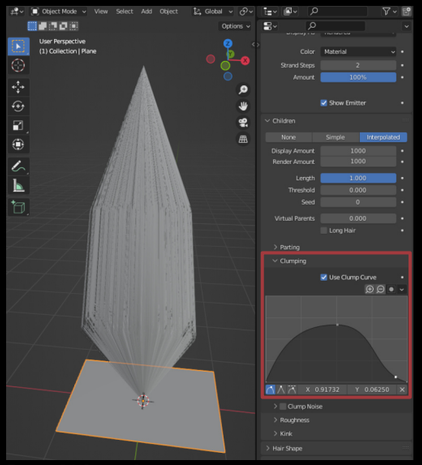

Figure 21 Clump Curve

To make the hair appear smoother, I set the strand steps under the viewport display to five (Figure 22).

I can also change the shape of the hair by going into edit mode and adjusting the plane (Figure 23), as well as going into particle edit mode and adjusting the vertices (Figure 24) to get a suitable shape for the hair.

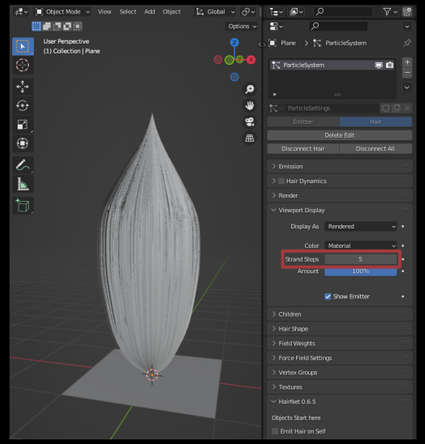

Figure 22 Strand Steps

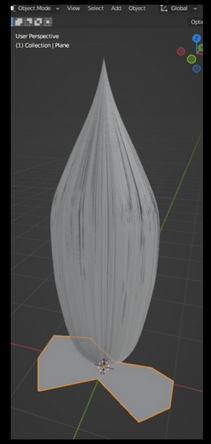

Figure 23 Adjusted plane

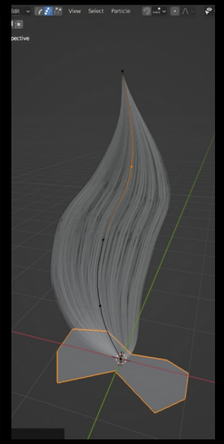

Figure 24
Plane shape changed

To add the hair to my character, I duplicate the plane and adjust the shape of the hair using the above methods. By modifying the guide hair, I ensure that the hair particles fit my character's head. I position the planes to cover my character's head, starting at the bottom and working my way up (Figure 25).

Additionally, I adjust the clump noise to give the hair thin-looking strands. I also add smaller planes with fewer children to create strands that stand out from the main hairstyle (Figure 26).

Figure 25 Placed hair

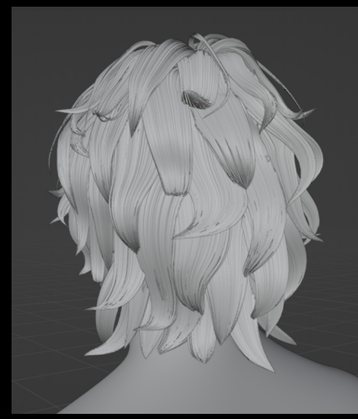

Figure 26 Hair with thin strands

4.5 DETAIL

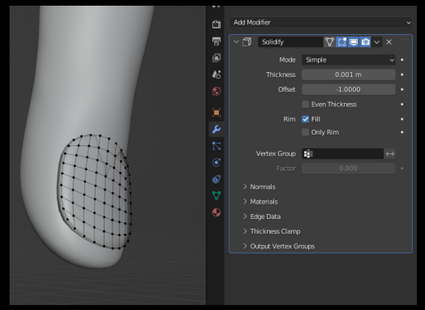

Figure 27 Creating fingernails

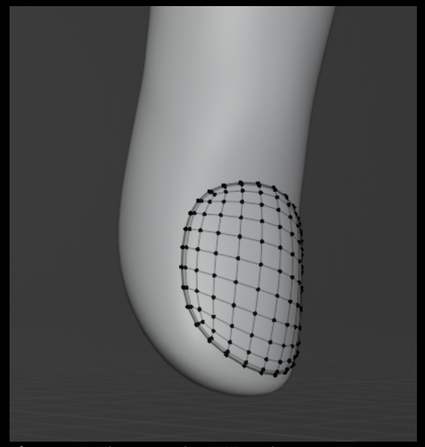

Figure 28 Nails accurately positioned

With the body and hair complete, I continue to add detail elements, starting with body-related features such as fingernails, eyebrows, and eyelashes.

To create the fingernails, I select an appropriate part of the hands and duplicate it. I then apply a solidify modifier to give the nails thickness and ensure they sit on top of the skin (Figure 26). By adjusting the modifier settings, I achieve the desired appearance.

After applying the modifier, I move the vertices to position the nails accurately (Figure 27).

For the eyebrows and eyelashes, I opt for a stylised approach instead of using hair particles. I employ the same technique as with the finger nails, duplicating a portion of the character's face and applying a solidify modifier.

In the case of the eyebrows, I add additional geometry to give me more control over their shape (Figure 29).
Similar to the face, I model the eyebrows asymmetrically.

Additionally, I begin modelling parts of the clothing that will not be simulated such as the shoes (Figure 30). Other details, like jewellery, are left for later stages, after the clothing has been simulated.
This allows me a better understanding of their placement.

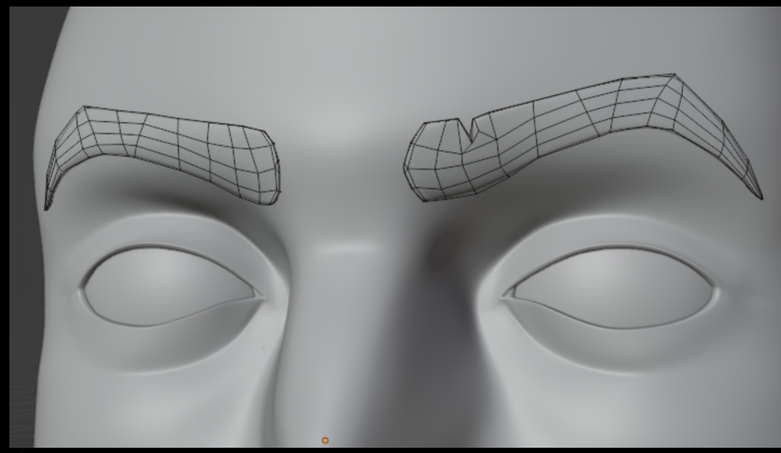

Figure 29 Modelled eyebrows

Figure 30 Modelled shoes

Cloth Simulation

05

Once the 3D character has been modelled and the clothing concept finalised, I will work on simulating clothes using Marvelous Designer [9]. This software allows the creation of 2D patterns that can be sewn together to emulate real-world garments. The resulting patterns can be simulated in 3D to achieve realistic behaviour.

5.1 SETUP

To prepare for simulation in Marvelous Designer, I start by exporting the mesh from Blender. I make sure it is scaled to the real world. I export only the body for simulation. The export file format chosen is Alembic (.abc) as it works well with Marvelous Designer [10].

Because my character mesh uses a subdivision modifier, it is important to apply it either during the export process or within the project itself.

I can now import the Alembic file into Marvelous Designer using the default import settings (Figure 31). I also have the option of adding more meshes to my project later.

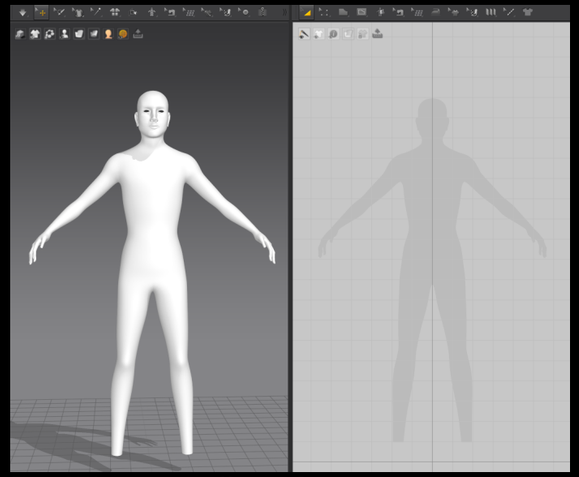

Figure 31 Model imported to Marvelous Designer

5.2 CREATING AND SIMULATING GARMENT PATTERNS

With the setup complete, I can move on to creating 2D patterns and simulating them in 3D.

To start working on the previously designed outfits, I look for images of people wearing similar outfits, as well as any similar garments I own.

In addition, I search the Internet for suitable garment patterns and refer to Harumi Maruyama's book "Oberteil-Grundschnittvariationen" (Figure 32) [11]. This research helps me gain a better understanding of how to create the patterns I need and how to sew them together.

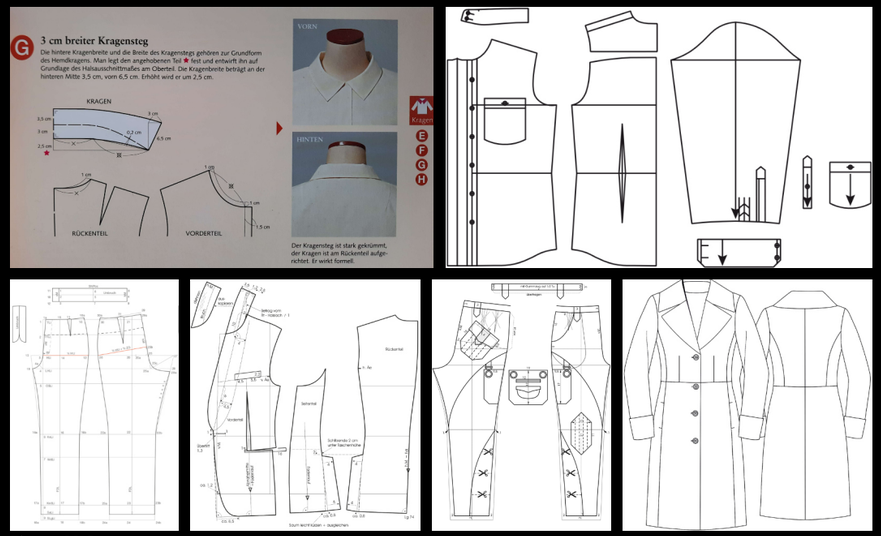

Figure 32 Garment patterns

Once the research is done, I start translating the garment designs into Marvelous Designer.

Using the Polygon (H) tool, I create a rough pattern in the 2D view. As I want the pattern to be symmetrical, I unfold it along the centre line by right-clicking and selecting “Unfold Symmetric Editing (with Sewing)”. Any changes made to one side will now be mirrored to the other.

Next, I adjust the patterns using editing tools such as Edit Pattern (Z) and Edit Curvature (C).

Once I am happy with them, I position the pieces in the 3D viewport, making sure that the front pieces are in the front, the back pieces are in the back and so on.

I then use the Segment Sewing and Free Sewing tool to sew the garments together (Figure 33).

Before finally simulating the clothing, I check the Particle Distance settings in the Property Editor. This setting determines the spacing between vertices.

To keep the geometry low and the performance good, I keep it at 20 (Figure 34). I can reduce the Particle Distance later to get a more detailed result.

I simulate the clothing by pressing the spacebar (Figure 35). If the clothing does not fit properly or does not look the way I want it to, I make adjustments to the pattern and simulate it again.

