Tampere University of Applied Sciences

The Process of Modelling and Animating a Stylised 3D Video Game Character

Jirko Haapapuro

BACHELOR'S THESIS
November 2022

Degree Programme in Media and Arts
Interactive Media

ABSTRACT

Tampereen ammattikorkeakoulu
Tampere University of Applied Sciences
Degree Programme in Media and Arts
Interactive Media

HAAPAPURO, JIRKO:
The Process of Modelling and Animating a Stylised 3D Video Game Character

Bachelor's thesis 40 pages, of which appendices 1 page
November 2022

Stylised game characters are different to realistic characters from the way they look and act. This thesis went through every work phase needed from designing to animating a stylised video game ready character and the things that needed to be considered while doing so. Every chapter holds a theory part, and those theory parts were applied to an original character that was created. This information can be used while creating characters.

Character creation went without any problems, and the information gathered was a crucial part in making the character fit into their fictional world. The character was also kept easily readable to the viewer. It was found that extra steps needed to be taken to make the character able to have stretchable bones inside game engines, and a solution for this was found from an addon, which was used to make this possible.

The thesis topic is broad so further information on the topic would be useful to acquire. Information like proportions, color theory, shape language, and animation principles were presented in this thesis. Skills like sculpting, baking, texturing, rigging, and animating among others were practiced in the thesis creation process. The Unity engine, and the world around the character, were not in the scope for this thesis even though they do play an important role in the game character creation.

Key words: stylised character, game character, 3d model, animation, character design

CONTENTS

ABBREVIATIONS AND TERMS

Archetype	Archetypes are like roles for characters which define how they generally behave.
Baking	Takes information from a 3D mesh and turning it into a texture map.
Blender	A 3D software.
Blend shape	Deforms 3D mesh from one shape to another, while possible to define how much deformation is happening.
Bézier curve	Bézier curves are a specific type of objects consisting of control points placed in a 3D space. They can be shaped using handles.
Box modelling	3D modelling technique where the modelling process is started with primitive low polycount shapes and adding more details and polygons when needed.
High poly	A mesh containing lots of polygons which is being used in the baking process where its details are being transferred to a low poly mesh using a texture map.
Low poly	The receiver in the baking process. This kind of mesh can be used when making games and animations. It has significantly less polygons than high poly.
NLA	Nonlinear animation. Animations in Blender can be turned into actions which can be manipulated in the NLA editor by organizing multiple different actions together.
Polygon	3D objects are made from polygons that cover all the surface areas. The outer area of a polygon is made from straight edges. And those edges are made from vertices that are at the ends of each edge.
Retopology	With retopology, a mesh with a high polycount or a bad topology can be simplified to have a low polycount and a clean topology which can be used in animation.
Rigging	A process where virtual bones are placed inside a character or object so it can be animated.

Stylised	Making a character or object stylised can be done to make it more appealing and expressive away from realism.
Substance Painter	A software used for texturing 3D models with the use of different materials and brushes.
Topology	It refers to a 3D object's structure and the way its polygons are placed.
Unity	A game engine.
UV unwrapping	A process of adding seams onto a 3D mesh so the surface area of the mesh can be flattened into 2D space.
Weight painting	Done to define what bones mesh's surface areas influence and how much.

1 INTRODUCTION

The thesis goes through the process of designing, modelling and animating a stylised 3D character and what things have to be taken into account in the different parts of the process. Also, the character and its animations are brought to Unity to see that they work. The thesis goes through every part of the process one by one from the theoretical standpoint and applies them to a character that is being worked on throughout the thesis. With the use of things like character's background information, shape language, color theory, values, and the basic animation principles to design a character that can be used inside a game engine. This information can be taken to create and animate own characters.

Blender was used for sculpting, modelling, UV unwrapping, rigging, and animating. Blender is a free software used for all sort of media production and it is aimed for individuals and small studios (Blender 2022a). Substance Painter 2018 is used for baking and texturing. The latest version of this software is called Adobe Substance 3D and it is an industry standard texture painting software from realistic to stylised needs. (Paint in 3D…). And lastly Unity was used just enough to see that the animation clips work inside of it. Unity is a 2D and 3D game engine with a large community behind it (What is Unity?...).

2 DEFINING A CHARACTER'S LOOK

2.1 Stylisation of a character

There are realistic and stylised character designs. In stylised character design, the way characters look and move does not need to follow realism. George Maestri (2006) says that people are more likely to accept unrealistic looks and movements if a character does not look photorealistic. But this does not mean the characters should not be visually interesting or move like they are not living beings. They live in their own world with their own rules which for them is very much alive and the audience should see it. Realistic means it could belong in our world, but there are also technical limitations.

As technology moves forwards character design over the years start to look less realistic as we can put more details onto characters with lightings and materials that follow realism. You could even say that the older designs that used latest technological advancements in their time, are looking stylised. (Aava 2017.) So, this split into realism and stylisation is not so black and white.

2.1.1 Character's background information

There are different levels of stylisations, and it really is about personal taste and the amount of effort wanted to put into it, what kind of character is made. But this choice also affects the world around them, so they fit together. (Maestri 2006, 9). Is it simple, hyper realistic or something between. All of them can be made to look stylised. You can make a realistic human character stylised by affecting the proportions of the body, using stylised textures or using different visual methods. Stylisation is about taking a character and highlighting features such as color and shape that are important about that character. But also taking out features that are not important to simplify them. (Aava 2017). There are also technical limitations. Looking back to video games from 30, 20 or 10 years ago and they look very different from today, apart from games that are intentionally made to look like they are from those eras. Even today technical limitations influence what kind of games are made on what kind of game platforms. As an example, mobile

phones are not generally as powerful gaming platform as PCs. With new technologies, new ways to stylise open for video games to use.

Before starting drawing and designing the look of a character it must be thought through which kind of media the character is in and what is the target audience of the character and any other important things that might affect the look of the character. Those important features to their appearance and the way they act can be then implemented into them.

A fictional male character for a video game was chosen for the thesis project. It is a stylised single-player adventure game for a casual audience aged seven and older. It has a top-down perspective where the main character runs around and punches and kicks enemies.

PICTURE 1. Screen capture to show a game's camera's perspective (Oceanhorn: Monster of Uncharted Seas, Cornfox & Brothers Ltd., 2013)

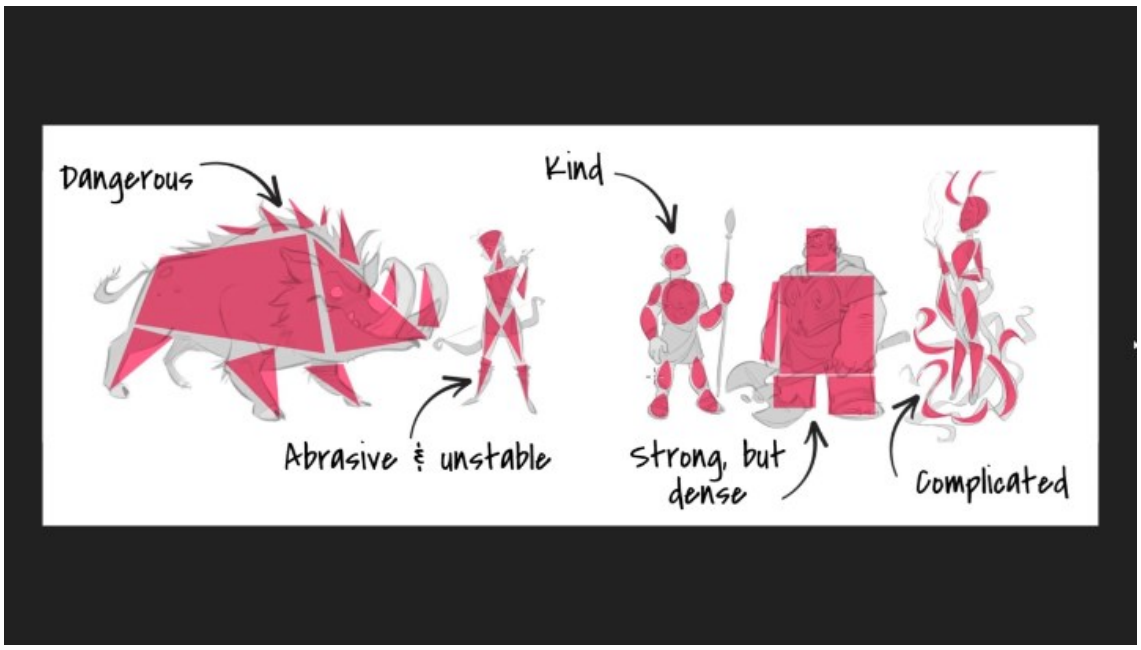
The game I'm imagining would have similar camera to Oceanhorn (Picture1). The game would also include simple puzzles for the player to solve. All of these should be taken into account when designing the character.

