12-13-2021

Winner

Yizhang Liu
yxl4521@rit.edu

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by

Yizhang Liu

Master of Fine Arts in Film and Animation

A Thesis Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Fine Arts in Film and Animation

School of Film and Animation

College of Art and Design

Rochester Institute of Technology

Rochester, NY

December 13, 2021

Committee Approval:

Mark Reisch Date

Chief Advisor/Dissertation (Thesis) Advisor

School of Film and Animation

Daniel LaTourette Date

Committee Member

School of Film and Animation

Vanessa Sweet Date

Committee Member

School of Film and Animation

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ABSTRACT

Winner is an animated 3D graduate thesis film. The entire film, including the credits, is 4 minutes 34 seconds long. The production phase went from August 2020 to December 2021.

The story is about an old man who wants to profit from a robot he invented, but finally paid for his selfishness in the end. The man is a robot inventor. He uses a chip to control the robot and uses it to participate in the robot fighting competition. His robot won one championship after another, and he was rewarded with bags after bags of money. He became richer and richer, but his greed did not diminish. He fantasized about drinking champagne on the beach with sunshine and beauty. However, at this time his robot has become scarred due to damage from the battle. The man did not give up his ambition and fixed the robot to prepare for the next fighting competition. However, the robot was eventually defeated by a powerful opponent. The chip in his body was punched out, and was swallowed by the old man dramatically. Finally, on the beach that the old man had imagined, his robot lay comfortably on a beach chair wearing sunglasses, and used the remote control to control the old man to serve it. It turns out that the robot is the real winner.

The software used to make this film mainly include: Autodesk Maya and Zbrush for modeling and animation, Adobe Photoshop and Substance Painter for texture map, TVPaint for animatic, Adobe After Effects and Adobe Premiere for editing and compositing. The final output format was 1080HD with a high-quality stereophonic track.

This paper will retrace the production process of the film, the difficulties encountered and the solutions.

INTRODUCTION

Winner is a comedy animation with some action elements. There are two main characters: the man and the robot. In addition, there are five other robots in the film, all of which are opponents of the man's robot. There is also a waitress who presents the man with a trophy and a money bag after his robot wins. At the same time, she also appeared as the man’s fantasy object in his imagined beach scene.

The man is a robot inventor. He is smart and talented in mechanical invention, so his robot can always win in fighting competitions. His home is full of trophies that his robot won for him, and it can be inferred that he has won a lot of money bags through this game. Reality and imagination always correspond. From the scenes in the man's imagination, it can be seen that he is an insatiable person, and the large amount of wealth he won in the past cannot satisfy his material needs. Money, beauty, wine, and a comfortable and lazy life are all he wants. His greed prevented him from seeing things other than money, which is why he finally reaped the consequences and did not become the ultimate “winner”. The man is a comedy character with rich facial expressions and exaggerated movements. He is more sensitive to the surrounding environment, so he reacts more violently to what happens.

The robot was originally a tool that the man used to make money, but he gained his own consciousness after multiple chip information input and multiple battle matches. Because of the man's intelligence, the robot is strong and flexible, and wins in fighting matches time and time again. However, repeated injuries made him unwilling to be the man's slave again. In the last game, the remote control was damaged due to the man's mistake, and the robot finally had a chance to

gain his own freedom. He is the final “winner”. The robot is not as expressive as the man. Most of his plays are broad performances like the fight and control the remote control. He has his own independent mind though it is weak. This is why he moves his head slightly on the work table and sits up. He finally picked up the remote control and lived on the beach like a human also explained this point.

I want to discuss some social issues and relationships through this animation. First, I noticed that technological development has affected humanity. People are increasingly relying on machines and technology, and many companies use machines to replace workers in order to save costs. Although this improved the company's earnings, it caused many people to lose their jobs.

“We showed that currently demonstrated technologies could automate 45 percent of the activities people are paid to perform and that about 60 percent of all occupations could see 30 percent or more of their constituent activities automated.” (*Where machines could replace humans—and where they can’t (yet)* by Michael Chui, James Manyika and Mehdi Miremadi, 2016).

This is why the man only wanted to win the prize and ignored the robot’s injuries. Second, Artificial intelligence has gradually replaced humans in some fields. Artificial intelligence was invented by humans. However, the development speed of artificial intelligence is far beyond human imagination. No one could predict what will happen in the future.

“The experts predicted networked artificial intelligence will amplify human effectiveness but also threaten human autonomy, agency and capabilities.” (*Artificial Intelligence and the Future of Humans* by Janna Anderson and Lee Rainie, 2018).

This is why in the end of the story, the man and the robot's status reversed. Third, Labor remuneration is exchanged for the free time of the laborer. People need work to get paid, and work takes time to do other things. As a college student who is about to graduate from school and want to find a suitable job, this is a topic that I often think about. Higher pay means more time and less freedom. This is why the robot gives up the future trophy and became a free robot.

REVIEW OF RESEARCH

IDEA DEVELOPMENT

This story took me a long time to figure out. I used to think about animals, fairy tales, realistic style, action movie, cold weapon era, cyberpunk, etc. When I wanted to try multiple elements in the story, I learned that a good story must have a distinctive style.

I have put forward several different ideas. Originally, I wanted to try to make an animation about animals, instead of all the characters being human as in the previous animations. The first proposal I made was a story about tigers. This is a tragedy that the hunter rescued the little tiger but his wife was killed by the mother tiger. But the mood of this story is too low, it is difficult to interest the audience. Moreover, there are no rich facial expression changes for these characters in the story, and such characters will not be vivid enough in 3D animation. Then, I proposed a story about an office worker and his puppy. But this time, because I deliberately catered to the element of animals, it seemed very empty in terms of the whole plot design. It seemed difficult to make an animation

related to animals, so I started thinking about other elements that I wanted to make into an animation.

First of all, I want to make an action film. Just like my previous work, I don't want to add too much dialogue to my animation. I want to convey to the audience what the character wants to express through their body language, facial expression, camera angle, and camera movement. In my previous 30-second animation *Thank You Kyrie*, I added a 7-second action element of the character playing basketball. The good response of that film made me interested in grand performance animation. I began to pay attention to every action movie I watched later, including the action animations in the games. The camera movement in these films gave me a lot of inspiration. I think the way the camera moves in an action movie can have a huge impact on the overall quality of the film. Even the length of each shot is very important. When to cut to the next shot and how to connect the shots are all interesting and worthy of research.