To further customise the simulation, I change the fabric of the garment. I can then change the settings in the fabric’s property editor (Figure 36). I focus on the physics properties because they affect how the garment is simulated.
For example, if I choose a preset for leather, it will be much stiffer than if I use a preset for cotton. I try them out to find the right material for my needs.

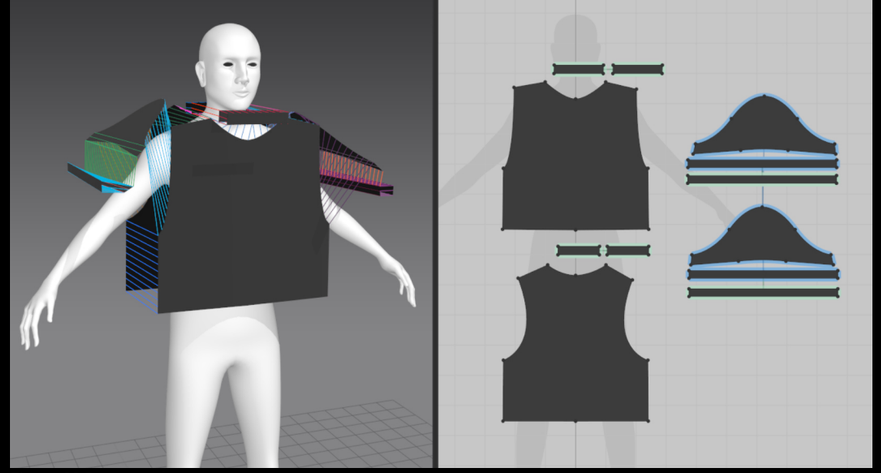

Figure 33 Pattern with sewing

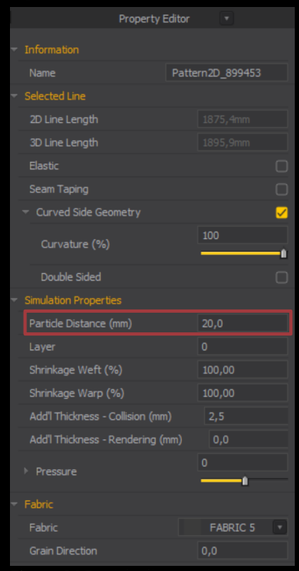

Figure 34 Particle distance setting

Figure 35 Simulated clothing

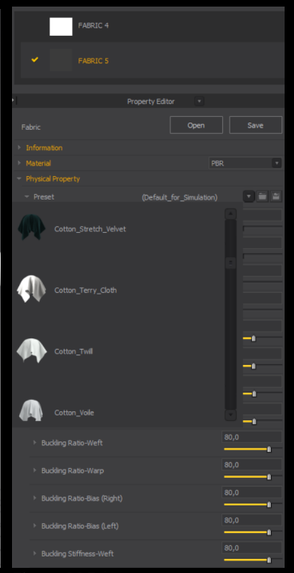

Figure 36 Fabric property editor

Once the first piece of clothing is finished, I move on to the remaining pieces. To temporarily freeze a garment, I can use the Freeze tool (Ctrl + K) by right-clicking on the garment and selecting Freeze (Figure 37).
This prevents the frozen piece from being simulated.

Another useful tool is the Strengthen tool (Ctrl + H). It makes the simulation stiffer and, as the name suggests, strengthens it (Figure 38).

In order to layer the clothes correctly and have a T-shirt under trousers for example, I use layers (Figure 39) [12].
Once simulated correctly, it is important to change the setting back to zero.

Figure 37 Freeze tool

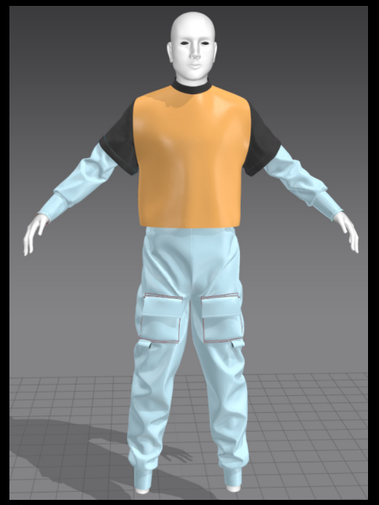

Figure 38 Strengthen tool

Figure 39 Layered clothing

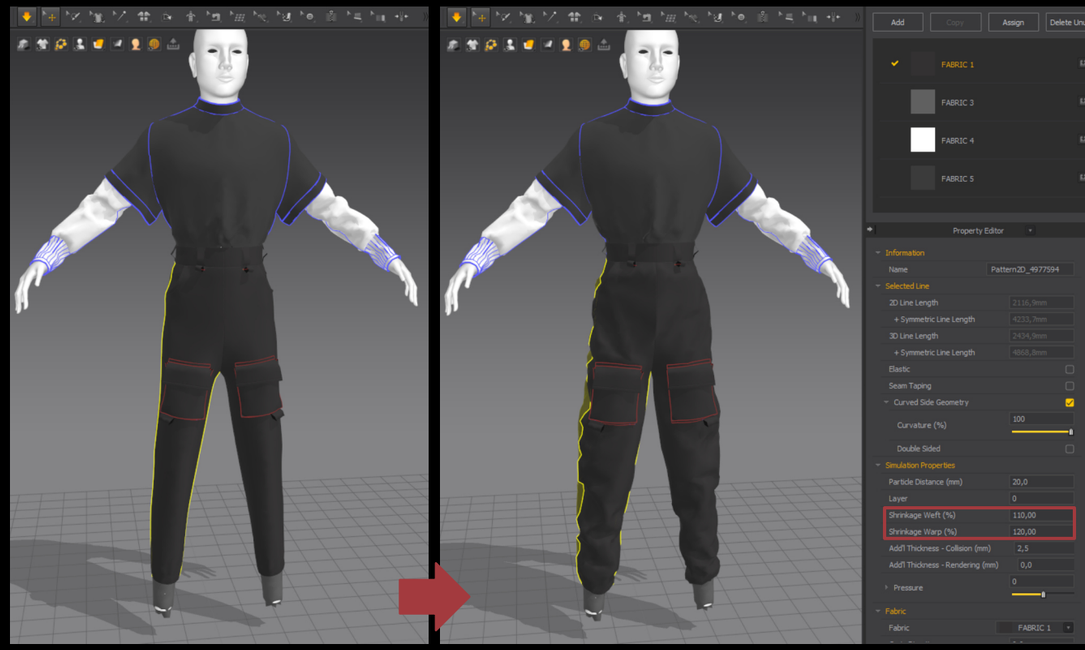

Figure 40 Shringkage Weft and Warp settings

For puffing up the trousers, I use the Shrinkage Weft and Warp settings in the Properties Editor (Figure 40) [13].

To add more detail to the simulation, I temporarily export the outfit as an OBJ file and import it into Blender. In Blender I add details such as metal parts. Now I can export the new details as an Alembic (abc) file again.

I import them into my Marvelous Designer scene using the Import (Add) option. This way I can simulate the clothes with the added details (Figure 41).

To finish my cloth simulation, I reduce the particle distance where more geometry is needed.

Using the same process as for the first outfit, I create the other two outfits (Figure 42 - 43).

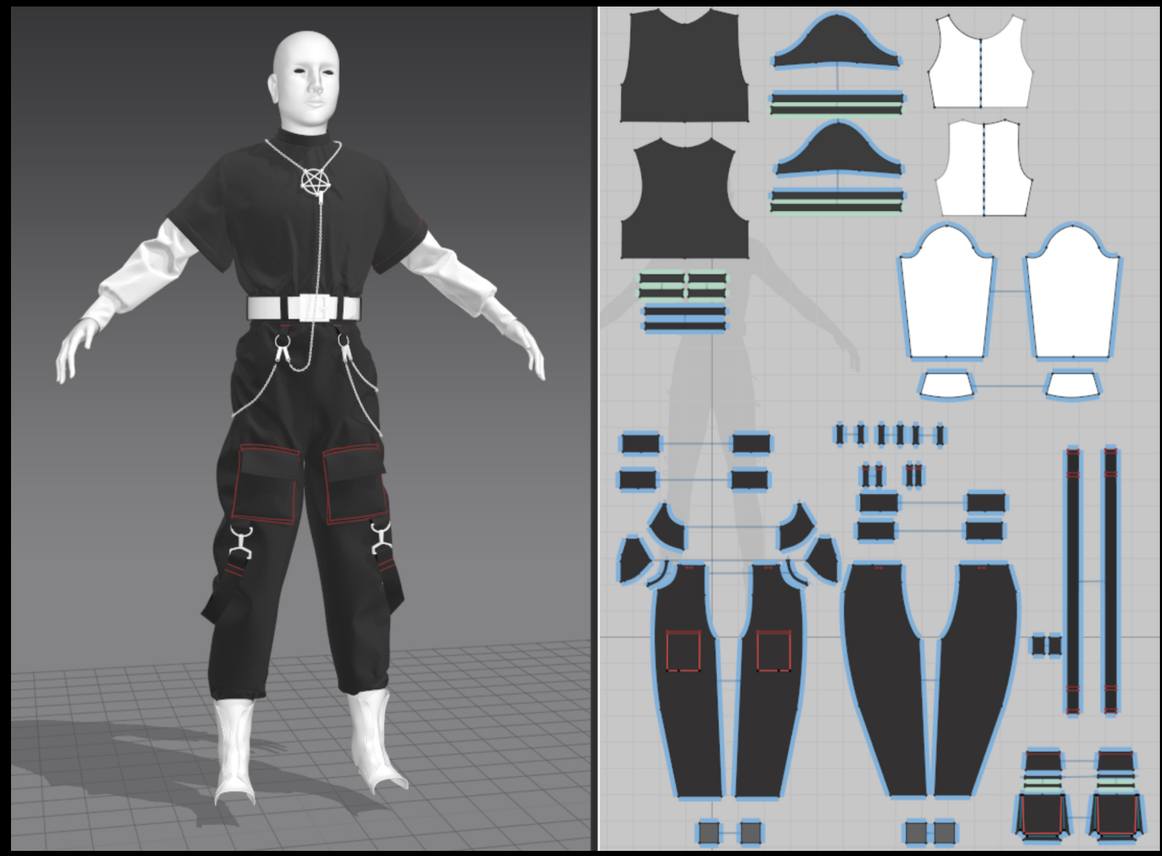

Figure 41 Techwear outfit simulated with details

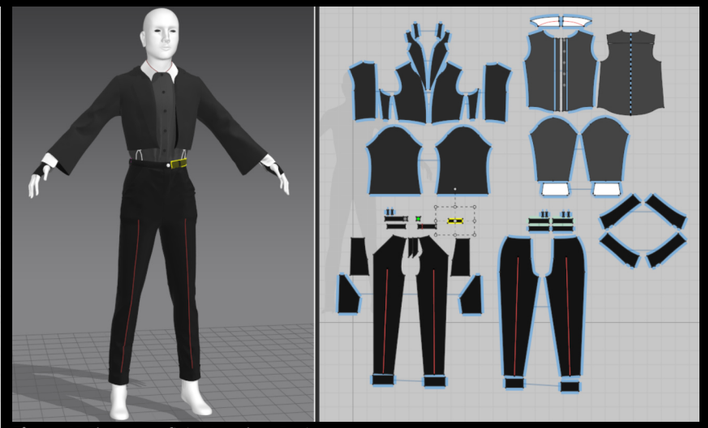

Figure 42 Elegant outfit in Marvelous Designer

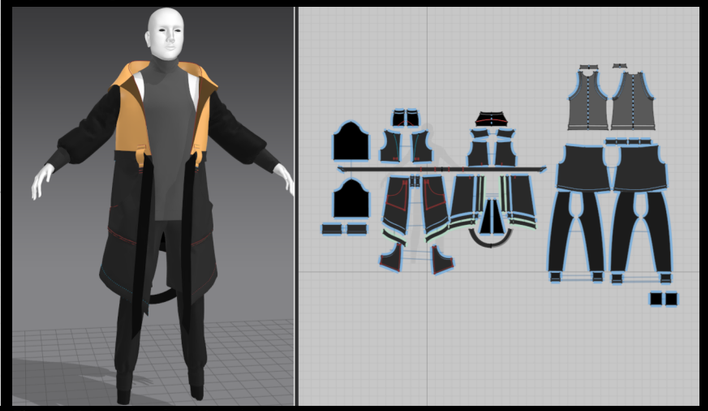

Figure 43 Casual outfit in Marvelous Designer

5.3 RETOPOLOGY AND DETAIL TRANSFER

The next step is to import the clothing meshes from Marvelous Designer into my Blender project.