Archetypes give a starting point for making a character, as they are like customizable templates for making personalized characters. And even though

two different characters start from the same archetype, they can be vastly different from each other. (Lebowitz & Klug 2012, 81). When writing a character's background, you can use these different archetypes to quickly narrow their essence into something simple and consistent. You can also look into other characters that use that same archetype to take a note how they acted in their own story. Or how they even could have changed from one archetype to another. Use this information to create your own character with your own little twists. For the thesis project, the character was wanted to be kept simple. The young hero archetype was chosen. It is a cliché and well used, but the viewer can easily see that they are young, enthusiastic and want to help others. Also, the game's age group makes it easy for the viewer to identify with those qualities and look up to him. (Lebowitz & Klug 2012, 81–82, 84–85). From this starting point too many things are not locked in so it is easy to develop the character and their backstory into something more memorable and interesting if there is a need for that.

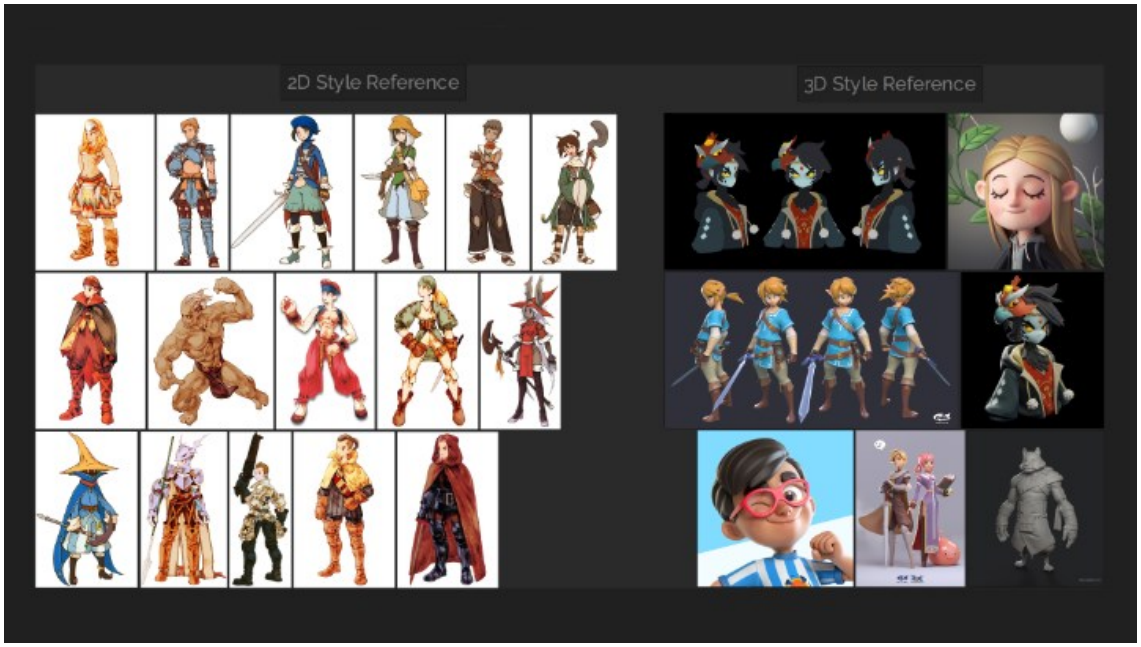
2.1.2 Shape language

To make a stylised 3D character you have to think about the basic 2D shapes, as that is the starting point. That is called shape language. Shape language is about using familiar, simple, shapes to form a character or move a character. The goal should be to use these shapes to make something visually appealing and easy to read. And the thing about stylised characters usually is, that you can easily see what they represent. Are they, for example, good or bad, lazy or energetic. You can use these simple shapes to make them seem like that or trick the viewer to think that they are something that they are actually not. (The Walt Disney… n.d., 1–5.)



PICTURE 2. Shape language (Sauer's Virtual Art Room, YouTube 2020)

From the picture (Picture 2) it is possible to see the use of these basic shapes to bring out what a character represents. Round is perceived as kind, square is perceived as strong, and triangle is perceived as dangerous or even smart (The Walt Disney… n.d., 5).



PICTURE 3. References gathered and split into 2D and 3D. 2D style references consist of Final Fantasy Tactics game character concept arts. 3D style references consist of different 3D artists.

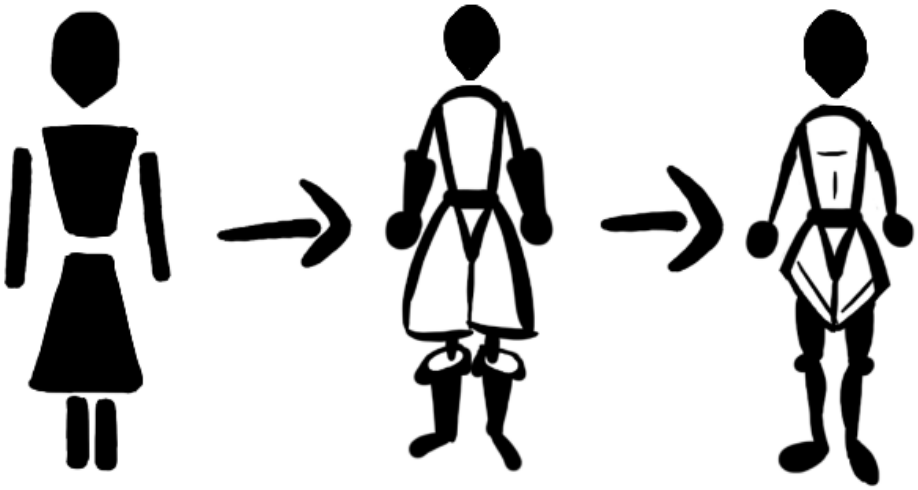


FIGURE 1. A picture of basic shapes used in the project and how it changed when more was drawn

For the main look of the thesis' character, a character concept art from different Final Fantasy Tactics games were chosen. This was kept up when thinking about the clothes, colors, proportions etc. but it should not hold back from creating an interesting character design. With the use of square and triangular shapes it was highlighted that he is strong and smart.

2.1.3 Proportions

When thinking about character's proportions, there is different things that have to be considered. Should they have realistic or exaggerated proportions? As even in realistic human proportions the younger a human is, the bigger their head is compared to the rest of the body. What about their age? Or camera angle, need for facial expressions, or characters' scale for the rest of the world? (Sivers 2016). If for example the character is small on the screen, then there is a need to think about how to get the most out their design. There is no need to even make facial features if they are not seen. And these things were taken into account in the thesis project. The camera angle is from top-down and the character is fairly small on the screen just like in Oceanhorn (Picture 1). That means there is no need for small details or even a detailed face as the camera angle almost always shows

the character at an angle. And the focus goes into making their overall appearance interesting to look at.

