Rochester Institute of Technology
College of Imaging Arts and Sciences
School of Design
Computer Graphic Design

Thesis Documentation for the Master of Fine Arts Degree

An Investigation of Facial Rigging for Animation

By: Patrick Clarke
Date: 5 - 9 - 2011

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Contents

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Abstract

The project " An investigation of facial rigging for animation " explores possible rigging methods for developing a stylistic 3D head that is both expressive and mimics realistic movements with animation. This project is broken into two parts: the modeling and rigging stage where most of the research and exploration takes place, and the animation stage that presents the final result of the rigging exploration. The first stage of this project explores developing an animatable head that resembles all basic emotions of the human face. The main focus of the project is on the formation of joint deformers and blendshapes, where more subtle emotions are created to increase its believability. The resulting product is an animatable head that can be used for animations for film, television, and motion graphics needs. Because of this, the project also includes a basic Macintosh computer, or PC , with the program Maya for modeling, rigging, and animation. The animations are done based on every possible emotion it can create while lip-syncing. The final presentation is a short film called "Barflies," with a talking character that is believable and interesting to watch, and that demonstrates the animatable end product.

Problem Statement

A recent independent study project inspired me to further pursue my studies in character modeling and rigging. I have noticed that facial animations are becoming more and more expressive and as a result have become very integrated and complex. With this project I hope to create a model that can express human emotions that are both clear and believable. I plan to explore the development of more subtle facial motions to further enhance this idea. The end result will be a product that is convincing, as well as straightforward and effortless to work with. With this I believe that, by creating a simple model and animation I can achieve my goal successfully in the time allowed.

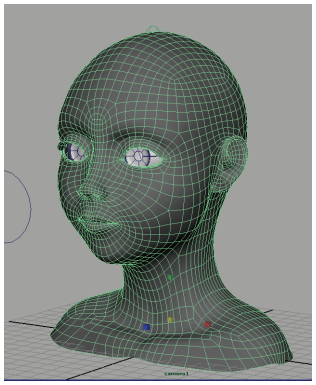
My process includes aspects of both the technical side and the artistic side of animation. I will first apply my knowledge of computer graphics to build the basic model and rig using information from various articles and books that are accessible, and from professionals in the field. The second part of the process centers around building the animation for the presentation. In order to best present my final project, learning proper animation techniques is a must. Without an animation, the model cannot present its emotions properly. The model and rig are to be assembled using Autodesk Maya where most of my time will be spent. Animations are to be used to test and concur that the rig is acceptable.

Documentation

Initially, my independent study research project focused on the development of a model and rig of a human head, mimicking the one highlighted in the book, "Stop Staring" by Jason Osipa. This book assists beginner 3D designers in building a face using polygons, aligning them to work well with deformers. This is at the core of what inspired my thesis project. I thought, 'Why not combine all the tools given to you in the program Autodesk MAYA, as well as the ones introduced in this book, to build a new hybrid of deformers that gives the animator more control?"

Model Created with blendshapes using "Stop Staring" as a reference

Because an abstract form can hold a wider range of controls and deformers I determined in the beginning that this type of form would work best for demonstration purposes in my project. An abstract form gives viewers a representation of the object and not a direct link, which might be a distraction to its purpose. In other words, if facial rigging becomes too realistic the viewer will become more critical of the model and see its 'natural' flaws. Abstract forms are more conceptual than tangible, and therefore allow the viewer the ability to connect by mentally 'filling in the blanks'. This is known as the 'Uncanny Valley'; the more realistic the character is, the more skilled the animator and rigger need to be to keep the audiences connection with the character.



Wire frame of the model

During my research I had the opportunity to consult with professional character rigger, Stephen Gressak, from Blue Sky animation studio. Blue Sky is well known for its popular animated films such as Ice Age and Horton Hears A Who. Gressak explained to me that within the 3D computer animated world there are 3 types of animation rigs. Each company has a specific rig that they look for when initiating each animation project. Depending on the job, it is important to know what rig you are creating to match the studios needs. The first rig is usually known as the cartoony rig, which is an extremely abstracted model that can stretch and bend in very unbelievable ways. The second rig is the realistic rig, which gives an audience a representation of realism, but has some of the same qualities of the cartoony rig.