As the imported mesh contains a high level of geometry which could affect performance, the mesh needs to be retopologized. This involves creating a low-polygon version of the mesh, while transferring the details from the high-poly mesh.

First, I export each garment separately using the Export OBJ (selected) option. Clothing that shows both sides of the garment, such as the T-shirt, is exported using the thick option.
For garments that only show patterns from the outside, such as the long sleeve, I use the thin option.

Now I import the OBJ file into my Blender project.

For the retopology I use two different techniques. The first is to build the mesh from scratch by tracing the low-poly mesh onto the high-poly using the magnet tool. This method is more time consuming and is used selectively when the other technique is not suitable.

For most of the retopology I use a simpler method [14]. To start with, I unwrap the meshes imported from Marvelous Designer (Figure 44). Meshes exported with thickness require some additional clean up, removing any unnecessary or small connecting faces (Figure 45).

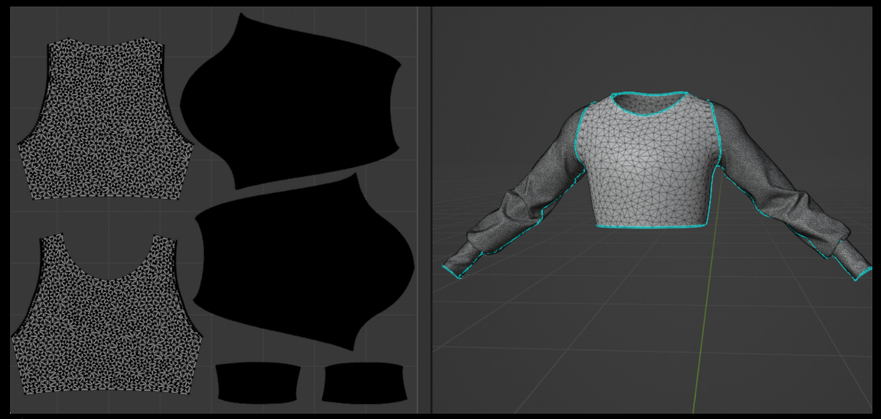

Figure 44 Unwrapped thin mesh from Marvelous Designer

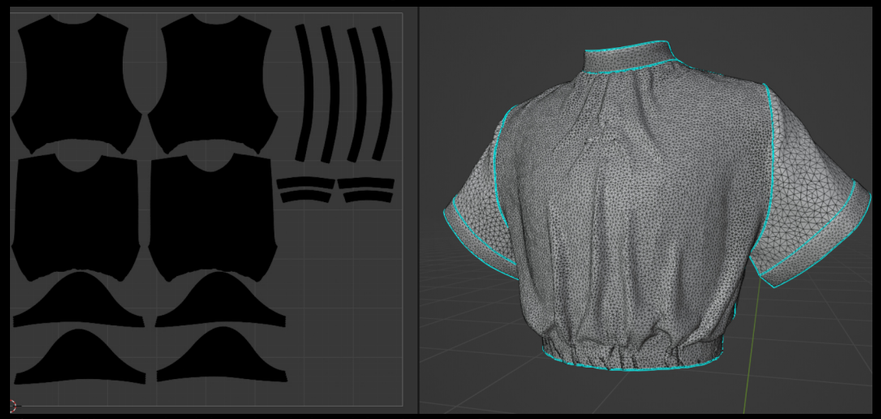

Figure 45 Unwrapped and cleaned up thick mesh from Marvelous Designer

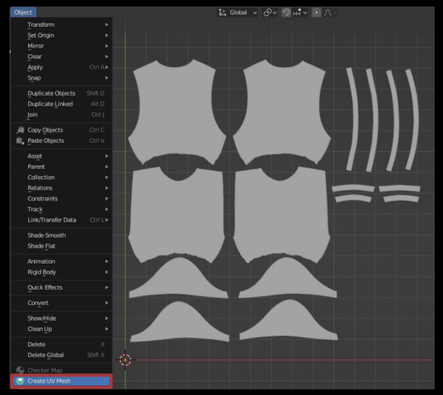

Figure 46 UV mesh

After preparing the mesh, my next step is to create a UV mesh from the unwrapped object.
To do this I use an addon called "UV: TexTools" [15] that I have installed in Blender. This addon gives me the option to create a UV mesh (Figure 46).

Using the created UV mesh as a guide, I add a plane to the scene and adjust its transformation to match the UV mesh in Edit mode (Figure 47).

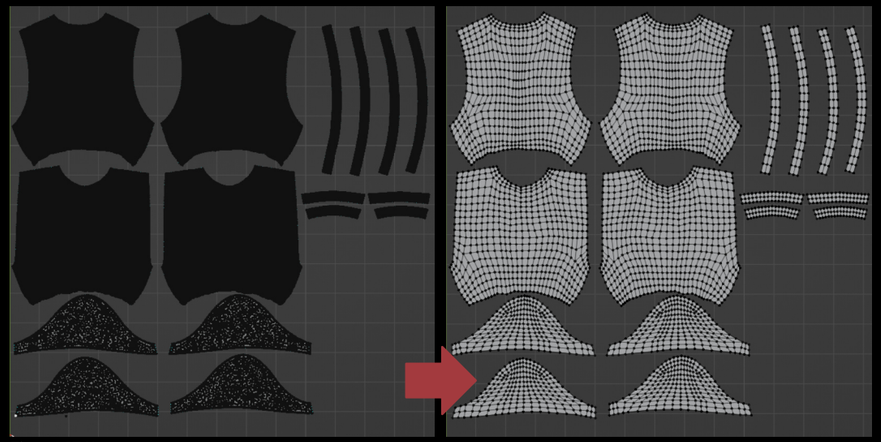

Figure 47 New mesh matching the UV mesh

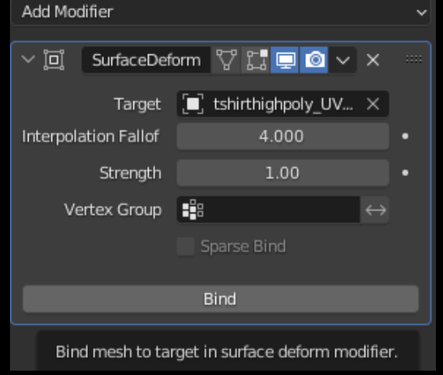

Figure 48 Surface Deform Modifier

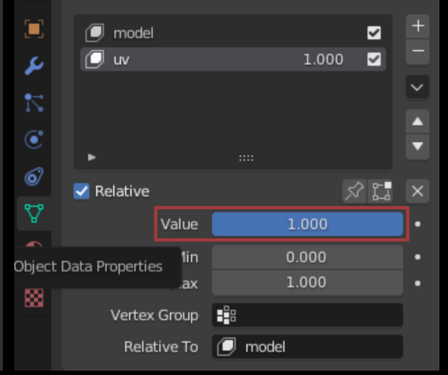

Figure 49 Transforming the meshes

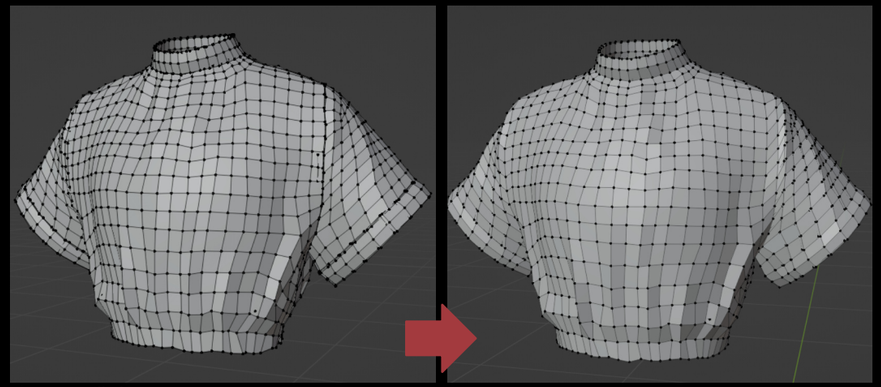

Figure 50 Filled in gaps

I now add a Surface Deform Modifier (Figure 48) to the newly created mesh and bind it to the high-poly UV mesh.

Using the addon, I can then transform the high-poly UV mesh to align with the 3D object by adjusting the value from 0 to 1 in the Object Data Properties tab (Figure 49).

As the low-poly mesh is bound to the high-poly mesh, it will also undergo the transformation.

Finally, I apply the Surface Deform modifier to the low-poly model and edit the mesh to fill the gaps (Figure 50).

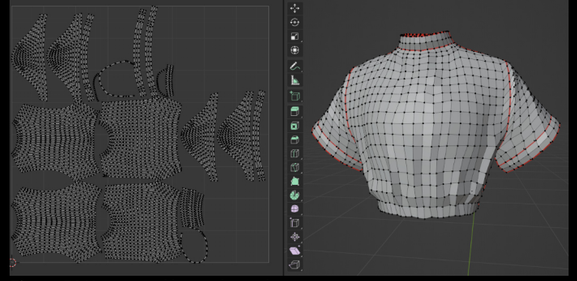

Figure 51 Unwrapped low-poly mesh

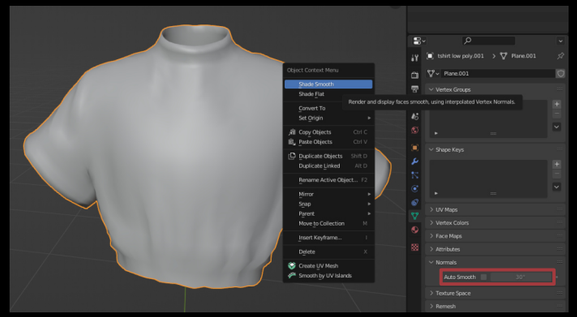

Figure 52 Smooth shading with Auto Smooth turned off

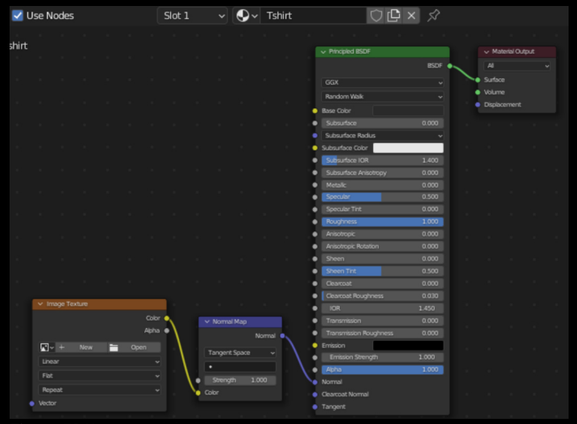

Figure 53 New material with normal map

To transfer the detail from the high-poly mesh to the low-poly mesh, I bake a normal map onto it [16].