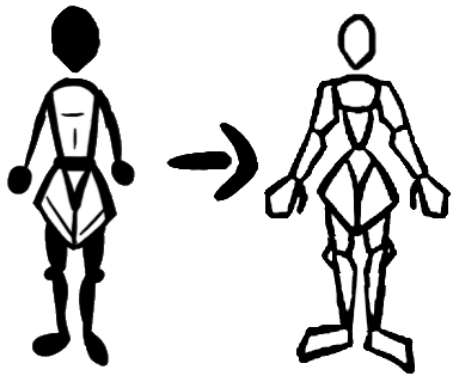


FIGURE 2. A picture how character's proportions were adjusted to bring more interest to it

At this stage the character design was taken even further away from realism. The body and the head were kept fairly small and his strength was highlighted by making arms and legs thicker as those are the ones he would be using for fighting.

2.1.4 Silhouette

A good silhouette makes a character recognizable in any lighting condition. This is especially important in multiplayer games where you need to instantly recognize characters from others.

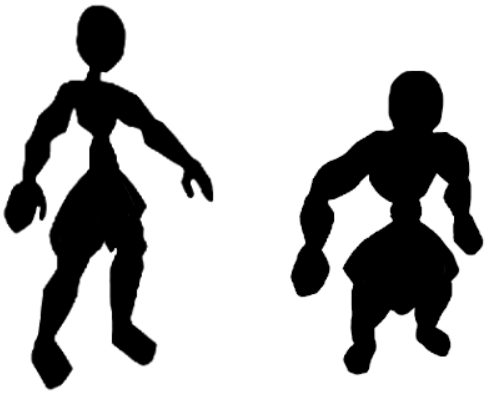
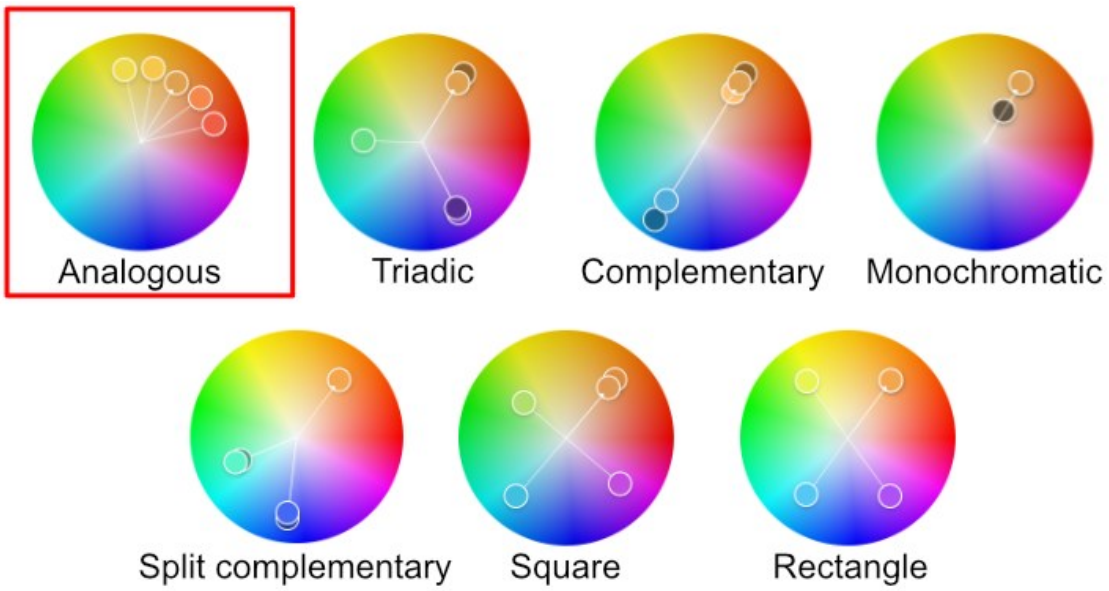


FIGURE 3. Silhouette pictures drawn from side and top

For the thesis' character this was not as important because firstly, it is a single-player game. And secondly, the character might even be the only human in the whole imaginative game. But there is one important feature the use of good silhouette brings. And that is the direction which the character is facing. (Dota 2 Workshop… n.d.). For a game where you are supposed to beat enemies up, it is important to know you are actually facing them straight on before attacking. So, the character's overall readability is extremely important even though it is a single-player game.

2.1.5 Color and value

When making a character, knowing the basics of color theory is useful for making good color combinations. With a color wheel there are seven major color schemes you can make: Analogous, triadic, complementary, monochromatic, split complementary, square, and rectangle.



PICTURE 4. Seven major color schemes. The one used for the thesis project's character has been highlighted (Adobe Color 2022, modified)

Using one of the color schemes makes a good starting point for colors. The idea is not to use all the chosen colors equally as it is better for the eyes to have some colors used to highlight parts. (Fanguy 2020).

PICTURE 5. The use of color and value in the characters of Dota 2 (Valve Corporation n.d., modified)

From the picture (Picture 5) it is possible see how the colors for the Dota 2 characters were chosen and how much each of them were used on that character (Picture 5). There is also a picture of the use of value right side of it. The higher parts of a character are lighter and lower parts darker in a gradient manner. That

is used to create depth as in the game the characters are viewed from top to bottom, and everything would look extremely flat if the game did not use value to differentiate higher parts from lower parts (Dota 2 Workshop… n.d.). The camera angle is similar to thesis' project's fictional game, so this is useful to keep in mind while texturing its character. The other thing for creating interest and increase readability is to use value patterning. It is about separating characters' different parts, such as a hat, hair, limbs etc. and giving them different values. It creates contrast between them, so they are easier to differentiate from each other. (Dota 2 Workshop… n.d.).

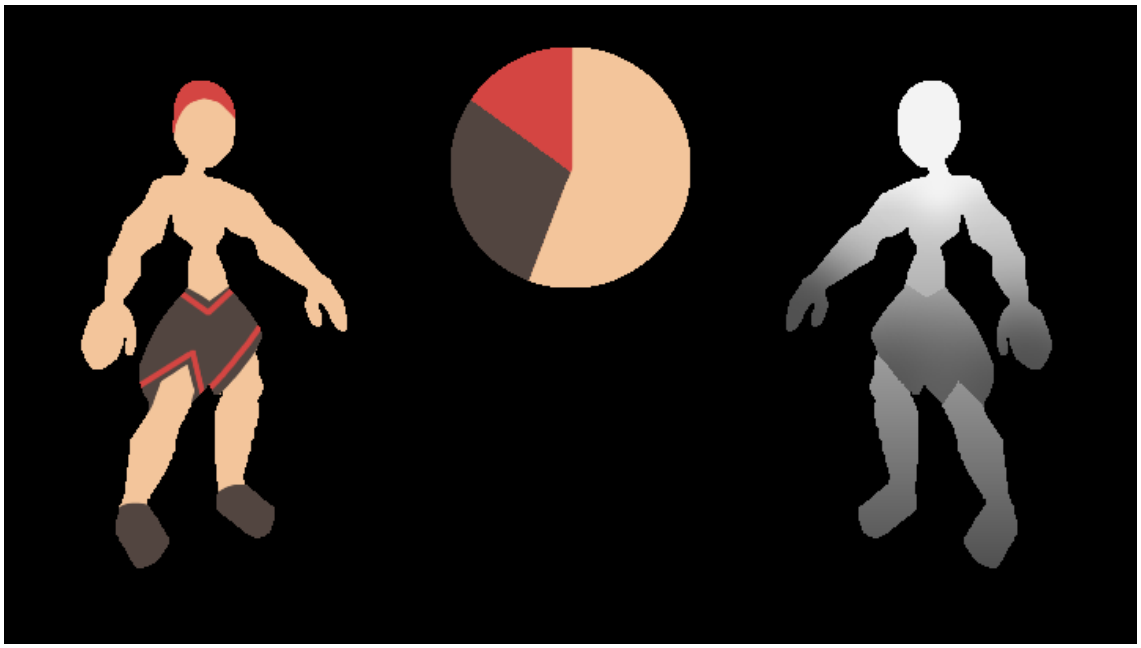


FIGURE 4. The colors and values chosen at this stage and how they were used to differentiate different parts