Second, I also hope to make a comedy animation. When I was a kid, the earliest Western-style animations I came into contact with were *Tom and Jerry*, *Mickey Mouse and Donald Duck*, *Bugs Bunny* and *Popeye*. Unlike the traditional Chinese animation and Japanese animation that I always watched before, the impressive humor in these animations is almost expressed in a way without dialogue, replaced by exaggerated performance art. Although this way of expression is very difficult for me, it has always been the method I want to try. The control of comedy elements in an animation is like creating a comic. Scott McCloud had his words in his book, *Understanding Comics*:

"The art of comics is as subtractive an art as it is additive. And finding the balance between too much and too little is crucial to comics creators the world over." (*Understanding Comics* by Scott McCloud, P 85).

Third, the theme of robots has always been on my mind. It is more fulfilling to make robot actions like humans than directly using humans as characters. In addition, considering that in action movies, it is difficult for the audience to observe the facial expressions of the characters due to the rapid movement of the camera. However, human characters with no expressions but only movement will look strange, even though their facial expressions may change slightly. And the robot as the character of this animation can solve this problem very well. I thought of an animated movie, *WALL-E* (Directed by Andrew Stanton, Pixar Animation Studios, 2008), which is the highest-rated animated movie on China's Douban list. In this movie, the main character is a robot with no nose, ears or mouth on his face, but only eyes. However, this does not affect the expression of emotions and feelings of the character itself. The robot performs this character vividly and energetic through rich body language and only eyes on the face.

After combining these factors, I proposed the script of this animation. However, since facial expressions are an important source of humorous elements, robots without facial expressions may difficult to play an important role in comedy movies. Although robot characters will save me a lot of trouble when painting skin weights, their body structure will also prevent them from completing many complex actions that humans can complete. I decided to add a human character to the animation. I thought of using a robot as the protagonist of the action part, and a human character for the comedy part. And after many discussions with professors and classmates, I made several revisions. The final proposal was approved by the professors at the committee meeting.

PROCESS

PRE-PRODUCTION

CHARACTER DESIGN

There are a total of eight characters in this film, including the man, his robot, five supporting robots and a waitress. For a 3D animation, eight characters may seem a lot because it will take me a lot of time to do modeling and rigging. And rigging is not something I am good at. But for the completeness of the script, I decided to make all these eight characters. The absence of any character will reduce the feasibility of this film. The good news is that robot characters do not have soft skin surfaces like human characters. They are hard objects themselves, which can save a lot of time when painting skin weights. In addition, three of the robots only have a few seconds of shots, so I can determine the parts that need to rigging based on their actions. The waitress doesn't have a facial shots, so I don't need to make her eye texture or use a shape editor to make facial expressions.

While thinking about the story, I was also considering how each character in the story should be designed. There should be similarities and differences between each character. William Strunk Jr. wrote this in his book, *The Elements of Style*:

"Choose a suitable design and hold to it. The first principle of composition, therefore, is to foresee or determine the shape of what is to come and pursue that shape." (*The Elements of Style* by William Strunk Jr., P 26).

The design of the protagonist is the most important part of the character design. The appearance of the character, including facial appearance, body shape and costume design, all need to conform to the character's identity and personality characteristics. At first I wanted to design the male protagonist as a young man, because young people are more like the kind of people who play games with a remote control and are interested in researching robots. I carefully recalled the movies I watched recently, and found that a thin middle-aged man can simultaneously portray humor and villain roles, such as *Joker* and *Loki*. Of course, the premise is to have exaggerated performances and facial expressions. Finally, Pixar's short film *Presto* inspired me. The moustache can make the character's facial expressions richer, and it will also make it more obvious that he is a thoughtful person.

As for the man's robot, I want to design him as a smaller robot, not a tall and strong robot. Because this robot is not just a tool that the man uses to participate in fighting and get money, he will also take on part of the comedy scene in the later part of the film. Although his opponents, those tall robots, look more like robots that will win the game, they do not fit the protagonist's character setting. Moreover, just like *Iron Man* defeated *Thanos*, the robot does not rely on its size to win the game. In the version I originally designed, due to the short limbs of the robot, in some fighting scenes, although he could perform the movements I designed, he could not touch the opponent's body. And because of the unreasonable design of the joints, he had to deform the joints when he bends his elbows and knees, which contradicted the properties of their hard surfaces. So I revised the character design again, extended their arms and legs, and replaced the joints with spheres, so that he can make more movements without worrying about body deformation.

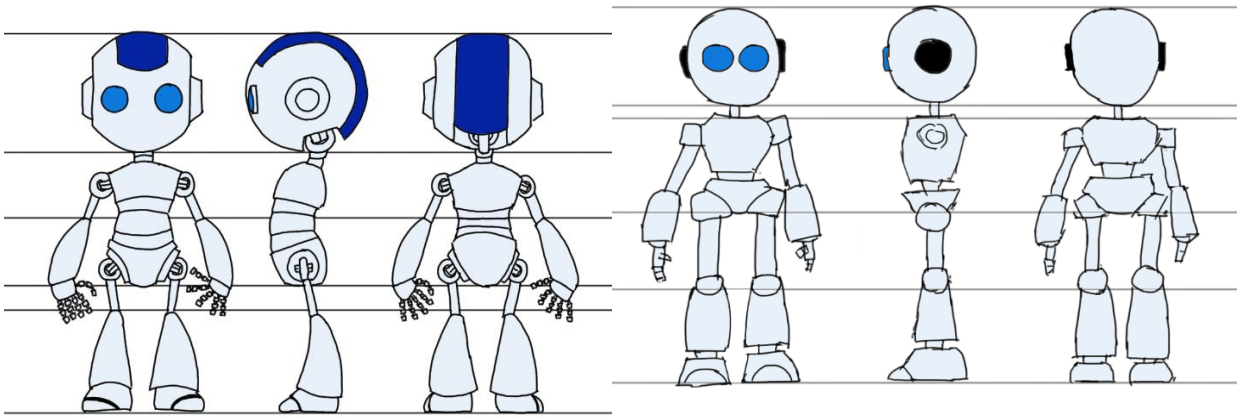

Figure 1-2: Previous robot design and revised version.