This rig is among the more popular ones because of its realism. The third rig is usually known as the hyper realistic rig and is usually the more difficult rig. This rig is hard to accomplish because the more realistic an artist gets the more critical the audience can be towards his or her work. Not only does the rigger have to pay attention to every muscle and bone structure in the human body, the animators have to understand realistic movement between their actions. These types of rigs are more for the experienced hand in the animation world.

The first image is an example of a cartoony rig. This rig has little detail and is purely representational. The Third is an example of a realistic rig which tends to be more difficult to create because of how close it is to real life. The middle image is a mixture of both and is the type of rig chosen for this project.

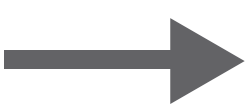
For my thesis project I decided to move along the more popular path, the realistic rig. This rig is among the more used rigs and will help express the facial movements better because of its familiarity among the animation world. Although I have had experience in the hyper realistic and cartoony rigs, I felt that this project provided me with the perfect opportunity to try something new, as well as to create a balance of skills within my animation tool kit.

Within a week of my researching and referencing, the next obstacle to address was project management. In order accomplish this project within the desired time, it would be important to understand what the end product should be. Character rigging is an important part in the animation process, but animation is the tool that presents the character best. It seems to benefit anyone in the animation field to understand every part of the process. If a character rigger is to build models and controls for the animator, than the rigger should understand animation. Therefore I determined that the end product of this thesis should include an animation of the model to show its capabilities.

After the end product was decided on, I needed to start to build a timeframe around it. This issue came up right at the start. The first rig that I created was able to blow up like a balloon and deflate. It took two weeks to create, but offered no substantial purpose. Since the boundaries of computer graphic programming can be limitless, I felt that it would be important to design a specific, and yet interesting, task for the character to do in the animation. This would give a rigger (or myself, in this case) a goal in mind, and eliminate any useless programming in the character rig.

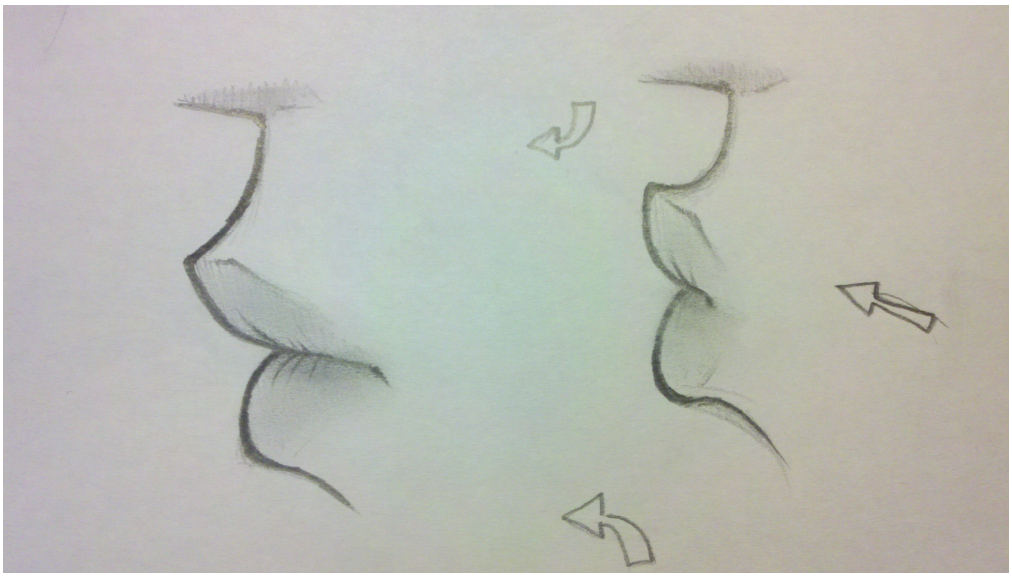
Now that the project scope was determined, the actual work could begin. The first action was to research current modeling procedures in the computer graphics industry. Referring back to the book "Stop Staring" was a great start, but to execute a successful rig the information needed to be expanded upon. In order for deformations to be correct with polygon modeling polygonal objects needed to be aligned in a certain way. I enlisted friend, and Syracuse University PhD student, Physical Therapy concentration, Brendan Boucher, to help me understand the natural human form and movement. He explained that in real facial structures there are lines that the skin follows called cleavage lines. These lines go up and down the entire body and help give our skin strength, but also over time form wrinkles. Surgeons follow these lines when cutting into the skin so when it comes time for healing, it's done quickly and effectively. As it turns out, most models in the computer graphic industry already follow these cleavage lines. Therefore this technique is quickly adopted for this project.