Analogous color scheme (Figure 4) was chosen to use in the thesis project's character with these chosen colors (Figure 4). Brown is the main color as it is the color of the skin and the character will show a lot of it. Darker brown/black for the pants and red for the hair and highlights as it evokes the feeling of danger. But nothing is set in stone as the colors need to be seen on the actual 3D character and see how they really fit him. Orange or yellow might also be good colors as they are about positivity and that really fits for the character. (Fanguy 2020). All those colors are in the ballpark of analogous color scheme so the final judgement will be made when eventually the texturing process for the 3D character starts. On the right side you can see the use of values (Figure 4). There is no clothes or

armor to differentiate arms from torso, so gradients are used. All of this might change if more elements are chosen to change things up.

Going with a combination of browns and reds is good because of another thing, the environment. If the environment consists of natural elements such as green grass and blue water, it creates a nice split complementary between the character and environment which makes the character easy to see. This can and should be combined with a difference in value and saturation with the hue difference between the character and the environment to further increase the readability. For the enemies, one of the colors which is rarely seen in nature, apart from plants, could be used, which is purple. This kind of way of using color makes everything easy to see if it is wanted to make extra sure that everything is as readable as possible. Though, taking advantage of the whole spectrum of colors might not always be possible with specific art styles.

3 CONSTRUCTING A STYLISED 3D CHARACTER

For modelling, rigging, animating, and rendering the character, Blender was chosen for its superb tools that make it possible to do all these steps, and much more, easily and free. Blender also gets updated regularly with new features and to make its existing features even quicker. For baking and texture painting Substance Painter was chosen even though it is not free, its workflow was already familiar. It has also become the industry standard, and it is not only great for realism, but stylisation too (Paint in 3D…).

With the use of already made sketches, the plan is to build the character's overall shape and work on the details after. The sketches do not have details, such as how the face looks like, but it is not a problem as it is fine to define those details during the sculpting phase. And as a fictional character that has not been made yet, there is freedom the make them look however the sculptor feels like. So, the previously defined features will be kept in mind but changes will be made whenever there is a need.

3.1 Modelling inside Blender

3.1.1 Sculpting

The sculpting process was started by adding basic shapes to the 3D scene for every major part of a human body. With the use of Blender's modifiers, especially the mirroring and subdivision surface modifiers on a low poly object, sculpting brushes could be used to start editing those parts. With the mirror modifier, a completely symmetrical character can be constructed. And with the subdivision surface modifier those low poly count objects look smooth but are still easy to edit so the proportions can be quickly adjusted to match the silhouette. At this point the clothes will be outside the sculpting process as they need a good base to be modeled onto later.

PICTURE 6. The character in the early stages. It is possible can see how different parts of the body are split.

Grab brush was used a lot as it is great for making the shapes needed. Edit mode helps too if some pieces need to be moved, rotated, or scaled around. The character was posed in a basic A-pose, where the arms are pointing at an angle downwards, so it will be easy to rig and there will be minimum deformation on the shoulders when the arms are in a resting pose on the sides. The other common pose that is used is called T-pose, where the arms are making a straight horizontal line. This might be better if the character would need to stretch its hands over its head and do more extreme poses that are not usually needed. After the parts looked good how they were scaled, positioned, and so on, the modifiers were applied, joining the object as one. Then with the Remesh tool with low enough voxel size a more detailed sculpting process was started. A low voxel size means that there are going to be more polygons on the mesh which then can be sculpted into smaller details.

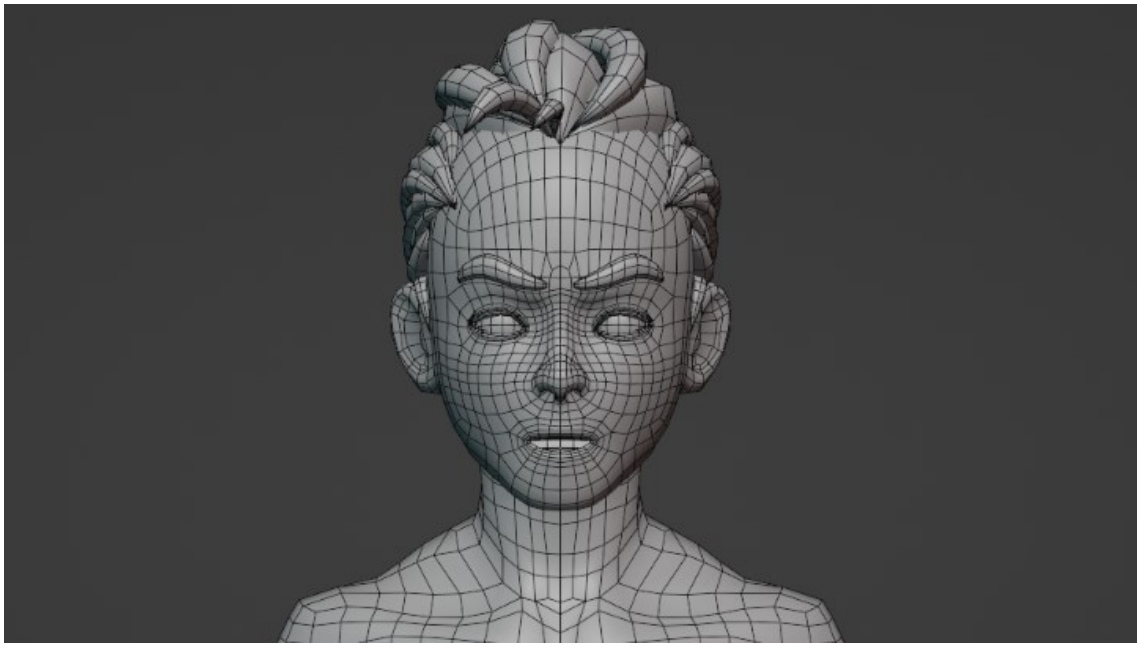
PICTURE 7. Sculpted high poly version of the character's body. All the parts of the body are combined as one.

Hands and feet showed to be problematic as fingers are so close together as are also toes. Hands and feet were kept as their own parts, and also every finger and toe. They were eventually joined together with low enough voxel size in the Remesh tool so they were not accidentally joined together in places where they were not meant to join, such as the sides of the fingers.

A lot of reference images were used for sculpting the muscle definition. Even though it is not completely needed for the character to look real and natural, it is still needed to know how muscles and bones work, or how long or big areas of a body are. If not, things would quickly start to look wrong. For the sculpting process a lot of the Grab brush was still used but also the Clay strip brush for creating volume. Crease, Scrape, and Pinch brushes were used to create those sharp edges around the body. And one brush that was definitely used the most was the Smooth brush to get rid of any bumpiness.

