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Viewer Interactions in Animation

Megan Smith
East Tennessee State University

Viewer Interactions in Animation

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by

Megan Smith

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Greg Marlow, Chair

Todd Emma

Jacy Richardson

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ABSTRACT

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The art of animation can be viewed in a multitude of ways. Passive viewing, in which an audience is merely observing the acting and are unable to alter the animation in any way, such as watching a TV show or movie. Interactive camera viewings, such as Augmented Reality and Virtual Reality, in which the viewer can manipulate the content visually in the same way you observe the world, by moving the camera around in a digital space. Interaction-dependent viewing describes animations such as video games, where the player has full control of the character's actions and the timing of those actions. With a multitude of viewing opportunities, each has its unique challenges for creating animations that work in these platforms. The level of viewer interaction greatly dictates how each animation is made. In the paper, I will discuss the differences in animation creation as it correlates to the level of viewer interaction.

DEDICATION

This research paper is dedicated to my mentor and friend, Greg Marlow. I couldn't have done this without you. You've taught me far more than keyframes and arcs and I'm thankful for all the life lessons I've learned in our time together. Thank you for pushing me to be the best version of myself and inspiring me to become an even better animator, I would have made a terrible doctor, so you've saved more than just my life.

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Jacy Richardson, for watching me give Todd sass and still agreeing to be on my committee.

My dog Maya, for showing me a good version of Maya exists.

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PREFACE

The animation examples throughout this document were completed as part of various freelancing opportunities I had, and one in partnership with a few very talented friends of mine. All the animations mentioned were made using the software Autodesk Maya. All of the characters mentioned in this document were part of a process referred to as rigging, however, I will be going over the rigging process for the Elf Girl character mentioned in Chapter 5. Though rigging is mainly mentioned in Chapter 5, it is necessary for all 3D animation.

CHAPTER 1. INTRODUCTION

The art of animation has always been intended to be an experience. Over time with all the technological advancements made in the industry, animation can be viewed in a variety of manners. To narrow the scope, we will be focusing on computer-generated three-dimensional animation only, commonly referred to as CG 3D animation. CG animation has risen to be an internationally sought-after medium, with everyone from commercial studios to independent filmmakers developing their entertainment. Some examples of how these animations can be viewed and interacted with, which I will discuss in this paper I have labeled as Passive Viewing, Interactive Camera Viewing, and Interaction-Dependent Viewing.

Passive Viewing typically gives the user little to no interaction with the media as the viewer is meant to just watch the animations and consists of mainly television shows and movies. There can be examples in Passive Viewing in which the media can break the fourth wall, meaning the character(s) doing or saying something that either explicitly or implicitly acknowledges the artificial (Wigmore, 2013). Many children's shows in particular use this method by speaking directly to their audience. Interactive Camera Viewing gives the viewer/player control of the computer-generated camera within a 3D space, able to view the animation at whatever angle the viewer wants. This type of media is commonly referred to as Augmented Reality and some Virtual Reality. In Augmented Reality, the viewer uses some external screen device such as a phone or tablet to view an animation projected on their current environment using the phone's built-in cameras. Interaction-Dependent Viewing gives the viewer the most control, typically within video games and some virtual reality games. These types of media allow the viewer to typically play as an avatar, move within an environment, and interact with other avatars and objects in the game level, solely dependent on viewer interaction. Viewers

have a multitude of ways to interact with CG animation, but how does the type of viewer interaction change how the animation is made? At what point in the viewing experience and interactive experience does the viewer cross into the threshold of becoming an active participant, and how does that change how the animations are made? Throughout this paper, I will be giving examples of the three categories mentioned, and how the intended viewing experience changed how the animations were made in production. I will go within the order of interaction level starting from least interaction to most interaction. I have personally worked on the three categories professionally and will be discussing the projects that coincide with those, as each one came with a different set of challenges along the way.