As for supporting robots, it's easier to design, because I don't need to consider their personality traits, but only their body shape. For example, the first robot to appear on the scene is a force-type, so he must be designed to be tall and strong. At the same time, I learned from the previous robot design experience and made a special design for his joints, using two connected rings to rotate his joints. However, two connected rings are not as flexible as a sphere, because they can only rotate on two axes at the same time, and the sphere can rotate in three directions at the same time. Of course, he is a robot himself, and it is impossible to make flexible movements like human beings.

The last robot is a tall and flexible robot. After all, he and the first robot are powerful enough to reach the finals. Because he has more than one minute to appear, I designed his joints into spheres as well, so that he can make complex movements more flexibly, which is convenient for me to make animations in 3D scenes.

The other three robots only have two-second shots, so their designs have all different degrees of functionality cut. For example, one of the robots cannot wave his arms left and right, while the

other robot cannot bend over. After all, they are all eliminated in the game, unlike the other three robots that can make complex fighting movements.

As for the waitress, she is not only the role that awards the winner in reality, but also appears in the man's fantasy beach scene. However, she didn't have any facial shots in both scenes, and she only appeared for a short period of time, so I only made a simple design for this character. She should look like a beautiful and sexy girl from the back, so she can appear in the man's fantasy scene.

ENVIRONMENT DESIGN

There are four scenes in the film, including the arena, home, beach and laboratory.

The design of the arena is the most important of these scenes, because the arena is mainly action scenes, the camera movement is more complicated. Another difficulty in the design of the arena is how to create a large number of spectators in the scene. I used to make an animation with a basketball court as a scene before, and I also thought about how to make these audiences. However, because the seats, fences and other objects in the scene took up a lot of faces, the Maya software became very stuck, so I finally gave up this idea. In the end, it became an empty basketball court. In this film, I once thought about avoiding the scene with the audience through the camera angle, so that I don't have to use a lot of faces to model the audience. So I designed the arena as a protruding semicircle with a huge wall behind it. However, I found that this would limit the angle of the camera to a certain range, which greatly restricted the production of animation. At this time, an animation called *Love, Death & Robots* inspired me. I changed the design of the arena to a

concave circle, which not only enables the camera to rotate 360 degrees, but also avoids the shots of a lot of audience, and reduces the pressure on the 3D software as much as possible.

The home scene is relatively simple. According to the needs of the plot, I need to design a sofa and a shelf for trophies. The height of the sofa should be the same as that of the beach chairs in the beach scene, so that I can switch back and forth between the two scenes. Because there are no walls in the beach scene, I need to consider which objects need to be made by 3D modeling, and which ones need to be made in the form of texture maps. On the whole, I hope that the design of the beach scene is as simple as possible, in contrast to other complex scenes. Only in this way can it be consistent with the man’s mood of relaxing and enjoying on the beach.

As for the laboratory scene, I designed it as a dim and cluttered small room. The necessary items are a bed for the robot and two computers. In fact, many objects were designed after the 3D scene has been modeled. After all, the sense of space is very important for the design of the scene, and I can't just rely on imagination.

STORYBOARD

The storyboard requires me to have a preliminary idea of the entire film's shots and character performance. Since there are many fighting scenes in my film, this undoubtedly increases the difficulty of making storyboards and animatic. Because those details cannot be described by the script, when converting them from words to pictures, I need a lot of imagination and find enough reference videos.

I imagined how this animation will be completed in the future, and selected some key shots from it. However, not every key shot of the film has to appear in the storyboard, and the duration between every two adjacent pictures is not fixed, so I considered which key frames should be placed in the storyboard. In the scene of the arena, the shots of two robots fighting and the shots of the man operating the remote control appear in turn, so I selected one picture from each and put it in the story board to show the progress of the plot. However, in this process, I did not use the reference video I recorded by myself and the live video I found on the Internet. After all, the number of pictures in the storyboard is limited, and the action details of the fighting scene cannot be depicted. In addition, painting is not something I am good at. I prefer to put more work in the 3D scene to complete. In the process of making the story, what helped me the most was thinking about the camera angle and focal length. When thinking about the angle and focal length of the camera, it is inevitable to consider the movement of the camera, which involves the concept of timing, so I started the production of animatic.

2D ANIMATIC

For me, animatic is the beginning of the animation production stage, even though the picture is rough and the key frame spacing is relatively large. In this process, I have a rough estimate of the duration of each shot and the total duration of the film, and selected at least one picture for each shot as a key frame and put it in the animatic.

I did not expect that there will be a total of 132 shots in a film with an estimated duration of 6,400 frames, which means that shots will be switched every 2 seconds on average. Among them, 42 shots have a duration of less than one second. Of course, the rapid switching of the camera is

related to the fighting scene. Moreover, in some shots, the camera moves very fast, which makes the fighting scenes look more intense. The duration of many shots is determined by the reference video I recorded. However, since the shots in animatic are not continuous, I can't see good effect from animatic, especially for an action film that has high requirements for camera movement. So I didn't stay in the 2D animatic stage for a long time, and quickly moved to the 3D animatic stage.

PRODUCTION

CHARACTER MODELING

3D modeling and 2D animatic production are carried out at the same time. When designing characters before, I have considered the feasibility of each character being made into a 3D model and applied to 3D animation. So in the stage of 3D character modeling, I only need to make it according to the previous design. According to the different processes and methods of character modeling, these eight characters can be divided into two categories: humans and robots.

Human characters, include the man and the waitress. First, in ZBrush, I modeled the character's body with basic geometry and sculpted it. Due to the cartoon style of the animation, I did not make their muscle structure, but paid more attention to the production of the general shape. Then, I imported the modeled character models into Maya and retopologized them. This process need to make the previous object live, and then use the Quad Draw Tool to draw quadrilaterals on the surface of the model. These quadrilaterals will automatically fit on the surface of the previous model. When the entire model surface is drawn, these quadrilaterals will form a model that is exactly the same as the imported model but has a different topology, which is the model to be used

for binding. The purpose of retopology of the model is to make the structure of the model more suitable for their deformation attribute. For example, the knee can only be bent backward, then the back side of the knee should have more edges than the front side of the knee, otherwise abnormal deformation will occur when the animation is made.