3.1.2 Low- and high-poly

After a finished sculpted mesh was made, it was time to move into making the low polygon version with a good topology. The low poly version of the mesh is needed to make the character less heavy to use by different programs and make the character easier to deform when animating it. With a good topology the character can move and bend while still looking correct with a minimum amount of unnatural deformations (Villar 2017). The details that the high poly version of the character has will be later placed on top of the low poly version with the use of baking. For the creation of said low poly version of the sculpted mesh, RetopoFlow addon was used. A tool which was made by Jonathan Denning, Jonathan Lampel, Jonathan Williamson, Patrick Moore, Patrick Crawford, and Christopher Gearhart.



PICTURE 8. Retopolized character

For the shorts, and smaller objects such as eyes and eyebrows, box modelling with different modifiers was used to make them. This was a good choice as they were fairly simple and with this way, a good topology could be kept straight away, so there was not any need to retopologize them. One new thing that was used was a multiresolution modifier to keep a high poly version of the shorts as the same object as the low poly version compared to the body where the high poly and low poly versions are going to be different objects. For the hair a completely

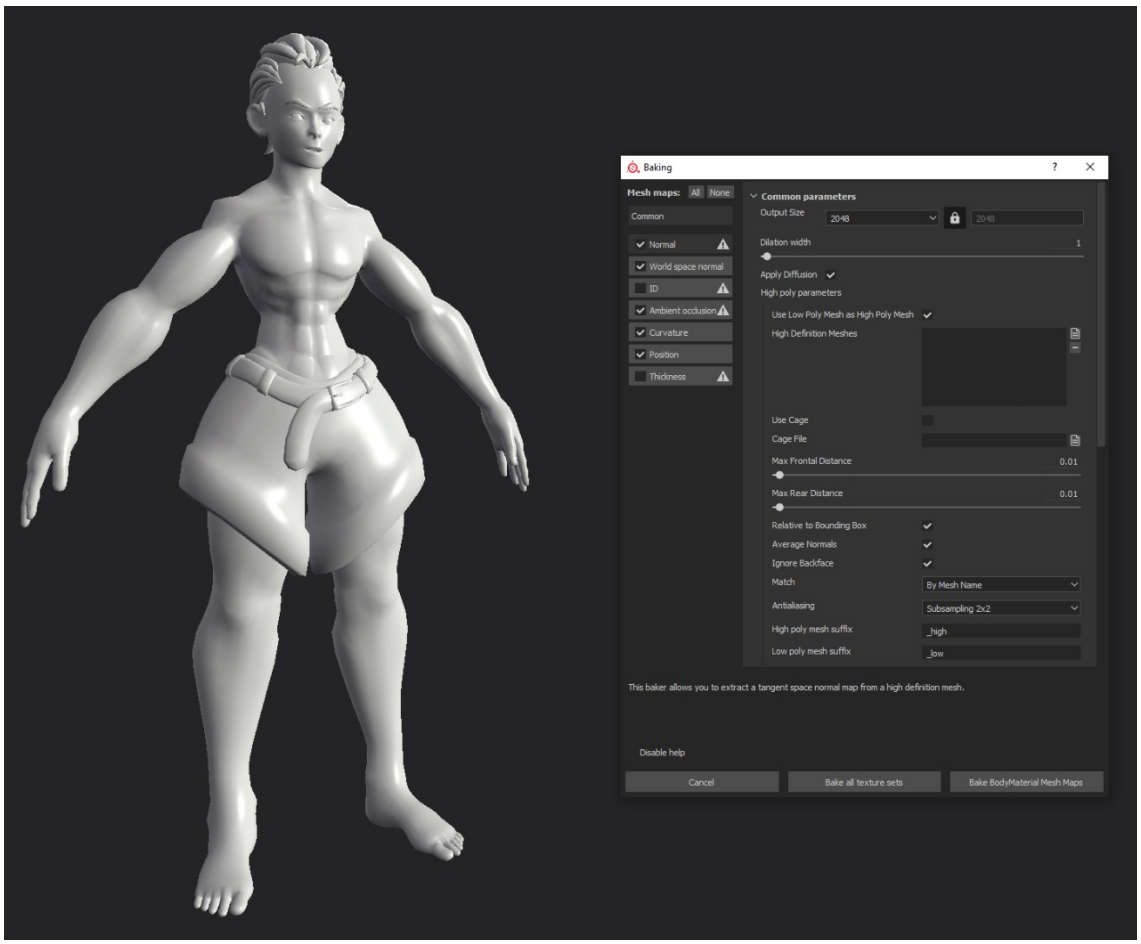
different method was used and curves were used to make them. With curves a low resolution could be kept and things like the shape, length, and location could be easily changed with the use of curve handles that are commonly used in a vector art. This way hair strands could be made on the character's head and later turn them from curves into mesh objects. The character was looking too symmetrical but with the use hair strands and the shorts belt, asymmetry and more visual interest was able to be brought to the character.

After the low poly mesh objects were made, they could be UV unwrapped for the texturing process. Just like Professor Nova Villanueva (2021) says in her book, an easy way to think about UVs is to think about a box that has been flattened and none of the parts are overlapping each other. To this flattened two-dimensional image, you can place textures and they will be transferred to a three-dimensional model, a box in this example. In the process of making UV maps for the mesh seams were placed around the mesh where they would be the least noticeable and cause the least stretching. These flat islands are where the texture will be later on placed and they will cover all of the character's surface areas.

3.2 Texture painting inside Substance Painter

3.2.1 Baking

At this point things moved away from Blender and the low and high poly versions were brought to Substance Painter for baking before starting the texturing process. In the process of baking different mesh maps are made. For the thesis project's character only the normal, world space normal, ambient occlusion, curvature and position were needed (Picture 9).



PICTURE 9. Character in Substance Painter 2018, on the right, the options screen.

3.2.2 Texturing

To create a clean and fairly simple stylised look for the character's textures, gradients were used with a minimum amount of small details. For example, from hands to shoulders the color and value changes from darker more reddish brown to a lighter brown. The character should look good without any lights so that is exactly what was done with the use of Baked Lighting Stylised filter. It used some of those baked maps to create a fake lighting on the base color. The fake light source was pointed to come from straight up to make it look like the sun is shining evenly on top of the character. This process also made it look better when there is a light source, so it is not only meant for no light conditions.

PICTURE 10. These are the finished textures on the character inside Blender. On the left is the character with environmental lighting and, on the right, only the base color is shown without any lights.

It is not completely possible rely on a single filter to get the best results so a lot of other tweaks were made. Such as make the gradients for the arms and legs, paint some redness on top of the most evenly flat parts, paint the face and eyes, add the nails etc. Substance Painter's different filters and generators speed up the texturing process immensely and they can be used to make things look better and more realistic than just hand-painting can do. Even though the end result should look stylised, realistic properties such as the light direction can be used to keep the look consistent. And with the use of fill layers and masks, in just seconds it is possible to completely change the color scheme to another.

4 BASIC ANIMATION PRINCIPLES FOR STYLISED 3D CHARACTERS

Thomas P Thesen (2020) says in his article that the 12 principles of animation came from Walt Disney Studios from their research of objects in motion. And they put them into 12 different categories with each representing different things. They were meant to be used in hand-drawn animation, but they can also be used in other types of animations even though the principles could not take into account the different animation techniques from the future. (Thesen 2020, 276–277.) In the thesis project's case 3D animation. Even though the principles were not specifically meant for 3D animation, they are simple guidelines that help to create pleasant animations. And this thesis will be going through them to show the importance they have.

4.1 Squash and stretch

Let's start with the first principle; squash and stretch. To simplify things, an object changes shape based on how heavy it is and how fast it is going. The important part about squash and stretch is that the volume of the object should stay the same the whole animation. So, for an example if something moves fast vertically it should thin down. But then it stops suddenly, the mass reacts to it by flattening and widening horizontally. You should keep in mind of what is the object's material is as not everything reacts the same way. Or how much you want to add exaggeration. (Becker 2017.)