Before the modeling stage started, there was a concept in modeling and rigging that I decided to explore. This idea is to expand upon the idea of using blendshapes. For example, to take joints and blendshapes in the program Autodesk Maya and combine them to create an endless variety of blendshapes. In theory this arrangement would allow the rigger to model and rig simultaneously. In addition, the rigging artist would be able to fix or delete parts of a rig without deleting the entire animation of the model. This process would allow the modeler, the rigger, and the animator to work at the same time. Also with rigging, animation is a wonderful tool to use to see if the rig itself is working correctly. Again, advantageous because as issues arose they could be corrected, as opposed to waiting until one process was completed only to find out later that it wasn't working correctly, or wasn't working as was intended.



Basic movement of a Blendshape. It can only go in a straight line, but it can give you a great deal of control over your shapes.

Basic movement of the joint can move in a curve. It also can scale and translate, but gives you little control.

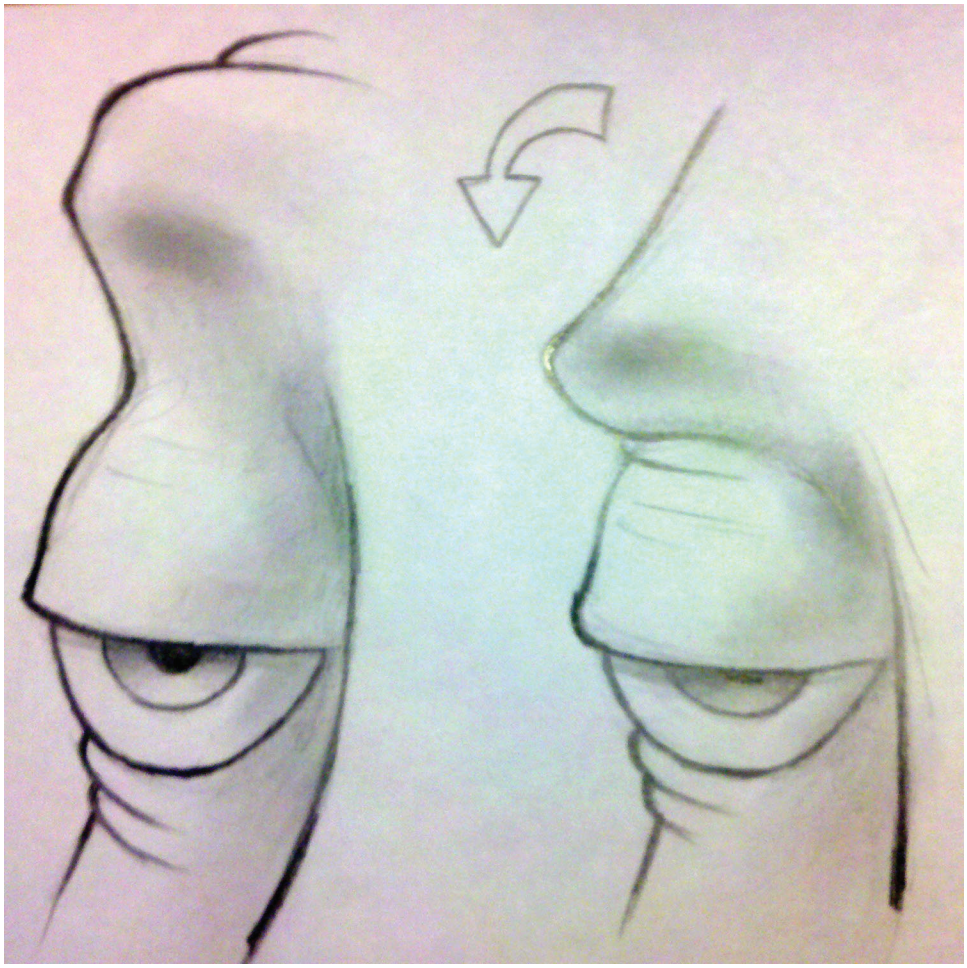


In the program Autodesk Maya, you are given the option to use influence objects called blendshapes. These objects can be used to influence the original polygon object by mimicking the created blendshape. For an example I created a blendshape of the characters jaw to move up and down, and then connected that influence object to the original face. When the blendshape is instructed to move the jaw, the original face moves its jaw as well. With this application you are also able to combine multiple influence objects giving you a great deal control. I concluded that this would be how I approached my original project objective: by creating a network of blendshapes I would be able to create believable character movement, while giving the rigger/animator significant control over his/her object.