Then, the five robots. Since robots are composed of hard metal objects, they cannot deform themselves, but make movements by moving parts of their bodies. I need to consider how their body structure does not deform when they perform actions, so I made spheres where they need to bend, such as wrists, elbows, and knees. At the same time, I also need to consider the topology of the robot model for the production of the textures. For those robots that are not so important, I can make simple textures in Maya. However, some robots need a texture map, which requires them to have perfect topology and UV, so as not to look strange after textures are applied.

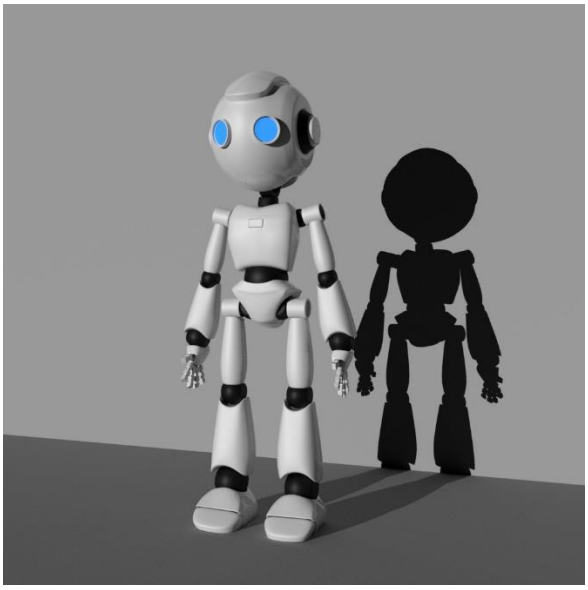

Figure 3: The robot after modeling.

ENVIRONMENT MODELING

Since the design of the environment has been thought over and over again before, the environment modeling is much easier. Most of the objects in the scene are composed of simple geometry, and the visual style of the film determines that they will not have very complicated materials, so some objects do not even need to unfold the UV.

The biggest challenge of environment modeling is how to control the number of faces reasonably. Every face in a 3D scene will occupy the computer memory. If there are too many faces in the scene, it will affect the reading speed of the file, and it may cause the software to get stuck when making an animation later. In character modeling, if the model has complex details and structure, it often requires a large number of faces to model. In 3D games, for the size and fluency of the game, modelers usually bake out normal maps or displacement maps and attach them to models with fewer faces. This will render the details of the model, which looks like a model with many faces. However, sometimes environment modeling is not suitable for using this method. For some models, even if many faces are deleted, there are still many faces remaining to ensure the overall structure of the model. Especially some objects will appear in some close-up shots, which must ensure their appearance. Because of this, some models had to keep a large number of faces, such as the iron chain in the arena scene and the coconut tree leaves in the beach scene. This put a lot of pressure on the computer when I made the animation.

RIGGING

The rigging process took me more than a month to complete. Before I started making this animation, I always thought that rigging was the hardest part for me. After all, I have never used my rigging model for the production of an animation, and my previous rigging models were not very good. Fortunately for me, the school offered a 3D character design course that semester. I chose that course and studied the whole rigging process seriously. This is really a huge help to me, I still keep the tutorial files for that course. In addition, there are a total of eight characters in the film, and I can start with the least important character and practice the rigging process again and again. In fact, I have rigged a total of more than ten characters, which makes me more familiar with rigging.

Some robots do not have the same structure as humans, so I adjusted the number and position of their joints. First of all, all robots do not have a collarbone, and their torso itself cannot bend left and right like humans. Secondly, the robots in this film do not have facial expressions, so I did not make joints for their mouths, and some robots do not have joints for eyes. Then, some robots can't rotate their necks, and some don't have fingers. I modified their joints according to their different characteristics.

Painting skin weights is the step that require patience most. The skin weight determines how the rotation of the joint affects the character's movement. At first I tried to paint skin weights for human characters myself, and the effect was okay. However, after repeated modifications, there will always be some vertices that move in a different direction from other surrounding vertices. Finally, I used a heat map to automatically paint skin weights for human character models. As for

the skin weight of the robot character, since all parts of their body cannot be deformed, I changed the weight of the part affected by each joint to 1. My advisor Mark taught me an easy way to directly parent each part of the model to the corresponding joints, so that I don't need to bind skin for the model. This suggestion is also an effective method, but I ended up using the bind skin method I am most familiar with. After all, it is not difficult to paint the skin weight of the robot.

When making joint controllers, I also thought about the use of FK controllers and IK controllers. The FK controller uses the parent joint to control the child joints, while the IK controller uses the child joints to control the parent joint. So if the character will touch the ground in the animation, I must make an IK controller for him. If the character is in the air all the time, I only need to make an FK controller for him, because the child joints must be constantly moving. Of course, I made FK controller and IK controller both for the man and the three main robot characters.