CHAPTER 2. LITERATURE REVIEW

History of Animation

The audience or viewer has been the center of the creation of art and can be traced back to cave drawings back to prehistoric times. “Man has always had a compelling urge to make representations of the things they see in the world around them” (Thomas & Johnston, 1981.p.13). Before the invention of written language, people used drawings and art to portray a message and communicate with the viewer. “As we began to interpret the world through drawing, a new way of thinking emerged, and we started to record our thoughts and experiences in the external world” (Goodman, 2019. p.1). Moving into the modern day, more people have access to digital media content than traditional physical art content, producing digital media as a new form of art, making its debut in the 1990s. By taking photographs or drawings that depict a continuing action, an artist could create the illusion of movement, opening the door to whatever animation they choose to create.

A doctoral thesis can be found deep within the archives in a museum of the Massachusetts Institute of Technology (MIT). The title of this thesis, ever fading from the time reads as,

> Technical Report No. 296, 30th January 1963
> Sketchpad: A Man-Machine Graphical Communication System
> By Ivan Sutherland

However what matters most in this thesis can be found on page 66, according to Sito, “Sketchpad need not be restricted to engineering drawings. Since motion can be put into Sketchpad drawings, it might be exciting to try making cartoons” (Sito, 2013.p.1). This sentence can be seen as what started a multibillion-dollar industry. Ivan Sutherland then went on to use an obsolete 1950s cold war computer to create the first true animation program. This program,

instead of presenting numbers, drew lines and formed recognizable images. This program went on to keep the name, Sketchpad, and is one of the baby steps for the art of computer animation known as computer graphic imaging (CGI), simplified later to CG.

Defining Animation

According to Hodge, "Animation in new media art, in turn, creatively articulates and expressed the widening chasm between lived experience and the insensible technical infrastructure that makes so much of it possible" (Hodge, 2019. p.1). Animation can now be used in many different ways, in a variety of experiences and mediums. Whether that be the newest animated movie, a simple animation on a corporate presentation, augmented reality, video games, and many other mediums. The definition of animation has changed over time. Previously, animation was defined as "a non-recorded (non-live action) illusion of motion and as a frame-by-frame production" (Martinez, 2015, p.1). However, in more recent technological times, that definition has become slightly skewed but can be defined more by the intent to portray illusory motion. In the early 1900s, animation gained immense popularity, thanks in part to the success of Disney Studios, which dominated the industry at that time. Two of Walt Disney's top animators, Frank Thomas and Ollie Johnson, authored a book called, The Illusion of Life, which was released in 1981. In this book, they introduced foundational ideas in animation that are still in use today, known as "The 12 Principles of Animation" (Walsh, 2006). The twelve principles list as the following:

1. Squash and Stretch
2. Anticipation
3. Staging
4. Straight Ahead Action and Pose to Pose

5. Follow Through and Overlapping Action
6. Slow In and Slow Out
7. Arcs
8. Secondary Action
9. Timing
10. Exaggeration
11. Solid Drawing
12. Appeal

These principles are used today to help teach inspiring animators the founding rules for creating high-quality animations.

Pokémon Go and Augmented Reality

A name known and beloved by many is Pokémon, a Japanese game series developed by Nintendo, that aims to train and collect monsters throughout a fictional world. The series has been in existence since February 1996, with the release of its first title (Occhi & Doerr, 2019). Over time, Pokémon has been able to keep their great success running for almost 3 decades, allowing multiple generations to grow up playing these monster-catching games. More recently, Nintendo found great success in a mobile game called Pokémon Go. This game takes advantage of new technology making the game more interactive than ever by incorporating augmented reality (AR). Pokémon Go is free-o-play and used GPS technology to track real-world locations making it seem like the player was in their own Pokémon world. This, in turn, encouraged people to get out and exercise and explore local geography like never before. When a player encountered a Pokémon creature on their route, they had the option to catch it using the AR

system that utilized the phone's back camera to display the animation of the Pokémon on a transparent background, creating the illusion that the creature was present in the player's surroundings. The AR technology also tracked the location of where the Pokémon was standing so the player could move the phone around and the Pokémon would stay in the real-world location rather than staying in the center of the screen, further pushing the illusion that the creature was there in the real world. Nintendo's success with Pokémon Go helped pave the way for more users and developers to take advantage of AR technology in future games and experiences.