Modeling of the figure began with multiple drawings. In the past I tended to be known for my asexual and female characters; not once have I ever drawn a male human. It was important to me that the character for this project defied all expectations. This is how I decided the sex of the character.

Next, this character needed to be semi realistic with some abstract qualities to perform the deformations in a believable and interesting way. This was accomplished by incorporating round and hard edges to give a slight contrast to the soft skin. Also, a feature that I always find intriguing, and that helped bring out the desired feel, is the use of the bean shape. This shape can easily express outward stupidity, sideways confusion, and inward shyness just by flipping the shape of the bean. The bean was quickly adopted as the over all shape of the head, and because this character will be drunk, the outward stupidity shape was chosen.

The nose became somewhat of a difficult battle between rounded and hard edged. The hard corner is great for over expressing emotion, also creating visual lines, but most modelers and animators like to draw attention away from the nose because its movement can look awkward to the viewer. This is also an issue when related to the movement of the tongue. Some animators leave the tongue out completely because its movement can become uncomfortable to viewers if done incorrectly.



The eyebrow was to be completely abstracted to create an extraordinary fold for expression. Hair in the eyebrows can be used to create curved lines to express emotion, but this character will not be given hair due to the lack of time. As a replacement, the character was given a fleshier based eyebrow.

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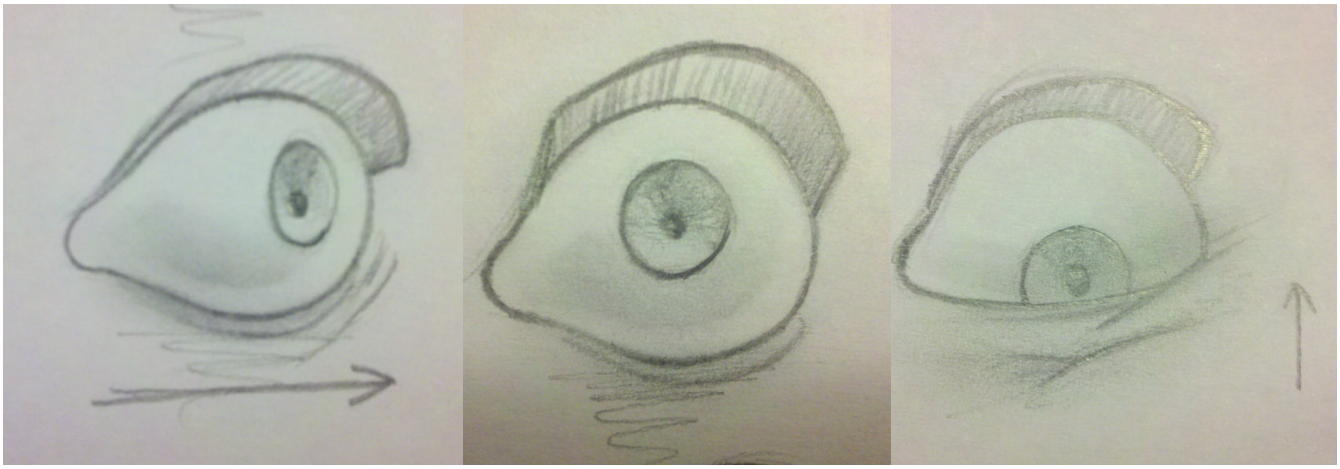
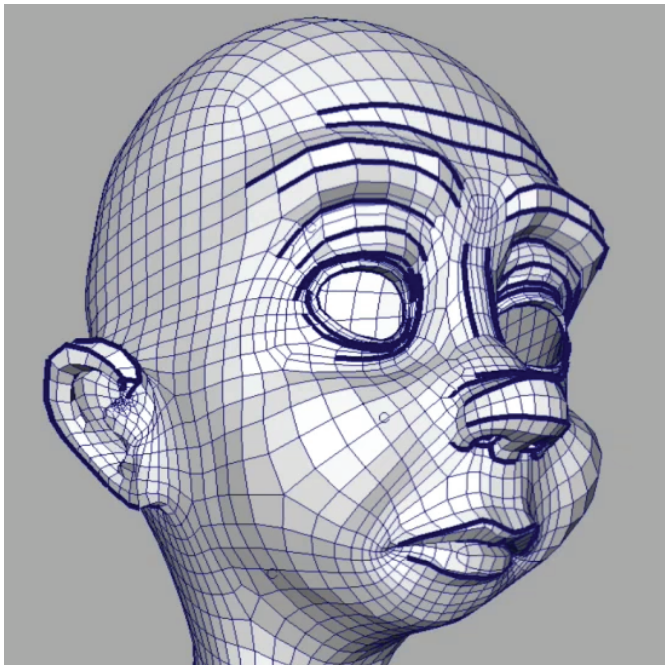
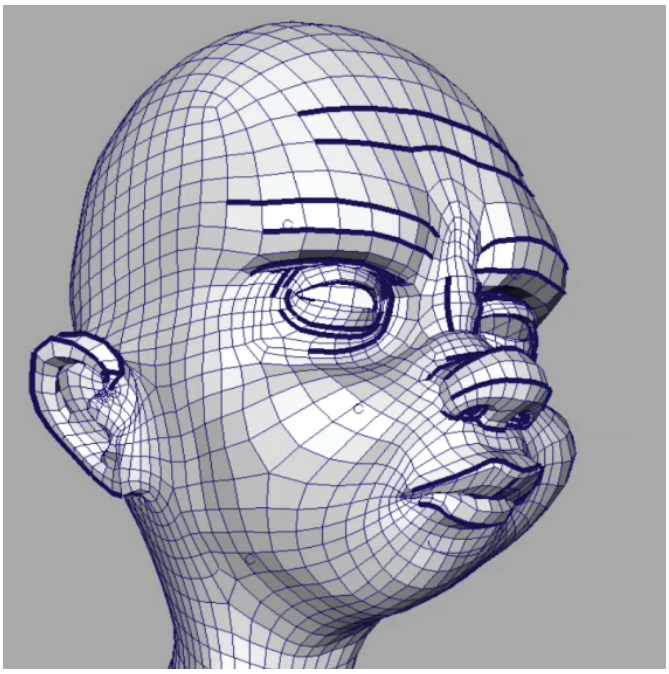
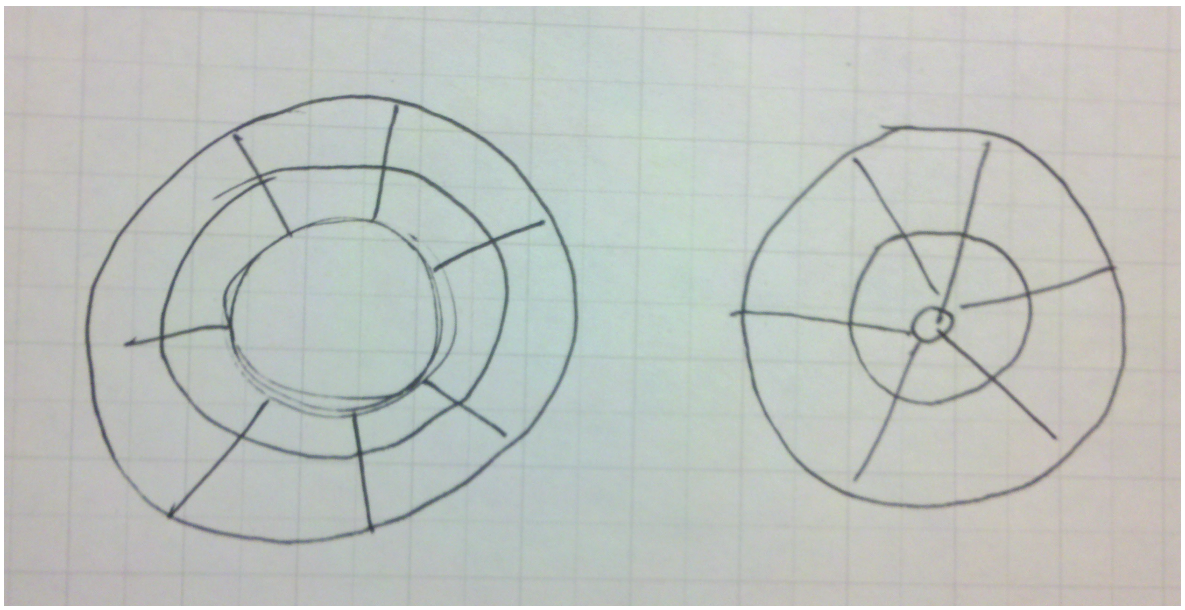