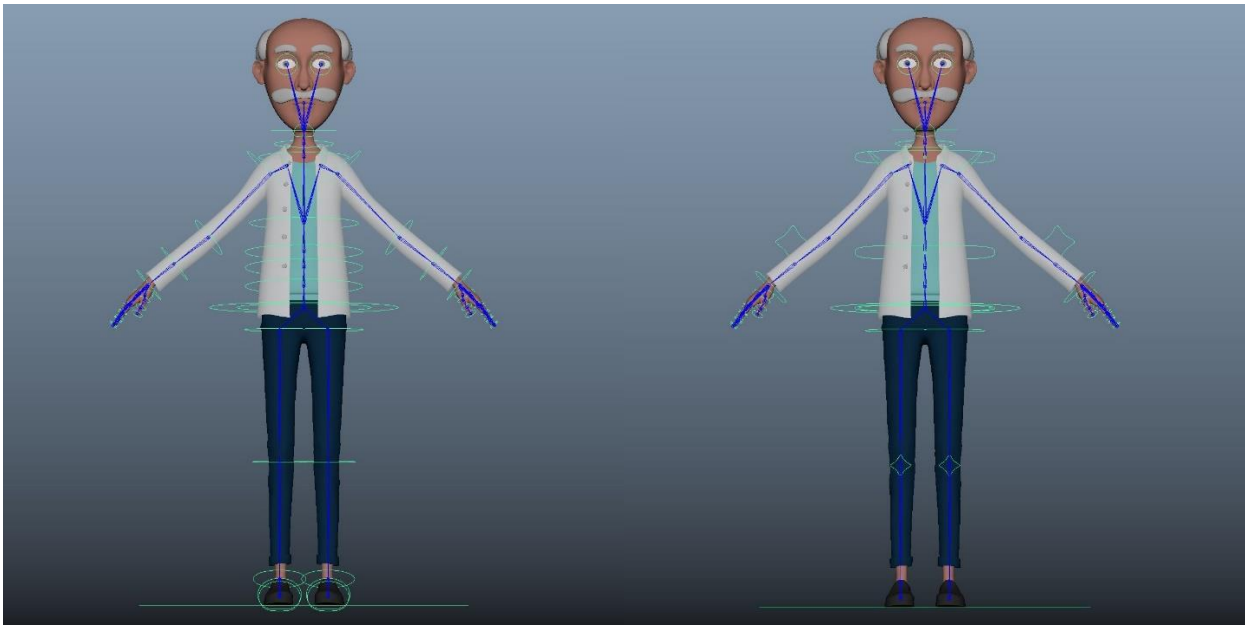

Figure 4-5: FK controller (left) and IK controller (right).

In addition, I learned how to add attributes and set keys to the controller in the 3D character design class. Through this method, I made a controller that allows the man to change clothes.

BLEND SHAPE

In the past, when I made facial expressions for character models, I always copied the original model first. After deforming the copied model, I used it as the target object of the original model's deformation. Every time I make a facial expression, I need to copy a model, so there are usually more than a dozen models in the final scene.

In this movie I used Shape Editor, which is what I learned in the 3D character design class. By creating Blend Shape, Shape Editor can remember the shape of the model before deformation, and switch the model between the original model and the target model through a weight of 0 to 1. And I don’t need to copy the model. This method saves the number of faces of the model and avoids higher pressure on the computer.

By making multiple combinations of basic facial expressions and changing the weights, more types of facial expressions can be produced. In addition, the expression of the mouth not only requires Blend Shape to deform the model, but also requires operating the controller that controls the jaw joints to control the opening and closing of the mouth. In this way, the characters' faces can be deformed more exaggeratedly, thereby enhancing their facial expressions. As Preston Blair said in the book, *Advanced Animation*:

"A cartoon head can be stretched or squashed to strengthen an expression." (*Advanced Animation* by Preston Blair, P 5).

3D ANIMATIC

In order to save the total file size, I used the method of creating reference to build my animation scene. I referenced the character model and the environment model to a new Maya scene. This method not only prevents the software from getting stuck, but the modification of the referenced model will also change the model in the animation scene, so there is no need to modify every animation scene.

For the fighting scene, I selected some key frames from the reference video I prepared, and then put the pose of the robot model as in the reference. Some of these reference videos were recorded by myself, some were live-action videos I found online, and some were live-action movies.

For those shots without a reference video, I put the character model where he should be in the scene, and then adjusted the angle of the camera. The character's movement curve is horizontal between the two key frames, otherwise their movement will be very strange. However, in the 3D animatic stage, I finished the complete camera stage. In this way, even if the character has not been animated, the movement of the camera will give me a deeper understanding of the whole film.

During the 3D animatic stage, I made a lot of adjustments to the timing of this film. First I deleted some shots. According to the feedback from the professors, the pace of this film is a bit slow, and there are some scenes that have nothing to do with the progress of the plot. Then I changed some camera angles and camera moving routes, because some camera movement methods can have

better solutions. In addition, I also need to make sure that these shots do not violate the 180-degree rule:

"The 180-degree rule is a basic guideline regarding the on-screen spatial relationship between a character and another character or object within a scene. The rule states that the camera should be kept on one side of an imaginary axis between two characters, so that the first character is always frame right of the second character." (*180-degree rule*, Wikipedia).

After this process, the problems of time and space are basically solved, and I can enter the animation production stage.

TEXTURE AND LIGHTING

I used the basic material in Maya for most of the models in this animation, mainly AiStandard Surface material. In addition, some models use texture maps, and the main robot models have some textures made in Substance Painter.

The material properties of the robot model mainly include base color, metallic, roughness, specular and normal. Since the style of this animation is not realistic, I only used three textures: base color, metallic, and normal. In addition, I made some metal rusty textures in Substance Painter.

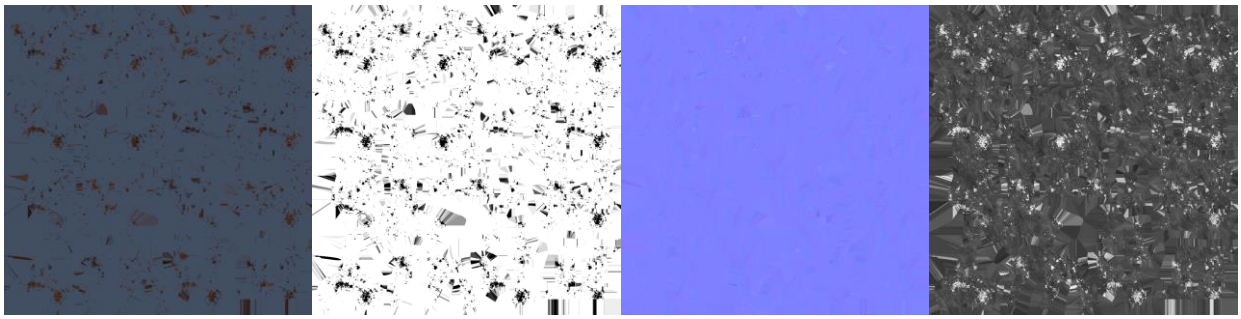

Figure 6-9: Four Texture maps of the robot (base color, metallic, normal, and roughness).

Although both the arena scene and the laboratory scene require dim lighting, the lighting of the arena is more complicated. The arena is dark in the long shot, and I have to make sure that the character's face is not too dark in the close-up shot. In addition, there must be a spotlight effect, after all, this is an arena. In order to render a conical spotlight effect, I added a fog effect to the scene to increase the degree of diffuse reflection of the light. In the close-up, I reduced the fog density and added some area light to make the characters appear in the camera more clearly. In addition, I thought of a way to produce the effect of the audience. I made simple human shapes with basic cubes and scattered them in the auditorium of the arena. Then I added a self-luminous material to some basic spheres, which were also scattered on the auditorium. Since the auditorium is relatively dark, it is rendered as if many audience are sitting in the auditorium.