To do this, I need to unwrap the low-poly mesh (Figure 51) and use smooth shading with Auto Smooth turned off (Figure 52).

Next I create a new material for the object in the shading tab and add a normal map and an image texture node (Figure 53).

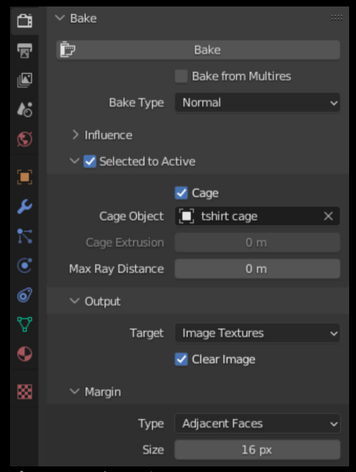

Figure 54 Bake settings

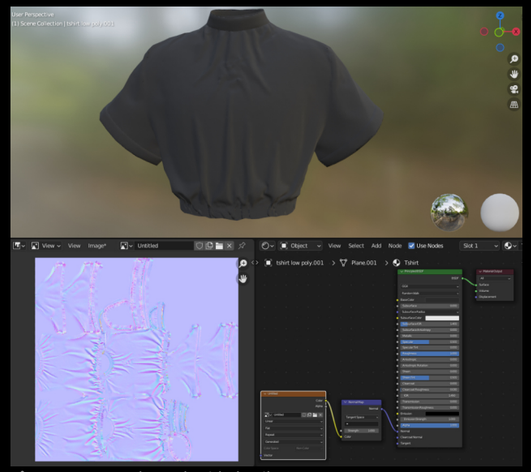

Figure 55 Low-poly mesh with detail

In the Image Texture node, I create a new image and set the colour space to Non-Colour. To bake the normal map, I select the high-poly mesh followed by the low-poly mesh.

In the Render Properties, I select Cycles as the render engine and navigate to the Bake tab. I set the bake type to Normal, and enable Selected to Active and Cage (Figure 54).

The Cage object will be a scaled duplicate of the low-poly mesh along the normals (ALT + S). It should have the same vertex count as the low-poly object and cover it completely.

Finally, I press bake to create the normal map and save the image.
I now have a low-poly mesh that has the detail of the high-poly mesh from Marvelous Designer (Figure 55).

Figure 56 High-poly vs. low-poly mesh

This process is repeated for each garment. It allows the meshes to be detailed without the need for a lot of geometry (Figure 56).

Texturing

06

Figure 57 Arcane

Figure 58 2D artwork inspiration

Figure 59 2D artwork inspiration

With the character model and clothing complete, I can start working on the textures. I am aiming for a stylised, almost painterly look.

A big inspiration for this is the animated League of Legends Netflix series "Arcane" (Figure 57) [1], but also various 2D artworks (Figure 58 - 59).

Since I want to achieve a stylised look, I mainly texture in a drawing program, in my case Krita [4].

I work with a square format and a resolution of 300dpi.
The size of the textures will vary from 512x512px to 8192x8192px depending on the resolution required.

I use brushes from Jazza's Ultimate Digital Brushes [17] as well as the standard Krita brushes.

6.1 UV UNWRAPPING

In order to texture the 3D model, the meshes need to be unwrapped. Since I already unwrapped the clothing during the retopology process, I only need to unwrap the body and any additional details I added in Blender.

To unwrap the objects, I mark the seams in Edit Mode (U ▸ Mark Seam). I try to place the seams in areas that are less visible. It is important to apply all modifiers, especially the subdivision modifiers, before unwrapping to avoid program crashes. In the UV Edit tab I can continue to unwrap the mesh (U ▸ Unwrap) (Figure 60).

For meshes with several parts of the UV map, I make sure that they are placed with enough space between them (Figure 61). This makes painting easier later on.

I also activate the Display Stretch option (Figure 62), which shows any stretched areas of the UV map.
Blue means no stretching and red shows extreme stretching. If stretching occurs, I adjust the seams to minimise it.

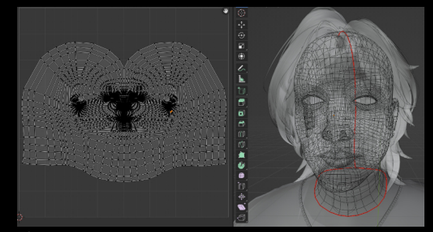

Figure 60 Face UV map

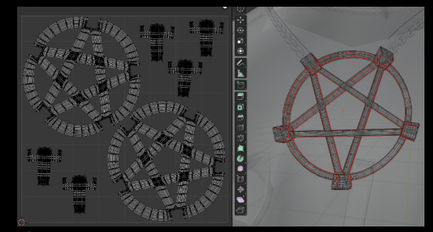

Figure 61 UV map with several parts

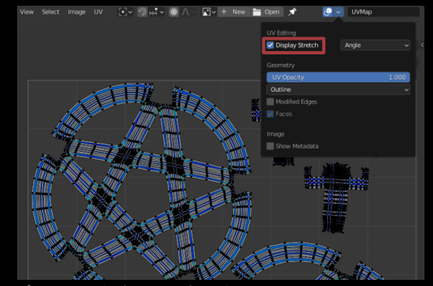

Figure 62 Display Stretch option

6.2 BLENDER SETUP

To display the textures I will create, I first add a material to each object and configure the nodes in the Shading tab. I use the default shader, Principled BSDF. To achieve the desired painterly look, I add image texture nodes linked to the base colour. I set the roughness of each material to 1, which gives a matte appearance and helps to achieve the style (Figure 63).

Throughout the texturing process I continually add drawn image textures to the material. To get a rough idea of how the final render will look, I set up a basic lighting setup (Figure 64).

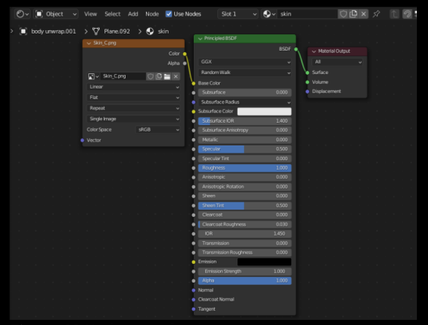

Figure 63 Node setup for the materials

Figure 64 Basic light setup

6.3 BODY

6.3.1 FACE

Once the Blender setup is complete, I start texturing the character's face. In order to determine where to draw the shadows and highlights on the 2D texture map in Krita, I use Substance Painter [18]. There I create a rough layout showing the different shading areas (Figure 65).

In Krita, I add a screenshot of the 2D map from Substance Painter, along with the UV layout exported from Blender, and align them accordingly (Figure 66).

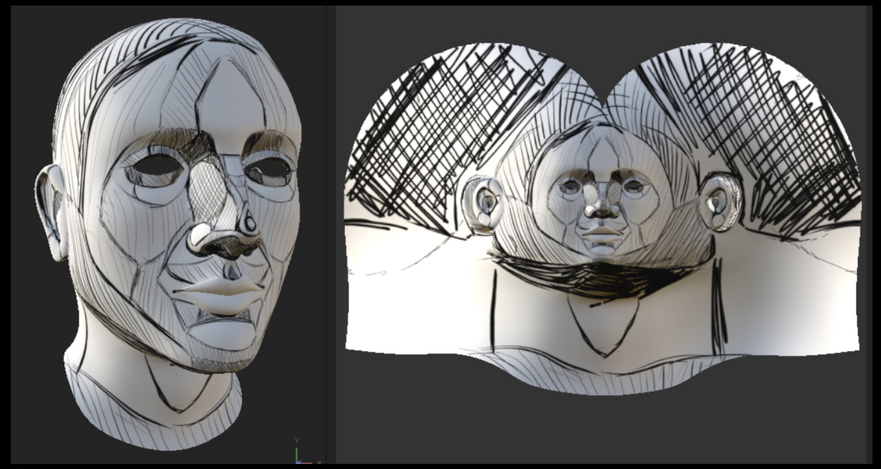

Figure 65 Rough face shading layout

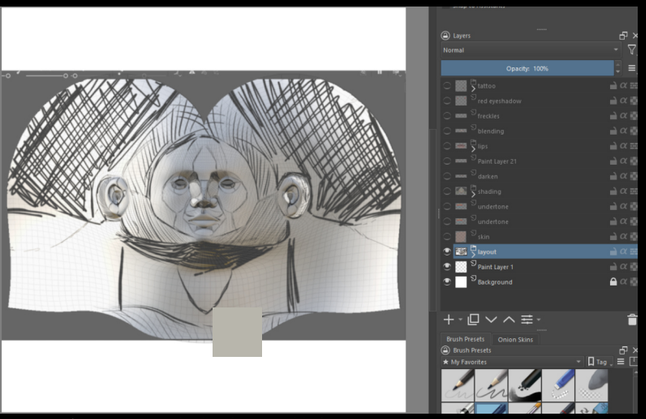

Figure 66 Face shading layout added to Krita

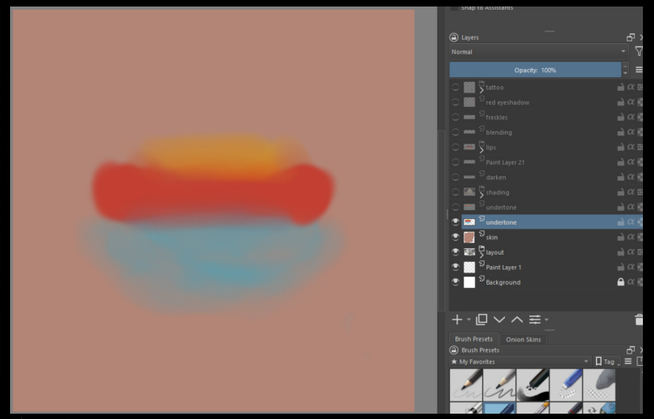

Figure 67 Undertones for the facial skin

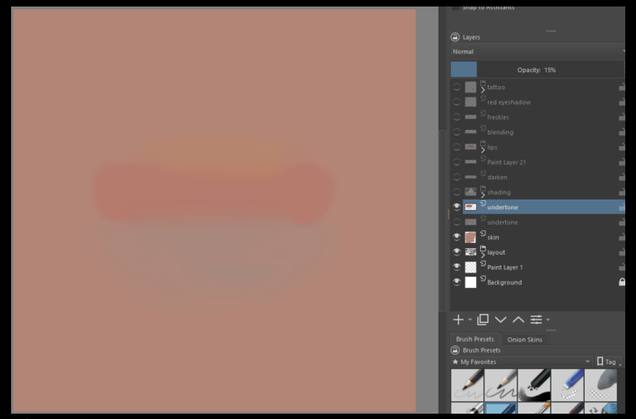

Figure 68 Undertones for the facial skin with less opacity

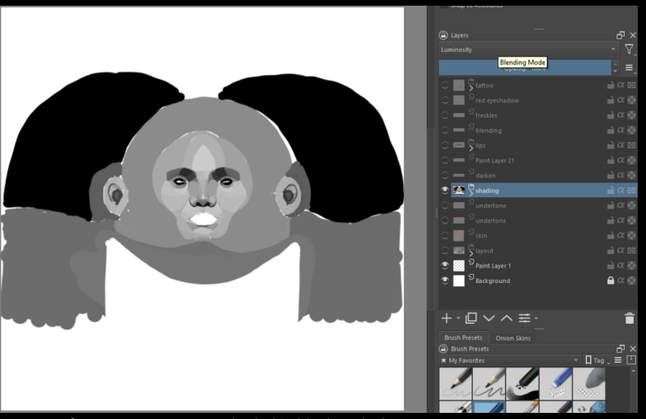

Figure 69 Face texture shaded in black and white

Figure 70 Face shading with luminosity blend mode enabled

Figure 71 Face texture with lips added

In Krita, I add a screenshot of the 2D map from Substance Painter, along with the UV layout exported from Blender, and align them accordingly (Figure 66).