PICTURE 11. A character from the game Overwatch in the middle of doing a forward roll (Overwatch, YouTube 2016)

Characters are mostly made of flesh and cloth which are both very stretchy substances. A lot of times these extremely distorted poses (Picture 11) are used and they are only shown for a few frames to highlight the fast movement they are doing. For this, you need to have good character rig with well done weight paints that is able to handle this kind of stretching, which can be seen on the fingers and on the face (Picture 11).

4.2 Anticipation

The second principle is called anticipation, which is about making clear to the viewer that something is about to happen (Becker 2017). A real world example of an action that has an anticipation is throwing a dart. The dart does not just fly away from the hand, but the thrower winds the hand backwards first before moving it forward to give the dart momentum to fly far. The winding of the hand is the anticipation.

In a stylised character's movement, anticipation gives the viewer time to react and understand what is going to happen. In games this is extremely important for example when someone punches. The anticipation of an enemy's punch gives the player time to react to it and move out of the way. The same can be applied

to the player. Giving them long anticipation animations before the main action can make the attack hard to hit, but powerful. On the other hand, anticipation can make actions in a game feel sluggish. Things like shooting, jumping, or punching, can feel like they are not responsive enough to the given input. That is why taking the anticipation out might be a better option or just showing it for a few frames. The character can then, after the action, do a longer recovery animation that indicate an action was done. (Floyd 2020).

4.3 Staging

The third principle is staging which can be split into framing and character staging. The framing is about how the camera is set up. Using good camera angles and compositions so things look the clearest. The character staging on the other hand is about how clear the character's movements and mood are. It is about visual clarity so if there are multiple things on screen at the same time, they do not fight for the attention of the viewer. This can be achieved by taking unnecessary visual noise out and making important actions happen one after another with a good pacing and not at the same time. (Becker 2017, Thesen 2020, 285–286.)

In the project of this thesis, the camera angle is predefined from a top-down perspective. So, the best way to make the staging as clear as possible is with the character design and animations it uses. If the backgrounds were also made for the thesis project, they would need to be clear to not make the character blend in with them. And keep it clear where the character is and which way it is facing. For example, with the use of colors and contrast.

4.4 Straight ahead and pose to pose

The fourth principle is called straight ahead and pose to pose. It is about two animation methods. Becker (2017) explains well the use of this principle. In straight ahead the animation is made in a linear way one frame after another. With a pose to pose method the main poses are first made. First, think of the animation's starting point and the ending point. Then you fill up the most important poses between. Then the most important poses between those poses etc. This way you can catch errors in your animation in an early stage compared to straight

ahead animation where end product might be something completely different looking that you initially had in mind. But straight ahead does have its uses. In some things where you cannot predict what the end pose looks like, such as a smoke, using straight ahead might be a better option. You can also mix these methods by first doing pose to pose and then filling the blanks between with a straight ahead method. (Becker 2017.) All of this depends on what kind of animation you are doing. For an example, doing pose to pose animation with a clay animation is not really an option as you cannot add the inbetween poses later. (Thesen 2020, 287.)

Pose to pose method when doing animations for 3D characters is preferable. With pose to pose, it is easier to time everything and try to keep the poses clear and easy to read. And in games a lot of actions are meant to loop, such as walking, so timing this with a straight ahead method can be almost impossible.

4.5 Follow through and overlapping action

Follow through is about how connected pieces move after the main part stops. And overlapping action is about how the connected pieces move in a different timing that the main part. These are similar concepts and are applied to a lot of things. (Becker 2017.) An example of this is a long dress when a person is walking. In movement it drags behind as the movement is pushing it. But when the person stops, it does not instantly return to a neutral position but it keeps the momentum and tries to keep on going forward slightly before going to a neutral position.

With 3D softwares some parts of the animation process can be automated. For example, it is possible to simulate the clothes on a person. Or add physics to bones and adjust things like gravity, stiffness, stretching etc. so the bones move automatically. This can be used for things like animals' ears or tails.

4.6 Slow in and slow out

The sixth principle is slow in and slow out. It is about the building of speed of an object and slowing down at the end of an action. This is because only a few things

in life move at a constant speed from start to finish as it is a very mechanical to move that way. Of course, it does not always make sense to slow in or slow out a movement. For example, if something is dropping down the movement does not slow down before contacting the ground. (Becker 2017.)

4.7 Arcs

The seventh principle is called arcs. It is about things moving in circular motions, or arcs. When things move in arcs, they look more natural as linear movements look mechanical. (Becker 2017.) Birds' wings flapping, ball bouncing, or a plant moving in wind. They all move in arcs as most things do.

4.8 Secondary action

The eighth animation principle is secondary action. It means adding other movements to accompany an action to give it more depth and personality. It also helps to communicate what main idea of that movement is. It is possible to do this for example with different facial expressions or hand motions. (Becker 2017.)

4.9 Timing

The next animation principle is timing. It is about the number of frames used in an animation and how it affects the feeling of it. Generally speaking, if there is a slow movement, a lot of frames would be used. And with a quick movement only a few frames. But there are always exceptions to this and personal opinions of how the principle of timing should be executed. A slow movement with a lot of frames can look trembling in a 2D animation. Or quick movements with few frames too jumpy without enough information for the brain to follow it. (Becker 2017.)

Movies are usually shot at 24 frames per second so you would animate at that same frame rate (Becker 2017). For game animations 30 or 60 fps (frames per second) is common and it depends on what kind of game engine you are using for which to use (Newman 2022). It would be ideal to know from the start how many frames per second are used. Because if a 30 fps animation is transferred

to 60 fps it adds frames to places where those might not be wanted. Or from 60 fps to 30 fps it can take frames away that are wanted and the action can look different than it was originally designed.

If you show a new picture at every frame, that's called animating on ones. If you show a new picture at every other frame, that's called animating on twos and so on. (Becker 2017.) It is possible to combine these different frame rates in a single animation for a stylised effect. For example, animating backgrounds in ones, and characters in twos.

4.10 Exaggeration

The tenth principle is called exaggeration. Exaggeration strengthens visual communication and what an action is trying to convey by making the action more extreme. So, if someone is happy, you would show them smiling. By exaggerating this emotion, you could make the person's smile wider with teeth showing, eyes closed and bringing the whole body into it by jumping and raising hands. You can also exaggerate short parts of an animation by stretching them out of realism just like in squash and stretch (Picture 11). When the animation is played in a normal speed this only a few frames long disfiguration looks good and enhances the motion. (Becker 2017.)

Exaggeration is also important in a stylised character design. With it you can move away from realism and create characters that from the first look can be seen for what they represent by the look of how exaggerated they are. The way they are dressed, what their proportions are, or what poses they use. All of these can be exaggerated to bring out more of their personality and what they are trying to say to the viewer just by the viewer looking at them.

4.11 Solid drawing

The next principle is called solid drawing. This principle is about three-dimensional shapes and the use of them. With the use of perspectives and forms that follow three-dimensional space you can create characters and objects that does not look flat. And also when 3D animating, not using symmetrical poses

makes things look more dynamic. (Becker 2017.) Thesen (2020) wrote in his article that solid drawing is not the best terminology for this principle, and he suggests that the term pose is better at describing it. Which can be good as it covers more than just 2D animation. He also wrote a large list of additional aspects that should be used to complete that principle, things like silhouette, readability, and anatomy. (Thesen 2020.)