The eye area, in general, tends to be an audience's most important focal point. When a viewer connects to a character most of their viewing time is spent on the eye, therefore most attention in modeling and rigging will be spent on the eye. This is where the "Uncanny Valley" becomes extremely important because eye movement makes or breaks the believability and accessibility of the character. One of the first comments made by Steve Gressak from Blue Sky Animation Studios was that the movement of the eye should resemble that of a clam. Basically, when the eye closes the lids close in from all sides, pulling the eyeball back into the head. This is a very subtle motion, unnoticeable if done correctly, and therefore essential for animation and rigging. Not only does the motion need to be right for the eyeball and eyelid, but the way the geometry flows around the area. When the lid closes around the eye, the lid scrapes across the eyeball pushing the eye and liquid. Due to time constraints for the final animation, this rig did not present any liquid motion. For this rig basic joint deformers were parented to the skin to move the skin with the eyeball. Using the joints and aiming them towards a constraint would allow the skin around the eye to move in relation to the eyes movement. For example, when a person looks up or down parts of the skin around the area move. Next, a MAYA sculpt deformer was placed and resized to match each eye size and adapted the skin around the area. This pushed out the skin of the lid to always match the size of the eyeball. Also, this would serve to simulate eye motion even when the lids were closed. For example, when a person is sleeping, eye movement is noticeable from the skin of the eyelid.





Geometry is set up around the eyes in a circular fashion to create believable blinking.
As the character blinks the eyes are pulled back into the head.



When it came time to skin the character, I decided early on to use Subsurface Scattering. This texture allows for the scattering of light into an object. Here you can build veins and many skin deep textures. A texture artist can create the skin to be more or less translucent by adjusting for how much light will pass through. For this character, skin should resemble that of realistic human skin without breaking the "Uncanny Valley" theory. Certain parts, such as the ear and nose, will be more transparent than others, lending to the believability through a variety in textures. Bump maps with pores and slight dents in the skin will allow visible skin movement the further add to the facial movement.

Final shinning render on left. All texture maps for Subserface Scattering on right, along with specular maps

When it came time to animate the character, I had to take into account the abstracted 'feel' I was going for. Because this character became both an exaggeration and simplification, the animation itself should match this aesthetic feel. As I worked to solve this problem I found inspiration in the process used in various CG movies of the low focal length. In particular, "Horton Hears a Who", created by Blue Sky Studios.

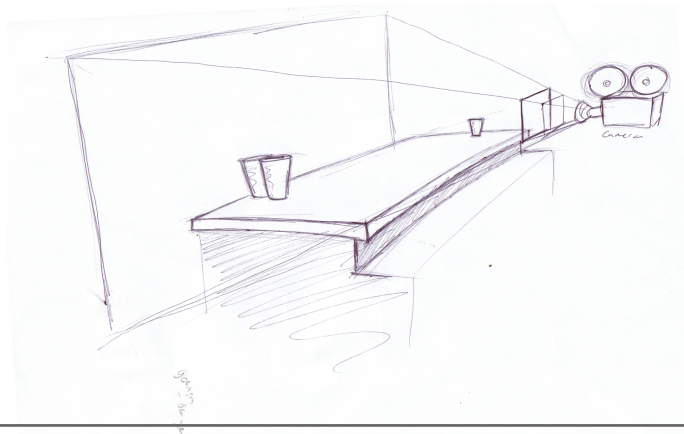
Here the studio used various methods to create the illusion of two-dimensions through three-dimensional space. The advantage of this technique is that characters become so overly abstracted that they become more representational. This emphasizes the feeling of the character, and focuses less on the exact. This method also offers silhouettes of objects and characters giving an aesthetically pleasing design.