Next, I add a base colour for the skin and draw in the undertones on a new layer (Figure 67). Following the principles outlined in "Jazza's Ultimate Digital Painting Handbook" [19], I use yellow for the forehead, red for the cheeks and blue for the chin area to represent the undertone colours of human facial skin.

The opacity of the layer is set to a lower value (Figure 68).

Using the luminosity blend mode on a new layer, I begin to roughly block in the shading based on the layout I created earlier. By focusing on the brightness of the colours and working in black and white (Figure 69), the luminosity blend mode ensures that the shading appears in the darker or lighter tones of the layers below (Figure 70).

The next step is to draw the lips (Figure 71).

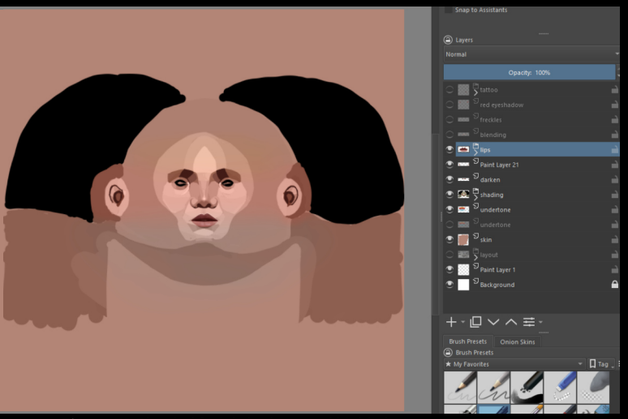

Figure 72 Blended facial shadows and highlights

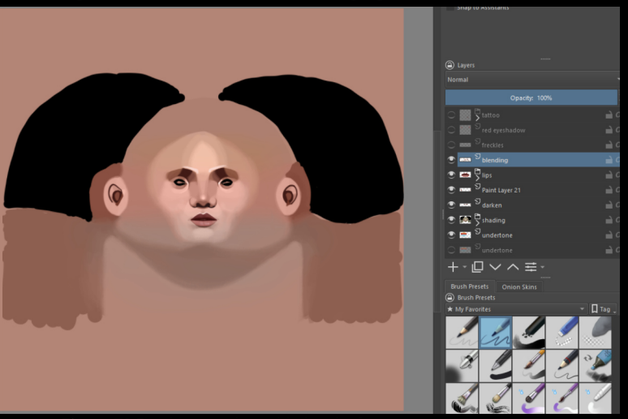

Figure 73 Finishing touches added to the face texture

Figure 74 Face texture added to Blender

Now I blend everything together (Figure 72). For blending, I use one of the pencils from Jazza's brush pack, specifically the "01g - Jazza's Pencils - Shading" brush. The texture of the brush gives a subtle textured effect. To make the colours blend smoothly, I constantly pick a colour (ALT) from one area and gently draw it next to another until the colours blend seamlessly.

Finally, I add some finishing touches (Figure 73). Using the same pencil brush, I add red eye shadow and freckles using the "09h - Jazza's Elements - Snow" brush.

I have now created a hand-drawn image texture that can be exported as a PNG file and added to the face in my Blender project (Figure 74).

6.3.2 EYES

Figure 75 Eye layout

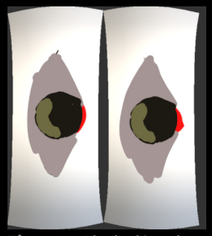

Figure 76 Blocked in colour

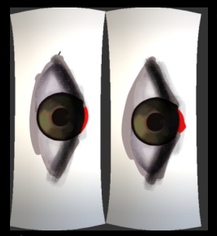

Figure 77 Blended eyes

Figure 78 Light spots

Figure 79 Eye texture added to Blender

I will now move on to texturing the eyes. Substance Painter is used again to draw a rough layout, this time the pupils and the edges of the eyes (Figure 75).

Using the layout in Krita, I block in the eye colours (Figure 76).

I blend them as before and add shadows and highlights (Figure 77).

Inspired by "Arcane" I keep the texture stylised and add three light spots (Figure 78).

I can now add the image texture to my model (Figure 79).

6.3.3 TATTOOS

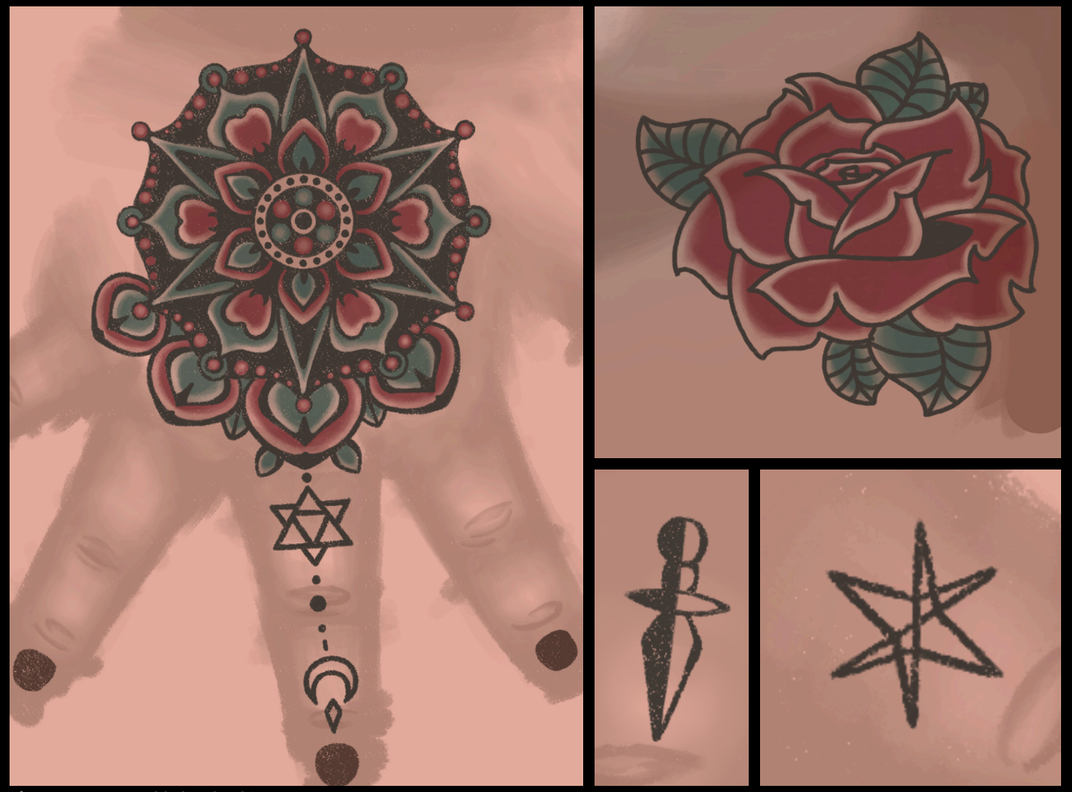

Figure 80 Tattoos added to the skin texture

Figure 81 Tattoos added to Blender

To match the character's style and add uniqueness, I include hand-drawn tattoos in the skin textures (Figure 80).

These tattoos are designed for the character's hands and neck and follow an old school tattoo style.

I use two colours to make them match. I then update the textures in Blender (Figure 81).

6.4 HAIR

To texture the hair, I use a material node setup in Blender to achieve the desired stylised look [8].

The final node setup (Figure 82) consists of three main parts. One part uses a Hair Info and Colour Ramp node to apply basic shading and root shadows to the hair (Figure 83).

Another part includes a Noise texture to add strands and create a painterly effect (Figure 84).

Finally, I include a Principled Hair BSDF node to achieve a rim light effect when rendering in Cycles (Figure 85).

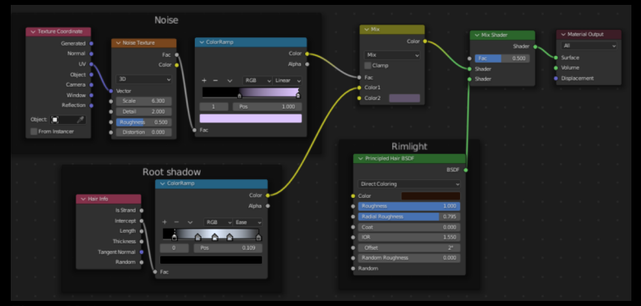

Figure 82 Hair node setup

Figure 83 Hair with basic shading and root shadow

Figure 84 Hair noise texture

Figure 85 Hair with rim light effect

6.5 CLOTHING

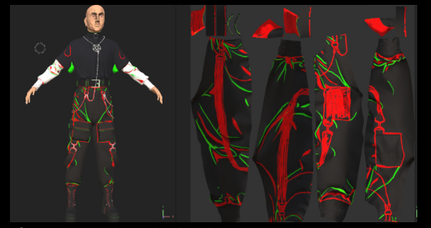

Figure 86 Clothing shading layout in Substance Painter

Figure 87 Clothing base colour with tinted texture

The next step is to texture the clothing. To achieve the desired stylised look, I concentrate on adding distinct highlights and shadows to the folds and seams.

To determine the placement of the highlights and shadows, I once again use Substance Painter (Figure 86). I use green and red to mark the areas for highlights and shadows.

Moving on to Krita, I start by adding a base colour. To add texture, I create a layer with a slightly different tinted colour and a transparent mask on top (Figure 87). Using Jazza's Pencil brush, I add texture by drawing softly on the mask. Masks make it easy to adjust the colour of the texture.

Figure 88 Shading added to the clothing texture

Next, I add the shadows and highlights, following the previously mapped areas (Figure 88). I again use masks. To make sure they are well placed, I keep adding the texture to my model in Blender.

To finish the texture, I add a few brighter highlights (Figure 89).

Finally, I repeat the same process to create an image texture map for each piece of clothing and add them to the Blender project (Figure 90).

Figure 89 Clothing texture with brighter highlights

Figure 90 Clothing texture added to Blender

6.6 METAL

Figure 91 Metal base colour

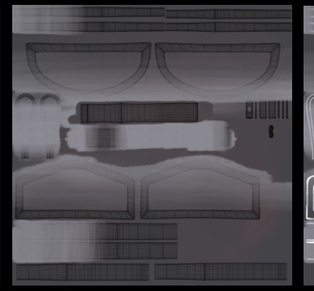

Figure 92 Basic shine

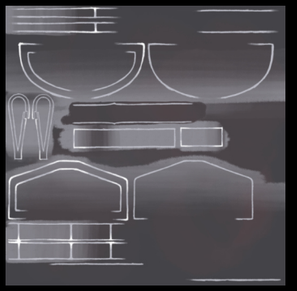

Figure 93 Highlighted edges

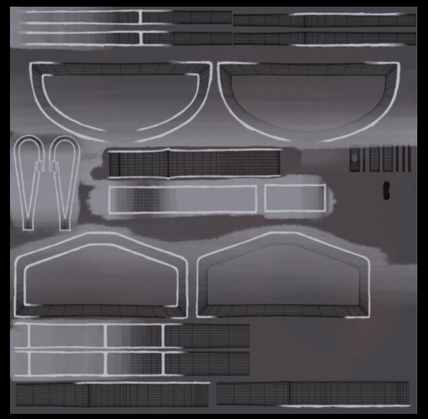

Figure 94 Brighter highlights

To texture the metal parts, I start by applying a grey base colour. Similar to the clothing texturing process, I use masks to create a red tinted texture on top (Figure 91).