The beach scene has different challenges. Since the beach is not surrounded by walls, it is necessary to make a suitable background for this scene. I created a Sky Dome light and found an HDRI image of a sunset environment. Its light can be used in this scene very well, but I can't directly use it as a background because its style is too realistic. So I adjusted its camera attribute in Arnold to 0 so that it won't be rendered. Then I found a picture of blue sky and white clouds as a background and added it to a plane behind the scene. However, when I tested the rendering, I found that the shadow of this plane would appear on the entire beach, as if there was an invisible but shadowed monster in the sky. I created a blocker whose size is just enough to cover the plane, so that the light from the Sky Dome will not cause shadows on this plane. But this way I can't see the color of the background image itself, so I added an area light. This area light only shines on the plane, so that the background looks better.

Figure 10: The Beach scene in this film.

MAYA ANIMATION

Before starting to animate, I deleted some shots that did not help the plot. However, when my animation was half done, the professors still felt that the film was too slow. Not only was the movement slow, but the overall path was also slow. In fact, I am very anxious about this, because at this time there is not enough time to make adjustments to the entire animation. There are two methods I can do. One method is to continue to delete some shots to make the plot develop more quickly, thereby reducing the duration of the entire film. Another method is to speed up the movement of the character for some fighting scenes.

The problem is that when I speed up the movement of the character, some movements will become incomplete due to insufficient frame rate. This problem appeared when I first started animating the character in this film. There are some fighting scenes I refer to some live action movies. These

movies may be 30 frames per second or higher, which is far more than the 24 frames per second of this animation. In this case, many details of that live action movie cannot be included in this animation. But this is not entirely the reason for the frame rate, the main reason is that the actions themselves are very fast. I used After Effect to change the frame rate of those live-action movies to 24 frames per second and exported it into a new video. However, this problem has not been solved well. Usually I set every two to five frames as a key frame for animation, but in these fast-moving fighting scenes, almost every frame must be set as a key frame, and this is not enough to make every detail of the movement. For example, in the 30-second animation *Thank You Kyrie* I did a few years ago, there is a shot of a basketball player moving five steps in 40 frames. Although it sounds a little weird, it makes people think how the action can be so fast. But the fact is that the duration of this action is consistent with the basketball game video I used as a reference, and I did not deliberately accelerate this action. Although I tried my best to make the details of each action, I still lost some key frames inevitably. And in that 24 frames per second animation, the character's posture changes greatly between each frame.

When I encountered this problem in this animation, I thought of three solutions. The first method is to increase the frame rate of the animation, but unless the frame rate can be increased to 60 frames per second, this will not help much to solve the problem. And this will increase the rendering time several times. Since the time for making animations is inherently tight, this solution is not feasible. The second solution is to make some fighting shots into slow motion, which will increase the rendering time, but I can set more key frames to increase the integrity of the action. The disadvantage of this scheme is that it will make the pace of the film slower, and it does not conform to the intense atmosphere of the fighting scene. The third solution is to delete some key

frames, thereby reducing the number of movements of the character. This solution makes the character's movement curve smoother, but compared with the live action movie that I used as a reference, the intensity of the action is insufficient. So I speeded up some actions. Although the effect is not perfect, it is much better than before.

In addition to the fighting scenes, I recorded most of the reference videos myself. This process is very interesting because I am very interested in acting and I hope to apply what I learned in the Acting of Animation class to actual animation production. At this time, I encountered another problem. The pose of the character in the animation could not be exactly the same as the character in the video I used as a reference. There are two reasons for this problem. The first is that the body proportions of the robot models are quite different from those of humans. For example, there is a robot whose arms are relatively short. When he is bent over, he cannot touch the ground with his hands like a human. So I asked him to bend his knees to lower the height of his waist so that his hands could touch the ground. Another reason is related to the weight of the skin. Since the skin weight value of the robot model is only 0 and 1, and there is no intermediate transition between them, these robots cannot make very soft movements. When humans bend their knees backward, the skin on the outside of their knees will stretch, and the skin on the inside of their knees will shrink. However, the robot does not have this function. If the knee is bent excessively, the calf of the robot may be inserted into its own thigh. I have two solutions to this problem. First I changed the model of the last robot. I stretched his limbs and enlarged the spheres at his joints. In this way, he can make various postures flexibly without making mistakes. Then, for those robots whose models cannot be changed, I adjusted their movements. I reduced the range of their movements so that their bodies would not intersect when they bend excessively.

Figure 11: Self-recorded reference video.

In addition, there is another problem to be mentioned in the process of making animation. There are several shots of pouring and drinking red wine in this animation. I used Bifrost to make the liquid. The process of calculating Bifrost and creating the cache was very long, and the calculation of each shot took several hours. Among them is an 8-second shot of the man drinking red wine, which took my computer than 15 hours to calculate, and finally generated a 45G cache file. This process put a lot of pressure on my computer. What's worse is that the calculated effect is not very good. I have to constantly modify the attributes of Bifrost. But I can see the effect of the fluid only after the calculation is completed, so I have to wait for it to calculate over and over again. The large amount of time spent in the calculation was beyond my expectation, and it also had an impact on my subsequent plans.

AFTER EFFECT ANIMATION

In the film, there are three scenes of the robot's avatar moving in the promotion table after the man’s robot wins. Since these three shots are not 3D animation, I made them with After Effect. Since it is all simple objects moving, there is no difficulty in this part, and I made it smoothly.