Dr. Suess books have a very unique drawing style, and it was important to the 'Horton' project that the design stay relatively true to the original feel of the story. Dr. Suess's work existed long before 3D computer graphics became popular, so Blue Sky Studios matched his drawings using 3D software. One noticeable method was to flatten the characters and scenes entirely. This created a two-dimensional illusion to the scene. The characters and rooms were fattened, bent, and twisted towards the camera to give the allusion of Dr. Suess's style. Another method was to use a low focal length in a camera. This method takes perspective lines and makes them more parallel to the viewer, enlarging objects from the distance, and shrinking those close up. Here the viewer has more of a left to right eye motion rather than an in and out motion.

In my project the bar scene was flattened, where the camera was parallel to a wall, giving the audience a straight on view. A low focal length was used to give the bar less visual depth to help focus more on the character. The low focal range also helped simplify the animation because of its elimination of the z depth. I hoped that this would give more focus to the facial movement and structure of the character. Also, using this technique helped emphasize the hard edged lines in the character's face to further emphasize emotion.

Constant motion tends to draw attention towards the animation. Secondary animations and small movements of light and objects were placed throughout the short film in order to accomplish this. Lights in the background were placed to flicker on and off as to give the allusion that a band was playing. Small variations in lighting added to the idea of moving objects around the character. In order to show the passage of time, positions of characters, lighting, sounds and objects will change to further enhance believability.

Overall I think this project was a success with all desired goals being reached. A highly stylized model was created with semi-realistic qualities. Subtle traits developed using deformations and animations were created to enhance realism. Consequently, a complete animated short was created to exhibit the project model and rig, and all of its capabilities. Through extensive research and problem solving I feel that the end product actually exceeded my own creative and technical expectations. The principal area of personal growth for me was in the understanding of time management.



First sketch of the basic scene with the camera setup

Lines that make objects further away from the camera smaller

Parallel lines make the image flat creating and easily readable scene

Defining the project week by to its conclusion gave me the foresight to understand the importance of achieving the individual milestones along the path to completion. It also allowed me to build in breaks where I could reflect and explore new ideas if extra time presents itself. I believe that it is at these reflective points that some of my best work was done.

The most important area of technical development for me was learning the dynamics of rigging in relation to animation. Basically I came to the conclusion that rigging is really no more than animation itself. A rigger creates built-in tools that follow basic animation physics in order to assist animators in their work. This discovery came out of my choice to do an animation with a rigged model, and my constant need to go back and forth fixing the rig to enhance the animation.

Lastly, the chief area of professional growth for me was the realization that defining goals upon the onset of a project is key to its success. With this I now more fully understand the difference between a project goal and the end product. In my case I defined my goal to be a clear representation of a modeled and rigged human face. It was easy to get sidetracked as I did my research and started to develop my animated character. This process made me understand that I needed to constantly circle back to my original goal in order to not get caught up in the by-product, the animated character. Overall I think I grew both personally and professionally through the development and execution of this thesis project. I learned much about the subject matter, developed a deeper understanding of the technology involved and ended up with a better appreciation of the importance of project management. Mostly though, I learned even more about myself and my future roll in the field computer graphic design and animation.

Appendix A: Project Outline of the Thesis Proposal

Modeling

Using Autodesk Maya, an abstract model of a human head and bust will be made. Polygonal objects that form the face are aligned with what is known as a cleavage line. Cleavage lines are lines within skin that run along folds and provide durability, just like the fibers in paper. Simple rigs are made through the modeling process to insure that the deformations of the face are correct. Subtlety is key; if the skin moves incorrectly, the entire model's believability is compromised

Rigging

Using Autodesk Maya, joint tools and blendshapes are used to rig and move the face. The rigging process should pay close attention to subtlety like movement of eyelids in relation to the eyeball. Using the joint tool, the arch and pulls of facial animation are easily created to increase its believability. This part of the process begins the focus on " micro expressions" which I believe is key to successfully achieving my goal.

Animation

Using Autodesk Maya to create the animation and Adobe After Effects to organize it, this last step of the project results in the final presentation. This will be the culmination of all the efforts that have gone into this investigation. The animation will show as a QuickTime movie on a computer screen that will ran in a loop. Text and screen shots will be made in the animation to point out the subtleness of the rigged model.