Using the UV map exported from Blender as a guide, I start by giving the metal a basic shine (Figure 92).

Then I highlight all the edges (Figure 93). To enhance the metallic look and make the highlights stand out, I add brighter highlights to various areas that have already been highlighted (Figure 94).

Figure 95 Textured techwear outfit

Figure 96 Textured elegant outfit

Figure 97 Textured casual outfit

Using this approach, I create image textures for all the metal parts of my outfit and then add them to the model in Blender (Figure 95). I repeat the texturing process for the other outfits (Figure 96 - 97).

Rendering

07

To effectively present my character and showcase the different outfits I have created, I will be rendering him using Blender's rendering engine, Cycles. The goal is to create high quality renders that highlight each outfit.

7.1 RIGGING, POSING AND WEIGHT PAINTING

To create a visually appealing and interesting final render, I want to pose my character in different positions for each outfit.
I modelled my character in a classic A pose to simplify the process.
To achieve dynamic and appealing poses, I will rig, pose and weight paint the character accordingly.

7.1.1 RIGGING

Rigging means adding an armature to a character, consisting of movable bones that control the deformation of body parts [20].

To create poses, I will be rigging both my character and the outfits I have created.

To simplify the rigging process, I use Mixamo [21], a program that automatically rigs and weight paints character models. Mixamo also offers a variety of poses and animations to choose from.

To rig my character in Mixamo, I export the model without the hair as an FBX file from Blender. I then upload the FBX file to Mixamo, where I can place markers on the model to indicate where the joints are (Figure 98).

Once all the markers are in place, Mixamo automatically generates a rig for the model. I can check the rig and make any necessary adjustments to the markers.

With my character rigged in Mixamo, I can see the available animations and poses (Figure 99).

As I will be posing my character manually, I can choose any pose and continue.

I download the model from Mixamo as an FBX file with an animation that will later be removed in Blender.

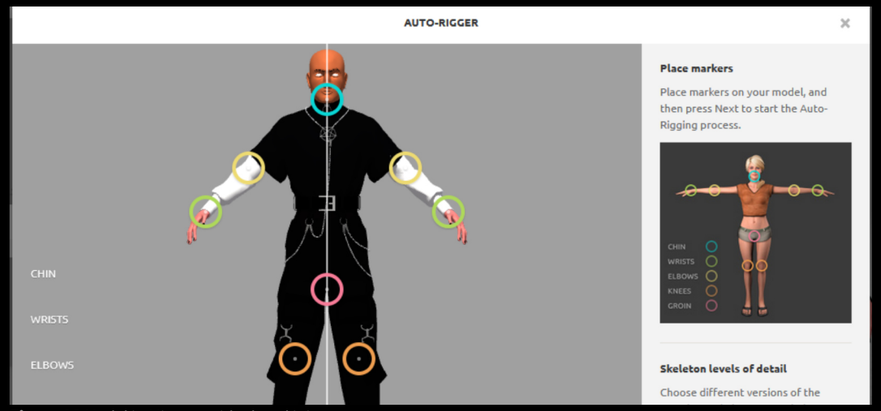

Figure 98 Model in Mixamo with placed joints

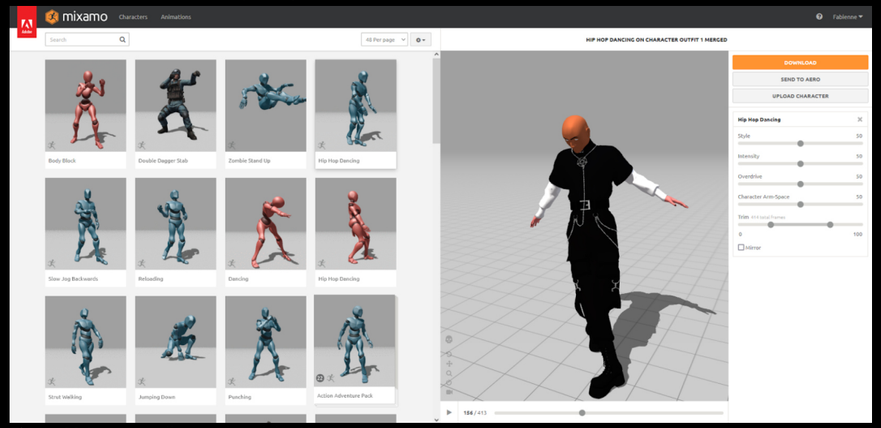

Figure 99 Automatically rigged model in Mixamo

Figure 100 Translucent model from Mixamo in Blender

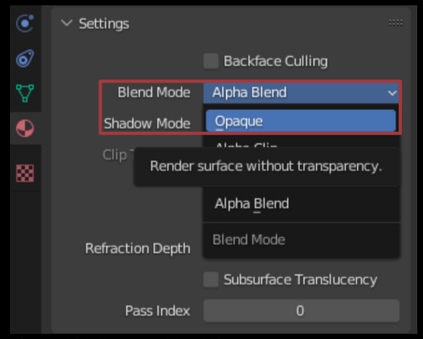

Figure 101 Changing Blend Mode

To get the FBX file with the rig into Blender, I create a new Blender file and import the FBX. Sometimes the imported FBX objects appear translucent (Figure 100), which can be easily fixed by changing the blend mode from alpha blend to opaque (Figure 101) in the material properties for each object [22].

Now I have successfully added the model with the rig from Mixamo to Blender.

7.1.2 POSING

The next step is to pose my character.
To prepare the rig for posing, I clear the animation keyframes and reset the pose (Figure 102).

I also add the hair to the armature by selecting all the hair, then the armature and going into pose mode.
From there, I select the head bone and parent the hair to it (Ctrl + P).

I then adjust the appearance of the armature bones to make them more visible.
To do this, I go to the data properties of the armature and display the bones as wired and show them in front (Figure 103).

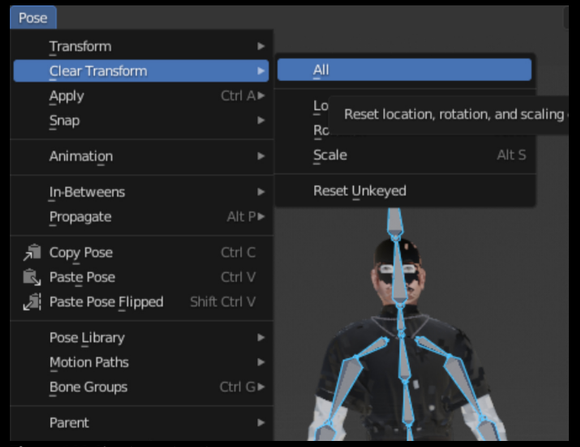

Figure 102 Clearing animation

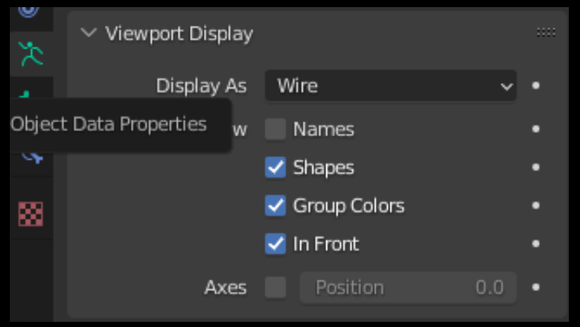

Figure 103 Armature properties

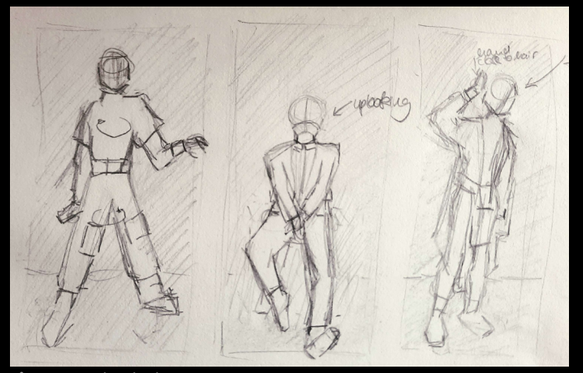

Figure 104 Sketched poses

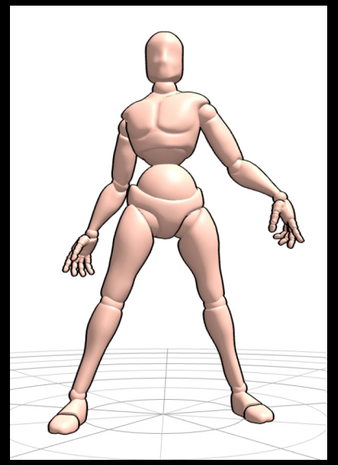

Figure 105 Pose in JustSketchMe

Figure 106 Pose in Blender

Moving on to the posing process, I start by sketching rough ideas for each outfit's pose (Figure 104).

To get a better understanding of the poses, I look for references that are similar to the sketches.

I also use JustSketchMe [23], a program that lets me rotate joints to visualise poses (Figure 105).
While JustSketchMe is primarily used as a reference tool for drawing, I find it helpful for understanding poses in 3D and quickly creating them.

With the help of JustSketchMe and various references, I can transfer the sketched poses to Blender (Figure 106).

7.1.3 WEIGHT PAINTING

Weight painting is the process of assigning parts of a model to specific bones in a rig. It determines how much a bone will influence the transformation of certain parts of the object.
In weight painting, blue means no transformation, while red means full transformation [24].

Although the Mixamo rig comes with pre-assigned weight painting, some areas require adjustment, such as the armpits (Figure 107) and solid objects like metal pieces (Figure 108).

To fix these areas, I manually adjust the weight paint. I select the armature, then the object I want to weight paint and go into weight paint mode.

I adjust the opacity of the weight paint for better visibility in the Viewport Overlays and start weight painting.
I select a bone (Ctrl + left click) and paint on the object using the paint brush and blend brush as required.
This process continues until any mis-weighting is corrected (Figure 109 - 110).

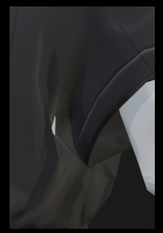

Figure 107 Mis-weighted armpits

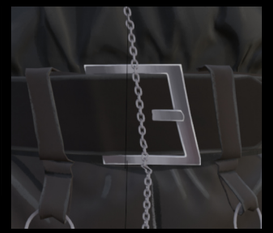

Figure 108 Mis-weighted belt

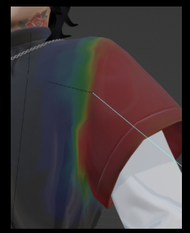

Figure 109 Corrected mis-weighted armpits

Figure 110 Corrected mis-weighted belt

Figure 111 Posed techwear outfit

Figure 112 Posed elegant outfit

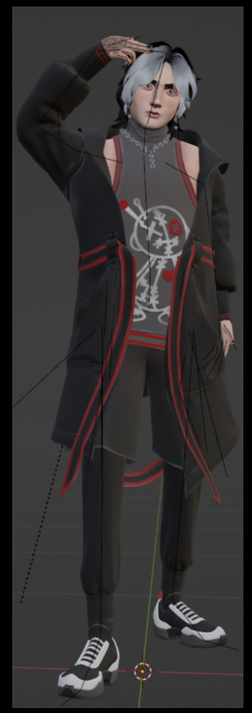

Figure 113 Posed casual outfit

I then repeat the same process for the other two outfits. For the second outfit, which is a seated pose, a stool is quickly created. Now I have a character wearing three different outfits, each with its own unique pose (Figure 111 - 113).