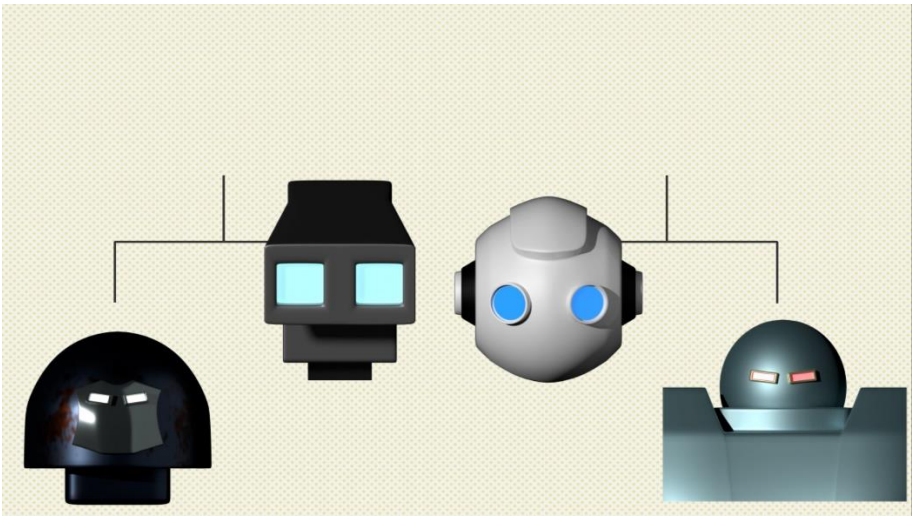

Figure 12: After Effect animation in the film.

POST-PRODUCTION

RENDER

The rendering of this animation is different from the animation I did before. My previous animations were done using the school's computer, so I can use the school's render farm to render my animation, or open dozens of computers to share the rendering tasks. However, everything in this animation was done with my own computer, not the school computer. Rendering is a process that takes a lot of time and requires relatively high computer hardware. So, if I use my own computer for rendering, I need to find other methods.

Initially I tried to use the school's VPN to connect to the school's render farm from outside the school, but it didn't work. Later, I tried to use Unreal Engine to render animation scenes. This method renders very fast, but I prefer the effects rendered by Arnold. In addition, I am a beginner who is new to Unreal Engine, and I am not familiar with many aspects of this software. In order to prevent unknown errors, I still hope to use Arnold to render this animation.

The good news is that I found several cloud render farms on the Internet and finally chose one of them. Although it requires a high cost, it should be the most convenient and fastest rendering method. In order to save costs, I reduced the rendering quality to a certain extent. In addition, I rendered the shadow effect by adjusting the exposure of different lights in the scene. Some shots were rendered a second time after I changed the lighting. The final rendering looks good.

COMPOSITING

After getting the rendered pictures, I imported them into After Effect and finally exported them as video. For several shots, I adjusted the exposure to make the picture appear in a clearer state. I did not adjust the color of the picture in After Effect, because I think the rendered color is acceptable. This animation has a total of 133 shots, so I composited 133 video clips.

MUSIC AND SOUND EFFECT

When I exported the video clips from After Effect, I received the music from my composer. My composer Kaman is a graduate student from Eastman School of Music. She is very professional and can compose music for different styles of movies. I contacted her three months ago and showed her the animation I was making at the time. In the past few months, we have kept in touch and discussed the style, duration and transition of the music. She also introduced me to the sound designer Fangyi, who is a graduate student from China. It is more difficult to make sound effects for action films, and it took two months to make the sound effects. I am satisfied with the final effect. These sounds help my film amplify the emotions of the characters and make the animation more complete.

EDITING

I imported the 133 video clips from After Effect and the received audio files into Premiere. I created new video tracks and combined these video clips into a complete animation. I also changed the order of some video clips and added some video transitions. Finally, I edited the title and ending credits, and added captions to the entire film.

EVALUATION

CRITIQUES AND RESPONSE

The screening of the film was a success. I couldn't see the big screen of the theater clearly from the Zoom meeting window, nor could I see the audience, but I heard their laughter. The comedy element I added to the animation made the audience laugh, which was a success for me.

Many audience members praised this animation, and some of them made some suggestions. The creativity of the story and the rhythm of the film are a good place for me. The design of the scene and the render effect have also been praised by the audience. The most complimented is music and sound effects. The sounds elevated the entire film to a new level.

Of course, there are still many areas that can be improved in the production of animation, especially for action scenes with dense key frames. In addition, some audiences have proposed that the one-dollar bills that fall from the sky can be changed into one-hundred-dollar bills. I think this is a good idea, because the man in the film has a dream of becoming rich.

Even though I was not able to go to the Wegmans Theater to watch the screening of the film in person, I was still very happy to see so many audiences online and heard their comments and suggestions. I want to thank everyone who watched and commented on my film, and everyone who helped and supported me.

CONCLUSION

This animation is a comedy with action elements. The protagonists of the film are two different characters of humans and robots. It can be said that this animation is a synthesis of my various ideas and creativity.

The production of this film is a long process. Before the production process started, I spent a lot of time learning and solving the technical problems that will be encountered during the production process. First of all, I took a 3D character design course, in which I learned rigging. The learning and production process took about five months in total, which is also the biggest difficulty in the early production stage of this animation. Another difficulty is rendering. It is a challenge to make a complete animation without using the school's rendering farm. I tried various methods and finally solved this problem using cloud rendering.

I think this film is a success. Both the story and the entire production process are complete, and the overall effect has reached my initial expectations. The feedback from the audience was mostly positive. Of course, there are many things that can be improved. First of all, animation can be better. In addition, the character I made cannot do more exaggerated movements and expressions, which is related to the amount of Blend Shapes. Also, the material can be made better. I simplified the material of many objects for a simple movie style.

The production of this film is undoubtedly unforgettable. I still have a lot to improve, and I believe I will do better in the future.

APPENDIX

THESIS PROPOSAL

Winner

Yizhang Liu

3D Animation

MFA in Film and Animation

Rochester Institute of Technology

March 27, 2020

Logline:

A man who wants to profit from a robot he invented finally paid for his selfishness.

Treatment:

Scene 1: Match scene

Under a spotlight in a dim place, two robots were fighting fiercely. One is tall and strong, the other is relatively short. Their eyes glowed with a blue light. Not far from them, a thin man, John, stood there. He held a remote control in his left hand an analog stick in his right hand, and looked anxious and nervous. John controlled his shorter robot, Leo, trying to win the game. As time goes by, John shook his analog stick faster and faster, Leo moved faster and faster still. Suddenly, Leo's left arm was ripped off from his body. At the same time, he punched his opponent. The tall, strong robot fell back to the ground.