Appendix B: Target Audience and Requirements

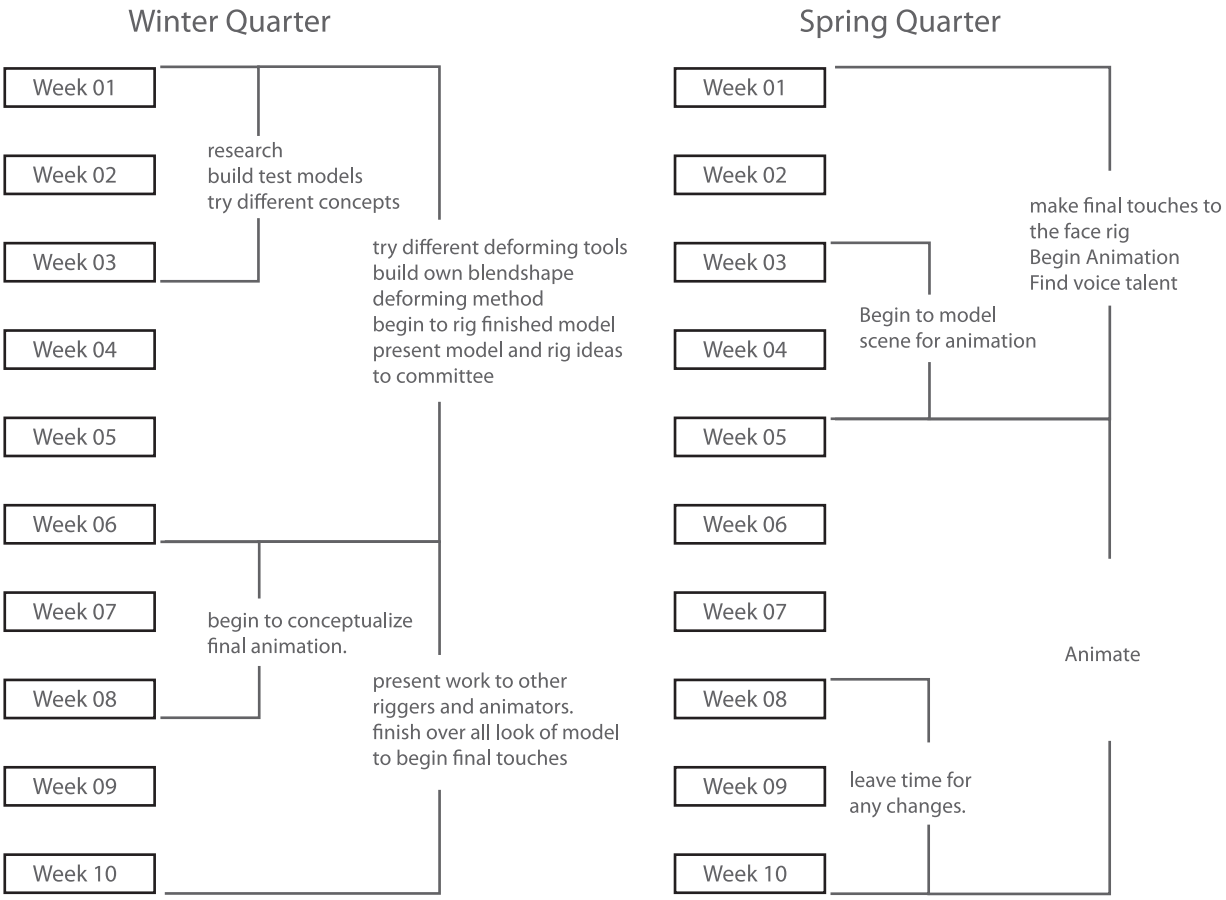
Male and Female
Ages 13 and up
No Education required
Motivation will be aimed at anyone who likes animation
If someone wanted to animate this model, experience in Autodesk Maya is needed

Software and Hardware Requirements

Macintosh G5
AutoDesk Maya
AutoDesk Mudbox
Adobe After Effects
Adobe Photoshop

Appendix C: Time Line

Time Line



Any breaks during this schedule will be time for experimentation of the model and rig, such as winter break and the breaks between quarters.

Literature Review

Much has been done already on this subject, but little visual improvement has come out of it. In this case, I focused the bulk of my research in the area of what has already been done, such as the technical elements needed to create rigs. This gave me a head start on creating interesting characters. I then focused on the basic structures of the human anatomy; which allowed me to understand how to make a successful model. Using these two basic research fundamentals were most important because they gave me a starting point to build off of. By Using this existing information, I could then devote more time and energy to develop my experimental rig system.

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