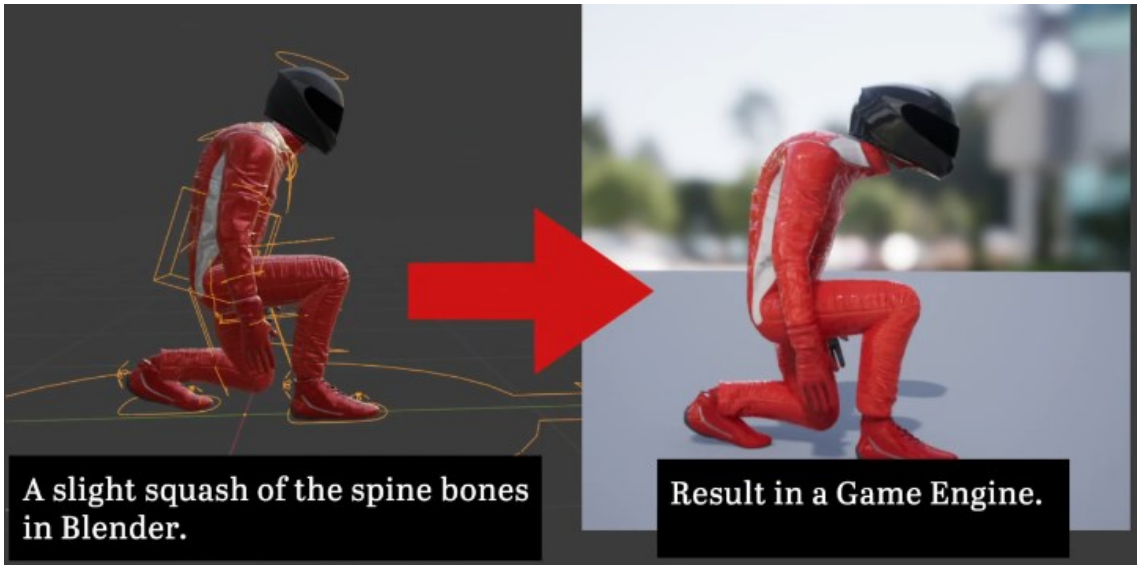
4.12 Appeal

The last principle is called appeal. It does not mean that a character should be good looking, but interesting to look at. Thesen (2020) talks about splitting this into three parts: variety of shapes, proportions, and keeping it simple. (Thesen 2020.) Variety of shapes goes back to the shape language which was talked about previously and so do proportions too. Keeping it simple is used so a character design is clean an easy to look at but also easier to animate (Thesen 2020.) In 3D animation that is not as much of a problem as when there is have a rigged character with all the small details in place, there is no need to place them there again. And when aiming for realism all those little details are needed. In stylisation it can definitely work too as it is an artistic choice. Of course, the overall clarity is the first thing that needs to work because if it does not, no amount of details can fix it.

5 ANIMATING A STYLISED 3D CHARACTER

5.1 Rigging

There were a few things that had to be kept in mind in the rigging process. Firstly, in the thesis project rigging only the essentials were wanted in an easy and quick way. The only facial movements operated with bones would be eyes and the jaw, leaving behind fine tuning to blend shapes. Blend shapes could be used to close and open eyes, move eyebrows, and do facial poses. Blend shapes are an excellent way to go at it because it is possible use sculpting brushes to move vertices quickly into a position that is natural. There is no need to add bones or weight paint. They are also often used with things like faces and are a good way to move organic parts. (Blender 2022b.) But as the thesis project focuses on the movements of a character, it was not a necessity to include blend shapes on the final product and they were not. The other thing that was also wanted in the rig to be able to do was to stretch bones so the basic animation principles would be easy to implement, while also make it possible to use the rig inside a game engine.



PICTURE 12. Game Rig Tools (Blender Addon) - game-ready rigs in seconds! (CGDive, YouTube 2021)

The thing about game engines is though that they do not like stretching of bones and do not work correctly without the right setup (Picture 12). The easiest way to

go about this would be to not stretch any bones at all. (CGDive 2021). But that was not an option. Luckily with an addon called Game Rig Tools, made by Todor Nikolov, a stretchable rig can be used inside game engines. This addon would be used right before bringing the animations to Unity.

Doing the whole rig from scratch would not be the most efficient way to go at it as it takes a lot of time. That's why another addon, Rigify, that is inside Blender was used. Rigify is made by Nathan Vegdahl, Lucio Rossi, Ivan Cappiello, Alexander Gavrilov. It can be used with game engines and with the Game Rig Tools addon so there is no problem there. Rigify is used to help automate the rigging process and it is highly flexible on what it can do. It helps to make the bones and the rig controls and it is easy to adjust what is or is not needed. (Blender 2022c.)

The bones were placed and rotated after applying them to the character to see if the limbs moved the correct way. If they did not, they were adjusted until they did. Rigify then generates rig controls that the animators use to control every part of the character. But there were problems with the way Rigify automatically placed these rig controls for hands and feet. The controls were following the world space even though the feet were pointing at a slight angle. That caused the controls not being accurate. To fix this, the feet were rotated to point straight ahead in edit mode with proportional editing on. The hands had the opposite problem. They were pointing straight in world space, but the controls were in a slight angle. Luckily Rigify has a lot of settings and one of them lets change the rotation axis for the hand rig controls from automatically generated to the way needed. After that the weight painting process was started to fine tune the most problematic parts that could not be solved with simply changing the bones' location. Weight painting is about adjusting what parts of a mesh a bone is moving and how much. It is applied to the mesh by painting on top of it with its own tools. (Blender 2022d.)

5.2 Animating

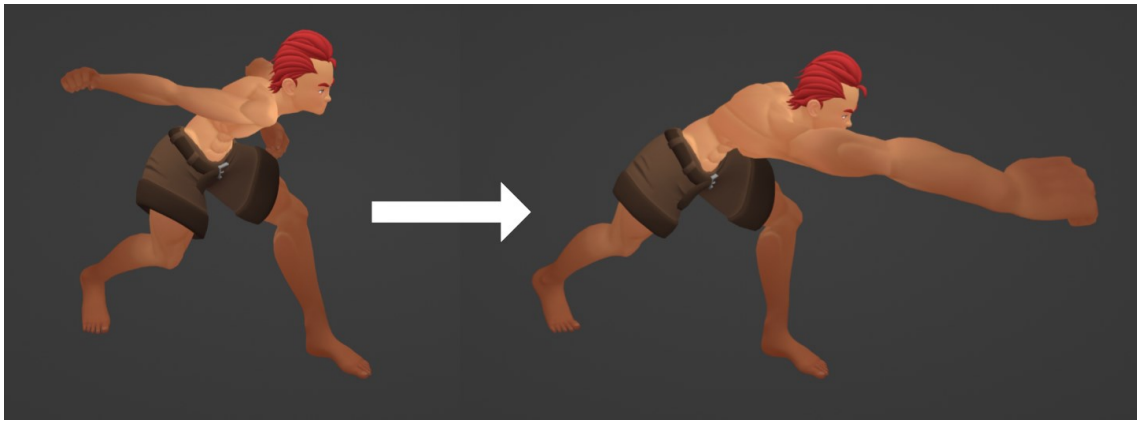
Before animating, understanding the FK and IK systems is needed. Forward kinematics and inverse kinematics, or FK and IK in short. These are two ways a connected group of bones behaves when one or more of them are moved. For

example, with FK when a spine bone is moved all the other bones in the upper body follow that movement the same direction. So, it is a very mechanical movement. With IK, handles are created at the end of a bone chain, such as wrists and ankles. So, when spine bone is moved these handles stay in the exact same place as they were before. (Cabrera 2008, 218–219.) With good character rigs its possible to change between which kinematic system to use in what situation as some motions are easier to create with the other. Running animation as an example; using IK for feet would be ideal as feet can be stick to the ground, so they do not clip through. But with hands FK might be a better choice in some situations as you can create smooth arcs where you can accurately rotate every bone.