7.2 SETUP

Before rendering images of my character, I need to prepare the scene. This includes setting up for a frontal shot, a turntable animation, and close-up shots to fully represent the character. The key components of the setup are lighting the scene and positioning the camera .

7.2.1 LIGHT SETUP

To set up the lighting for my scene, I start by adding a light in front, keeping it simple to accentuate the textures (Figure 114). To do this, I use a dim white area light (Figure 115) positioned slightly above to brighten the scene.

Next, I add rim lights on either side of the character. This involves placing two spotlights behind and slightly above the character (Figure 116). To get a strong rim light, I increase the light intensity (Figure 117).

I want to create three different colour schemes with the rim lights for each outfit. The first will be blue and purple, the second green and yellow, and the third orange and red.

I adjust the colours of the spotlights accordingly to ensure that they complement each outfit individually, but still harmonise when the outfits are displayed together.

Figure 114 Light placed in front

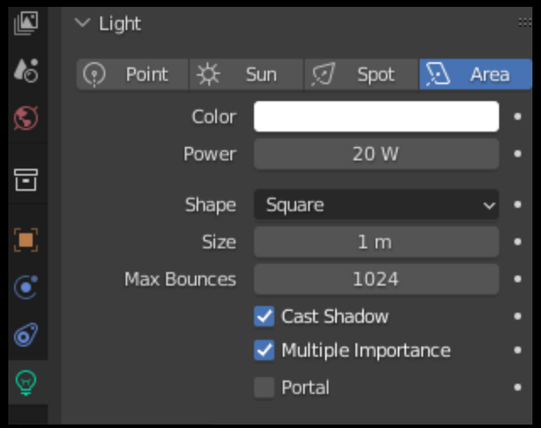

Figure 115 White dim light settings

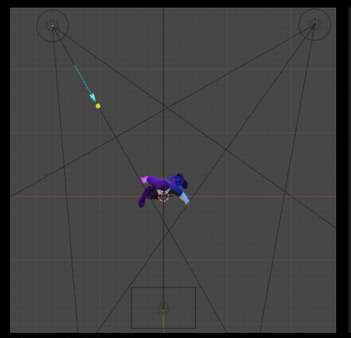

Figure 116 Rim lights placed in the back

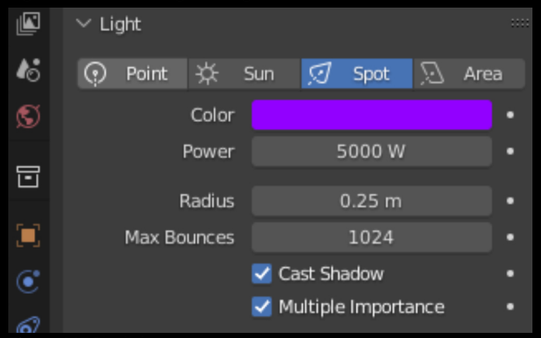

Figure 117 Rim light settings

7.2.2 SCENE SETUP

Next I set up the scene. First, I add a plane as a background and place it on the floor. I extrude the back of the plane and bevel the corner. I give the plane a black material with roughness set to one.

I decide to let the rim light hit the ground (Figure 118). This will allow the lights to illuminate the floor and add visual interest to the final render.

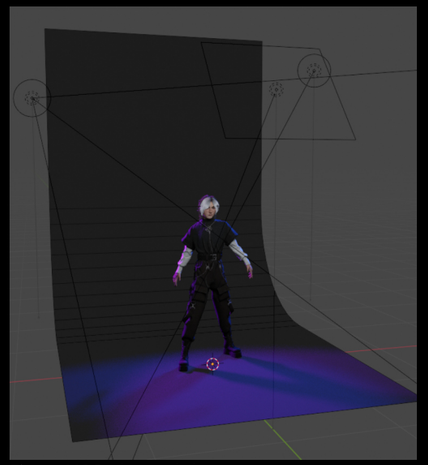

Figure 118 Background plane

With the lights and background in place, I continue to add cameras to the scene. I need one camera for the front view, one for the turntable animation and one for each of the close-ups.

Starting with the front view camera, I chose to make it upright with a resolution of 1920x4320px (Figure 119). I keep the focal length at 35mm (Figure 120), as it works well for body shots.

I position the camera directly in front of the character and tilt it up to create a slightly lower angle, resulting in a more heroic and visually appealing image (Figure 121 - 122).

Figure 119 Camera Resolution

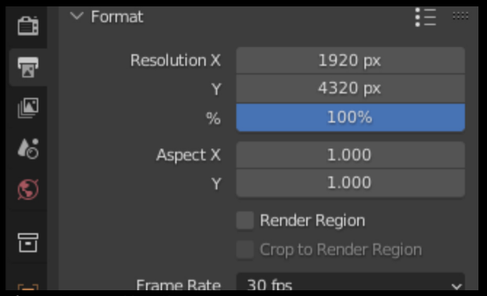

Figure 120 Focal length

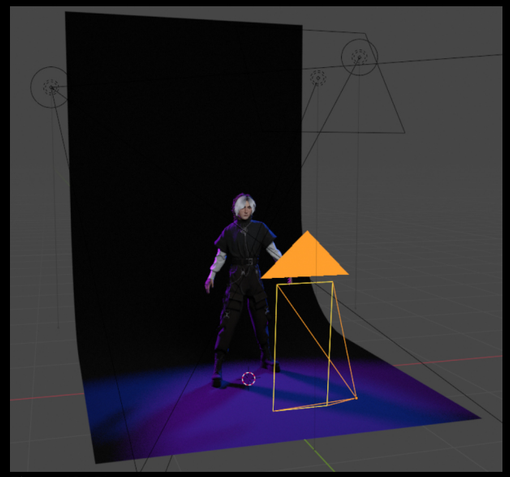

Figure 121 Placed camera

Figure 122 Camera perspective

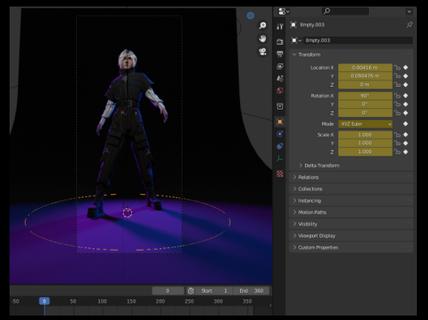

Figure 123 Turntable setup

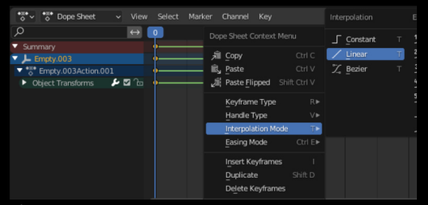

Figure 124 Interpolation mode set to linear

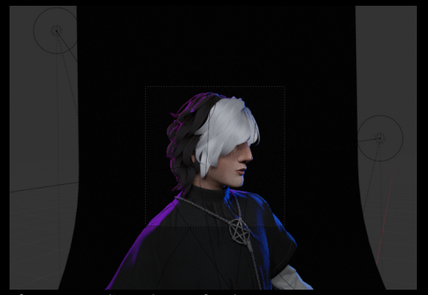

Figure 125 Adjusted setup for close-ups

For the turntable animation, I use the same camera as for the frontal shot.

Instead of rotating the character, I choose to rotate the background, lights and camera around the character. To do this, I parent them to an empty circle. By adding keyframes for rotation around the z-axis, from 0 degrees in the first frame to 360 degrees in the last frame (Figure 123), the setup will rotate around the empty circle and the character.

To keep the rotation at a constant speed, I set the interpolation mode to linear in Blender's Animation tab (Figure 124).

Finally, for the close-up shots, I use a square camera with a focal length of 85mm, which works well for portrait shots.

To position the camera and lights, I rotate the empty circle created for the turntable. Once the camera is roughly at the desired angle, I adjust its position and rotation, as well as the placement of the rim lights (Figure 125). I repeat this process for each detail I want to capture in a close-up.

7.3 RENDERING USING CYCLES

Figure 126 Render in Eevee

Figure 127 Render in Cycles

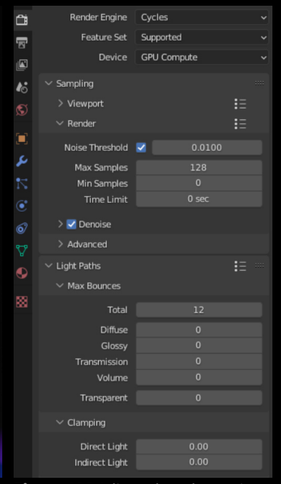

Figure 128 Adjusted render settings

Blender has two main render engines: Eevee and Cycles. While Eevee provides an estimate of light interactions, Cycles accurately calculates the behaviour of light [25].

To determine which render engine to use, I compare the results by rendering an image of my character in both Eevee (Figure 126) and Cycles (Figure 127).

Based on my evaluation, I choose to work with Cycles as it produces more depth.

I make some additional adjustments to the render settings (Figure 128) and proceed to render the body shots, turntable animation and close-ups using Cycles (Figure 129 - 134).

Figure 129 Techwear outfit turntable

Figure 130 Techwear outfit closeups

Figure 131 Elegant outfit turntable

Figure 132 Elegant outfit closeups

Figure 133 Casual outfit turntable

Figure 134 Casual outfit closeups

7.4 FINAL ARRANGEMENT

Figure 135 Graffiti inspiration Arcane

Figure 136 Music video of “sugar honey ice & tea” by Bring Me The Horizon

Figure 137 Music video of “Monday” by FRED

To complete and bring the renders together, I arrange the three outfits and add animated scribbles to make the presentation more appealing.

Inspired by the "Arcane" series (Figure 135) [1] and various music videos (Figure 136 - 137), I decide to animate the scribbles frame by frame using Krita.

In Krita, I first add the frontal renders of each outfit on a black background and frame them with borders that match the rim light colours of each outfit (Figure 138).

Then I draw and animate the scribbles on top of the renders, using the other rim light colour for the animations to keep the colours consistent and add an interesting touch.

To set up Krita for frame-by-frame animation, I activate the animation timeline and the onion skins dockers (Figure 139) [26].

The animation timeline shows which frame is currently being drawn.
If onion skins are active, the previous and next frames are also shown, the visibility can be controlled with the onion skins docker.

To complete the animation setup, I select the length of the clip and a frame rate (Figure 140). I choose a fairly low frame rate for a clunky animation to emphasise the frame-by-frame character.

Figure 138 Renders in Krita with added borders

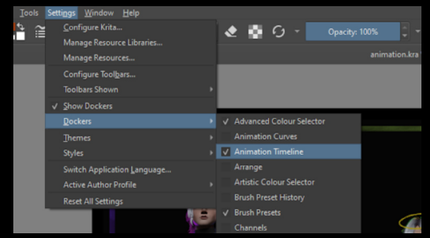

Figure 139 Setting up dockers for animating

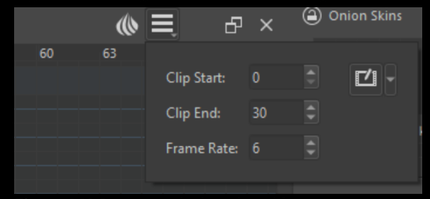

Figure 140 Setting up the length and frame rate

For the animations, I decide to have three different looping animations for each render, one being lines that move around and randomly appear and disappear, framing the character and outfits.