John stood on the podium with a smug look on his face. He held a golden trophy in his left hand and waved his right hand around as if there were many spectators around him. A well-dressed waiter came with a tray and handed him a money bag. Suddenly his eyes widened, his right hand held the money bag and stared it intently. Not far from the podium is Leo's broken arm.

Scene 2: Home

John went back home with the trophy and the money bag in his hands. There is a shelf full of various trophies. He put the new trophy next to the last one. He went to the dining table, put the money bag on the table, opened the refrigerator, and took out a carton of milk. He poured a glass of milk into the cup, put down the milk carton and picked up the money bag. John sat on a sofa near the window, took a sip of milk, and looked at his money bag proudly.

Many banknotes and coins fell from the sky like rain.

Scene 3: Imagination, A beach

The whole scene changed. The wall behind him moved sideways away from the camera, and a beach appeared behind the wall. The coffee table on his left transformed into a round beach table, he looked to the left. Then his sofa transformed into a beach chair, his body fell a little. A large parasol opened from the back, he looks back. He looked down and his eyes widened, the glass in his hand became a goblet. Someone poured him a half glass of orange juice, someone put him on a pair of sunglasses, someone put a wreath on his neck, and someone put a slice of lemon on the edge of his goblet. John picked up a banknote from the ground and kissed it. He glanced at the goblet in his hand and drank the orange juice. A beautiful waitress pours him juice again, he drank it and laughed.

Scene 4: Home

John snapped out of his dream and returned to reality, slowly closing his mouth, and his expression became serious. He glanced at the glass of milk in his hand and poured the milk out of it in disgust. John stood up and walked out of the scene.

Scene 5: Lab

The lab is dark with some faint light from the computer screen. John picked up Leo's broken left arm on the ground and walked to a work table. Leo was lying on the table, a shadow slowly appeared on his body. His head moved very slightly, but the light in his eyes had gone out. John began to work hard on the work table with his back to the camera. After a while, he went to the computer on the left and typed some words. Then he went back to the work table, and then went to type on the computer. His facial expression was tense. Finally, he shoved a chip into the robot's chest. John stopped working and smiled. Leo's eyes lit up again with a pale blue light. He sat up slowly, stretched out his left arm, and moved his fingers a few times.

Scene 6: Match scene

Leo defeated an opponent. John raised his hand to cheer. A hand drew a line on the promotion table. Leo won, John cheered, they advanced, Leo won, John cheered, and they advanced. Leo's scratches were increasing, and John's expression became more and more ecstatic.

The finals were fierce. John rocked the analog stick faster and faster, and the robot moved faster and faster. Suddenly, the analog stick was unplugged from the remote control. In John's surprise, Leo stopped his movements. Leo got a hit on his back, the chip in his chest was punched out, and flew into John's surprised opened mouth. John made a swallowing gesture.

The light in Leo's eyes changed from light blue to red. He walked towards John and grabbed the remote control and analog stick from him to assemble them together. Leo shook the analog stick, John raised his hands without any expression. Leo shook the analog stick again, John put his hands down. Leo kept the analog stick in one direction, John walked towards Leo's opponent.

Scene 7: A beach

Leo sits on a beach chair and sucks juice from a glass with a straw. He took the remote from the table next to him and shook the analog stick. John ran over with a bottle full of juice, and poured him another glass of juice. Leo shook the analog stick again. John ran away and run back with a fan. He stood by Leo and fanned him. The camera slowly zooms out.

End.

Rationale:

This story took me a long time to figure out. I used to think about animals, fairy tales, realistic style, action movie, cold weapon era, cyberpunk, etc. When I wanted to try multiple elements in the story, I learned that a good story must have a distinctive style.

Actually this is a comedy with some action elements. The main character, John, is obviously a comedian. He has exaggerated movements and expressions, and he is more sensitive to the surroundings. The richness of his subtle performances places high demands on the character's model. However, the robot, Leo, is not as expressive as John. Most of his plays are broad performances like the fight and control the analog stick. He has his own independent mind though it is weak. And this is why he moved his head slightly on the work table and grabbed the remote control in the end.

This story can reflect some of the issues and relationships in the society. First, technology development and humanity. People are increasingly relying on machines and technology, but they are ignoring their own emotions and feelings. People pay more attention to the profits and forget that profit can also serve humanity. This is why John only wanted to win the prize and ignored Leo's injuries. Second, humans and artificial intelligence. In the beginning, humans always thought that their wisdom was above artificial intelligence. However, the development speed of artificial intelligence is far beyond human imagination. No one could predict what will happen in the future. This is why in the end of the story, John and Leo's status reversed. Third, labor remuneration and freedom. Higher pay means more time and effort and less freedom. If you give

up part of your pay, you may get more freedom. This is why Leo gave up the future trophy and became a free robot.

Vision:

This animation will be produced by using 3D technology. I will do the model part by using ZBrush and Autodesk Maya, create texture by using Substance Painter and Autodesk Maya, do the animation part with Autodesk Maya. I may also learn new software during the production process. I will try to make the visual style looks similar to my favorite animation “Up”. In addition, I will do more thinking about lighting. Different scenes will be rendered with different light colors and light temperatures to set tone and atmosphere. The overall style is soft and warm. The model will be made neat and soft, but their placement can be a bit more complicated. The background model will be made as finely as possible. A visually cartoony style but the lighting design will be close to real life.

Budget:

Item	Estimated Cost
Hardware	
Computer	IK
Wacom Tablet	$249.00
Software	
Autodesk Maya	IK
ZBrush	IK
Substance Painter	IK
TVPaint	IK
Adobe Premiere	IK
After Effect	IK
Photoshop	IK
Other	
Composer	$200.00
Sound designer	$200.00
Render	IK
Festival Fees	$400.00
Total	$1049.00

Timeline:

	Jan	Feb	Mar	Apr	May	Aug	Sept	Oct	Nov
Character Design									
Environment Design									
Storyboard									
Rough Animatic									
Environment Modeling									
Character Modeling									
Texture									
Lighting									
Animation									
Render									
Background Sound									
Sound Effect									
Compositing									

SCREENSHOTS


[Whirring, scraping metallic swings and hits]


[Typing]


DIRECTOR
YIZHANG LIU


Submitted in partial fullfillment of the
requirements for the MFA degree in the
School of Film and Animation,
Rochester Institute of Technology
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