The plan was to do three short animations: idle, attack combo and running animations. Then play them as a single loop. In Blender the animations were split in action editor as their own actions so they could be used easily. The actions could be made into strips that in turn are used inside NLA (Nonlinear Animation) editor. And they can be easily exported to Unity as their own animations. With NLA editor those short animation clips could be easily looped and blended with each other so they could be rendered into a video. A separate strip was also made for the camera, so it spins around the character to show it from all the angles.

Keeping in mind the basic animation principles, the actual animation process was started. First versions of each action were created with the pose to pose method with constant interpolation mode, in other words single poses were made without any blending between the keyframes. The most important keyframes were made with easily readable silhouettes and placed with the correct timing next to each other. Also keeping in mind that the thesis character would be from a fighting game with a top-down perspective, an idle pose was made that was easy to read which way he is pointing by putting and arm and a foot further away towards the forward direction. These keyframes give a good base to start animating with the straight ahead method so you'll know which poses to move towards to (Appendix 1). At this point the animations were missing a lot of the animation principles like squash and stretch, anticipation, follow through and overlapping action, slow in and slow out and so on. The swift movements from pose to pose at this stage

work well with a fighting character, so that feeling was wanted to be kept, but the basic animation principles were still needed to be applied.



PICTURE 13. Two keyframes next to each other from the final animation.

The blanks between the poses were filled and the movements became more refined as the basic animation principles were applied. Singular frames next to each other might look weird but as these poses are only shown for a few frames it does not look weird in the real time. (Picture 13). These unnatural poses with scaled bones actually reinforce the movement to create a desired final result that works well with stylised character animations (Appendix 2).

As those were done the animations needed to be exported to Unity. Previously mentioned Game Rig Tools addon was used. I followed the tutorials the addon's maker made for this exporting and importing process and it all worked smoothly. Unity's Timeline was used to combine the clips made but nothing fancy was done with the lighting or texturing. The priority was to see if the animation bones stretched and that they could be used in an actual game making process. And they did work (Appendix 3). Without doing any fine tuning, the animations matched the ones inside Blender almost perfectly. It is almost perfect and not completely perfect just because I noticed there was a little bit weird shakiness on the character. It was really minor and the camera had to be really close to notice it. Another thing that changed in the animations that could just be easily fixable inside Unity, was the frame rate. There were more keyframes than before which led to, for example, the first punch having extra keyframes between the poses (Picture 13). And it might be easily fixable just by tweaking some settings inside

Unity. But the main thing was that the bones looked right even though they were moved, rotated, stretched, and scaled around.

6 DISCUSSION

The thesis went through every part needed for creating and animating a video game character and each of them can change the way the character could end up looking or moving. So, it is important to remember the character created during the thesis might not work in a different kind of setting as he was personalized to his own fictional setting - setting that could be further improved and expanded by making the actual world the character belongs in. The thesis goes through the whole process from designing to animating in a fairly short time so every part could be further deepened. Problems did arise when the animations were to be used in game engines as they do not like stretching of bones unless the bones are not connected. But the problem was solved with the use of a Blender addon. Another thing that could be further looked into was the use of game engines. The character was brought to Unity to check if the animations worked as they should be, and they did. But would the animation work in the context of a gameplay? That could be looked into and if they do not, it could bring the animations back to the drawing board as every part of making an animation is crucial.

REFERENCES

Aava, K. Environment artist. 2017. Interviewer Tokarev, K. https://80.lv/articles/realistic-vs-stylized-technique-overview/

Adobe Color. 2022. https://color.adobe.com/create/color-wheel

Becker, A. 2017. 12 Principles of Animation (Official Full Series). YouTube video. Published on 30.5.2017. Referred on 21.9.2022. https://www.youtube.com/watch?v=uDqjIdI4bF4

Blender 3.3 Manual. 2022a. Introduction. Updated on 2.11.2022. Read on 2.11.2022. https://docs.blender.org/manual/en/latest/getting_started/about/introduction.html

Blender 3.1 Manual. 2022b. Introduction. Updated on 30.9.2022. Read on 30.9.2022. https://docs.blender.org/manual/en/latest/animation/shape_keys/introduction.html

Blender 3.1 Manual. 2022c. Introduction. Updated on 2.5.2022. Read on 30.9.2022. https://docs.blender.org/manual/en/3.1/addons/rigging/rigify/introduction.html#main-features

Blender 3.3 Manual. 2022d. Introduction. Updated on 1.10.2022. Read on 1.10.2022. https://docs.blender.org/manual/en/latest/sculpt_paint/weight_paint/introduction.html

Cabrera, C. 2008. An Essential Introduction to Maya Character Rigging. Focal Press.

CGDive. 2021. Game Rig Tools (Blender Addon) - game-ready rigs in seconds! YouTube video. Published on 24.6.2021. Referred on 30.9.2022. https://www.youtube.com/watch?v=iZBx1I7vmQ0

Dota 2 Workshop - Character Art Guide. N.d. Read on 28.8.2022. https://help.steampowered.com/en/faqs/view/0688-7692-4D5A-1935

Fanguy, W. 2020. What Is Color Theory? Meaning & Fundamentals. Read on 1.9.2022. https://xd.adobe.com/ideas/process/ui-design/what-is-color-theory/

Floyd, D. 2020. ANTICIPATION - The 12 Principles of Animation in Games. YouTube video. Published on 21.3.2020. Referred on 19.11.2022. https://www.youtube.com/watch?v=28s1Hv3Zqlo

Lebowitz, J. Klug, C. 2012. Interactive storytelling for video games: A player-centered approach to creating memorable characters and stories. Focal Press.

Maestri, G. 2006. Digital Character Animation 3. New Riders.

Newman, H. 2022. WHAT FRAME RATE Do Animators Use In Games? And why... YouTube video. Published on 14.4.2022. Referred on 23.9.2022. https://www.youtube.com/watch?v=CiYmQqvwGIA

Paint in 3D. In real time. N.d. Read on 11.9.2022. https://www.adobe.com/products/substance3d-painter.html

Sauer's Virtual Art Room. Shape Language. YouTube video. Published on 8.12.2020. Referred on 25.8.2022. https://www.youtube.com/watch?v=z6YI3F4pcMs

Sivers, Y. 2016. Design Tips for In-Game Character Proportions. Read on 28.8.2022. https://blog.kongregate.com/design-tips-for-in-game-character-proportions/

Thesen, T. 2020. Reviewing and Updating the 12 Principles of Animation. Animation: an interdisciplinary journal 15 (3), 276–296.

The Walt Disney Family Museum. N.d. Tips & Techniques. Read on 18.8.2022. https://www.waltdisney.org/sites/default/files/2020-04/T%26T_ShapeLang_v9.pdf

Villanueva, N. 2021. Beginning 3D Game Assets Development Pipeline. Berkeley, CA: Apress.

Villar, O. 2017. Learning Blender: a hands-on guide to creating 3D animated characters. 2nd edition. Boston: Addison-Wesley.

What is Unity? – A Guide for One of the Top Game Engines. 2022. Read on 19.11.2022. https://gamedevacademy.org/what-is-unity/

APPENDICES

Appendix 1. Fighting character's key poses

A YouTube video which has my character’s animations combined from the blocking phase: https://www.youtube.com/watch?v=9TsVI1idT2E

Appendix 2. Fighting character's animations

A YouTube video which has my character’s animations combined: https://www.youtube.com/watch?v=R2R8XbuLEsw

Appendix 3. Fighting character inside Unity

A YouTube video which has the character that was created exported inside Unity: https://www.youtube.com/watch?v=SXbSFkCCwac