In addition, each render will have permanent and randomly appearing scribbles to keep the animation dynamic and captivating.

I start to animate the lines that move, expand and disappear around the character and outfits.
To do this, I create a new layer and add a blank frame to it (Figure 141).

Every time I want to draw on a new frame, I have to add a blank frame first.

To animate the lines, I start by drawing a short line (Figure 142).
Using the onion skins function, I draw a slightly expanded and moved line on the next frame (Figure 143).
I repeat this process until the line reaches the desired length (Figure 144).
I then let the line move around the outfit a little, and finally I shorten the line until it disappears (Figure 145).

I apply the same procedure to different parts of the outfits, adding lines at random intervals to create a dynamic effect. I make sure that the lines on the last frame continue on the first frame so that the animation loops seamlessly.

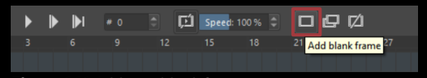

Figure 141 Adding a blank frame

Figure 142 Short line

Figure 143 Expanded

Figure 144 Desired length

Figure 145 Shortened line

Figure 146 Horn scribbles

Figure 147 Halo scribbles

Figure 148 Scribbles of effect around the hand

The next step is to animate the static scribbles. First, I sketch the designs, which include horns for the first outfit, a halo for the second outfit and an effect around the hand for the last outfit.

I animate the scribbles by tracing them frame by frame using onion skins (Figure 146 - 148).
This results in slightly moving scribbles.

Finally, I animate the elements that appear briefly and randomly on the image.
The first outfit has stars appearing on the metal parts and the second outfit has crosses appearing on the buttons.

To create them, I draw the scribbles in a small size on one frame. In the next frame, I increase their size, then rotate and finally shrink them.

The last outfit, with the voodoo puppet print, will have a grinning expression that blinks in and out. For this, I draw the grin on some random frames.

The final animation is rendered as a gif using an additional program called FFmpeg [27], recommended by Krita [28].
With FFmpeg integrated, I proceed to render the animation (Figure 149).

Figure 149 GIF

08

Conclusion and Outlook

Throughout this project, I successfully achieved my goal of creating a 3D character that met my expectations in terms of textures, cloth simulation, and rendering quality. The process of bringing a 2D concept to life has taught me a lot for future projects.
By creating three different outfits for my character, I was able to master Marvelous Designer, which allows me to create more outfits in the future.
My understanding of 3D character design, particularly in stylised texturing, has been deepened by creating high-quality textures by hand.
Additionally, my rendering skills have notably improved, especially in working effectively with lighting.

The main achievement of this project is the successful development of a fully realised 3D character. In addition, I have established a viable character creation process that can be replicated and built upon in future projects.

Looking ahead, I plan to further explore animation possibilities for the character, which would require refining the existing rig.
I also see the character's potential in video games. This would involve further optimising the character's geometry.
In addition, I see the possibility of designing more clothing styles to increase the character's versatility.
The clothing designs could replicate clothing from a brand and be used for their online store and promotions.
I also intend to improve the character's body model to allow for even more clothing design possibilities.

Appendix

09

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9.2 LIST OF IMAGES

Figure 1 References and moods in PureRef
Source: Own Picture

Figure 2 Face moodboard
Sources:
2.1 https://i.pinimg.com/564x/5b/18/fd/5b18fd84bb60e50f4c3b7c3640afba3e.jpg
2.2 https://i.pinimg.com/564x/57/54/0a/57540a219c6f08e7e8ff673fb3be2e5f.jpg
2.3 https://i.pinimg.com/564x/14/59/a5/1459a513bcfb8820edb09b023cadc726.jpg
2.4 https://i.pinimg.com/564x/88/1e/5e/881e5eb1e292d2c4edc0590638895d52.jpg
2.5 https://i.pinimg.com/564x/f4/33/91/f4339174617bd185a0074bd22fee5eea.jpg
2.6 https://i.pinimg.com/564x/34/b1/57/34b1570886b8888ddad7ac3acadffaa4.jpg

Figure 3 Techwear outfit moodboard
Sources:
3.1 https://i.pinimg.com/564x/75/ac/ce/75acce401bde43bc58dc10b557bc912a.jpg
3.2 https://i.pinimg.com/564x/2f/92/9e/2f929e530cbb03d4bd64b06555b6ab95.jpg
3.3 https://i.pinimg.com/564x/eb/d8/f6/ebd8f67749ed8134310b5b19d907bbe2.jpg
3.4 https://i.pinimg.com/564x/64/12/ab/6412ab74f7652781bbe93ce550459709.jpg
3.5 https://i.pinimg.com/564x/41/1f/87/411f87e79326d63231ef9fa37a9e1abb.jpg
3.6 https://i.pinimg.com/564x/4b/4a/9b/4b4a9be97f0c05764502bf254b0e2ba6.jpg

Figure 4 Elegant outfit moodboard
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4.3 https://i.pinimg.com/564x/96/8d/42/968d42408e6ea0aa9a7f51934c77707b.jpg
4.4 https://i.pinimg.com/564x/b4/3f/a9/b43fa971f3a0c39b3f0b820d92f1ecf8.jpg
4.5 https://i.pinimg.com/564x/b6/fc/0a/b6fc0a369fbd37fac60f26c1e311666f.jpg
4.6 https://www.tower-london.com/cdn/shop/products/drmartens_27818.jpg?v=1682332147&width=800

Figure 5 Casual outfit moodboard
Sources:
5.1 https://i.pinimg.com/564x/5a/87/12/5a871207bbb9213ab4a8521b142946f7.jpg
5.2 https://shorturl.at/advHY
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Figure 6 Face and body sketch
Source: Own Picture

Figure 7 Techwear outfit sketches
Source: Own Picture

Figure 8 Elegant outfit sketches
Source: Own Picture

Figure 9 Casual outfit sketches
Source: Own Picture

Figure 10 Final techwear outfit sketch
Source: Own Picture

Figure 11 Final elegant outfit sketch
Source: Own Picture

Figure 12 Final casual outfit sketch
Source: Own Picture

Figure 13 Symmetrically modelled face
Source: Own Picture

Figure 14 Asymmetrically modelled face
Source: Own Picture

Figure 15 Body model
Source: Own Picture

Figure 16 Hair particle system on a plane
Source: Own Picture

Figure 17 Hair shape type strip
Source: Own Picture

Figure 18 Number of hairs set to one
Source: Own Picture

Figure 19 New hair added
Source: Own Picture

Figure 20 Children set to interpolated
Source: Own Picture

Figure 21 Clump Curve
Source: Own Picture

Figure 22 Strand Steps
Source: Own Picture

Figure 23 Adjusted plane
Source: Own Picture

Figure 24 Plane shape changed
Source: Own Picture

Figure 25 Placed Hair
Source: Own Picture

Figure 26 Hair with thin strands
Source: Own Picture

Figure 27 Creating fingernails
Source: Own Picture

Figure 28 Nails accurately positioned
Source: Own Picture

Figure 29 Modelled eyebrows
Source: Own Picture

Figure 30 Modelled shoes
Source: Own Picture

Figure 31 Model imported to Marvelous Designer
Source: Own Picture

Figure 32 Garment patterns
Sources:
32.1 Harumi Maruyama. Oberteil-Grundschnittvariationen. 3rd ed., stiebner, 2022, p.63.
32.2 https://www.muellerundsohn.com/app/uploads/2021/07/Hemd-Regular-Fit-Schnitt.png
32.3 https://www.fashionmakery.com/wp-content/uploads/2016/04/Hose_Konstruktion-510x716.png
32.4 https://www.muellerundsohn.com/app/uploads/2018/12/Sakko-mit-Schalkragen-naehen.png
32.5 https://www.muellerundsohn.com/app/uploads/2019/03/1_Cargo_Hose_1.png
32.6 https://www.schnittmuster.net/media/image/product/20033/lg/schnittmuster-berlin-damenmantel-luzie~5.jpg

Figure 33 Pattern with sewing
Source: Own Picture

Figure 34 Particle distance setting
Source: Own Picture

Figure 35 Simulated clothing
Source: Own Picture

Figure 36 Fabric property editor
Source: Own Picture

Figure 37 Freeze tool
Source: Own Picture

Figure 38 Strengthen tool
Source: Own Picture

Figure 39 Layered clothing
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Source: Own Picture

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Source: Own Picture

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Source: Own Picture

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Source: Own Picture

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Source: Own Picture

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Source: Own Picture

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Figure 54 Bake settings
Source: Own Picture

Figure 55 Low-poly mesh with detail
Source: Own Picture

Figure 56 High-poly vs. low-poly mesh
Source: Own Picture

Figure 57 Arcane
Source: https://m.media-amazon.com/images/M/MV5BYmU5OWM5ZTAtNjUzOC00NmUyLTgyOWMtMjlkNjdlMDAzMzU1XkEyXkFqcGdeQXVyMDM2NDM2MQ@@._V1_FMjpg_UX1000_.jpg

Figure 58 2D artwork inspiration
Source: Josiah “Jazza” Brooks and Alysha Lowery. Jazza’s Ultimate DIGITAL PAINTING HANDBOOK. 2023, p.99

Figure 59 2D artwork inspiration
Source: https://i.pinimg.com/564x/a2/35/13/a23513eeab79382e0d17156ec4caf61f.jpg

Figure 60 Face UV map
Source: Own Picture

Figure 61 UV map with several parts
Source: Own Picture

Figure 62 Display Stretch option
Source: Own Picture

Figure 63 Node setup for the materials
Source: Own Picture

Figure 64 Basic light setup
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Figure 65 Rough face shading layout
Source: Own Picture

Figure 66 Face shading layout added to Krita
Source: Own Picture

Figure 67 Undertones for the facial skin
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Source: Own Picture

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Source: Own Picture

Figure 71 Face texture with lips added
Source: Own Picture

Figure 72 Blended facial shadows and highlights
Source: Own Picture

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Source: Own Picture

Figure 74 Face texture added to Blender
Source: Own Picture

Figure 75 Eye layout
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Figure 76 Blocked in colour
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Figure 77 Blended eyes
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Figure 78 Light spots
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Source: Own Picture

Figure 80 Tattoos added to the skin texture
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Source: Own Picture

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Figure 92 Basic shine
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Figure 93 Highlighted edges
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Figure 96 Textured elegant outfit
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Figure 97 Textured casual outfit
Source: Own Picture

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Source: Own Picture

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Source: Own Picture

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Figure 108 Mis-weighted belt
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Source: Own Picture

Figure 112 Posed elegant outfit
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Figure 113 Posed casual outfit
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Figure 133 Casual outfit turntable
Source: Own Picture

Figure 134 Casual outfit closeups
Source: Own Picture

Figure 135 Graffiti inspiration Arcane
Source: Own Picture

Figure 136 Music video of “sugar honey ice & tea” by Bring Me The Horizon
Source: https://youtu.be/-iM83TiKdY0?t=36

Figure 137 Music video of “Monday” by FRED
Source: https://youtu.be/4DAYRt49Pmw?t=25

Figure 138 Renders in Krita with added borders
Source: Own Picture

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Source: Own Picture

Figure 147 Halo scribbles
Source: Own Picture

Figure 148 Scribbles of effect around the hand
Source: Own Picture

Figure 149 GIF
Source: Own Picture

9.3 STATUTORY DECLARATION

I declare that I have authored this thesis independently, that I have not used other than the declared sources / resources, and that I have explicitly marked all material which has been quoted either literally or by content from the used sources.

Weingarten, 07 August 2023

Ort und Datum

Signature