Game Animation

Game animation has become a developing career over the years and has branched into many career titles given the more technical process of creation to be playable in the game engine. "For the typical in-game animation, animators will take the rigged character and create cycled movements that can be activated with in-engine scripts" (Totten, 2012, p.194). These scripts control the character's movements following player input. This style of animation can have different technical requirements than animation for film and television. Game animation creates a strong connection between the audience and the characters, as players feel invested in their actions and believe that their input is what gives their characters life, making them an integral part of the story and overall experience.

However, this style is more dynamic and interactive because each animation made has to relate to the entire game set of animations. For example, if a character is going to do an attack, that attack animation's first frame would need to be an identical pose to the character's idle animation so that the character can seamlessly start the attack, while simultaneously keeping

quick timing to match the player's input. "It is highly likely that the player run cycle will be the animation viewed the most in the entire game by a wide margin, so it needs to look flawless by the end of the project" (Cooper, 2021, p.145). This field also comes with many branches of the animation job title including, "Gameplay Animator, Cinematic Animator, Lead Animator, Animator Director, Principal Animator, Technical Animator, and Facial Animator" (Cooper, 2021.p.14-17). While animators still get creative liberty in-game animation, it comes with it's own set of technical challenges and the animators collectively need to work on how one big body of 6 (the game set) will correlate together and flow. This technical workflow is what makes game animation one of the most complicated pipelines in animation but provides the most immersive experience for the viewer.

From cave drawings to retro computers, viewers have always been the center of artists' work. Creating the best viewer experience has become more of a priority, the more technology advances. Once drawings were able to be played quickly to simulate motion, it created a big boom in animation media. Frank and Ollie became the pivotal leaders of animation, writing what animators consider the animation bible and introducing the 12 principles to new generations of animators. With the rise in popularity of AR and Video games, animators are having to consider how the viewer will interact with their animations to make it an immersive experience. Animation means much more than just moving pictures, as are the responsibilities of anyone choosing to be an animator. The different paths an animator can go down are vast and get more complicated the more specialized the work is.

CHAPTER 3. PASSIVE VIEWING

Passive Viewing animation is one of the most common forms of animation interaction. Most everyone has at some point watched a form of animation, whether that be an animated movie, television show, a gif online, or even animated widgets in our favorite apps on our phones. Passive Viewing gives the viewer little to no interaction with the piece aside from watching. However, there are examples of animations that often break the fourth wall, by directly interacting with the viewer such as children's shows asking for a response to a question. Regardless, since the animation does not change depending on the child's response, which would still classify as a passive viewing experience. For this example of viewing, I will be using some of my professional work to analyze how it was made. The animation in question is a Children's show developed for a national early childhood education program known as The Learning Experience or TLE. At the TLE facilities, children from ages six weeks old to five years old can participate in their programs. TLE also has a cast of anthropomorphic characters that are used in their curriculum to make learning more tangible for small children. As part of their curriculum, they show the children animated episodes of their show titled "Bubbles and Friends" which I as well as a handful of animators work on. The episodes can vary in terms of topics from learning about bees and their importance, to how to clean up their toys, to have a safer environment. I will be referencing shots I animated from Bubbles and Friends throughout this paper.

Passive viewing is one of the more straightforward forms to animate because it gives the animator more control over what the viewer can see. The animator has control of what is in the frame which is the important keyword here. The frame refers to what the camera sees within the 3D environment. In Autodesk Maya, there is a tool that can be used to see the exact layout of the camera and what the output view will be. This gives the animator the best idea of what to

prioritize when animating. For example, if the camera is only showing the mid-chest up on a character, the animator can choose to not animate things outside the camera view, such as the feet and legs. This is a very common trick in animation to make turnaround times quicker. For example, **Figure 1** is a shot I animated of a character named Lionstein. It was a short shot of him speaking to another character and only showed the chest up. Figure 1 is the final render of how the shot looked. However, in Maya, you can see the defined camera shape indicated by the small gray outline of what the viewer will see on the left image of **Figure 2**, versus what only the animator will see on the right image of **Figure 2**.

Figure 1 Lionstein Render (Bubbles and Friends)

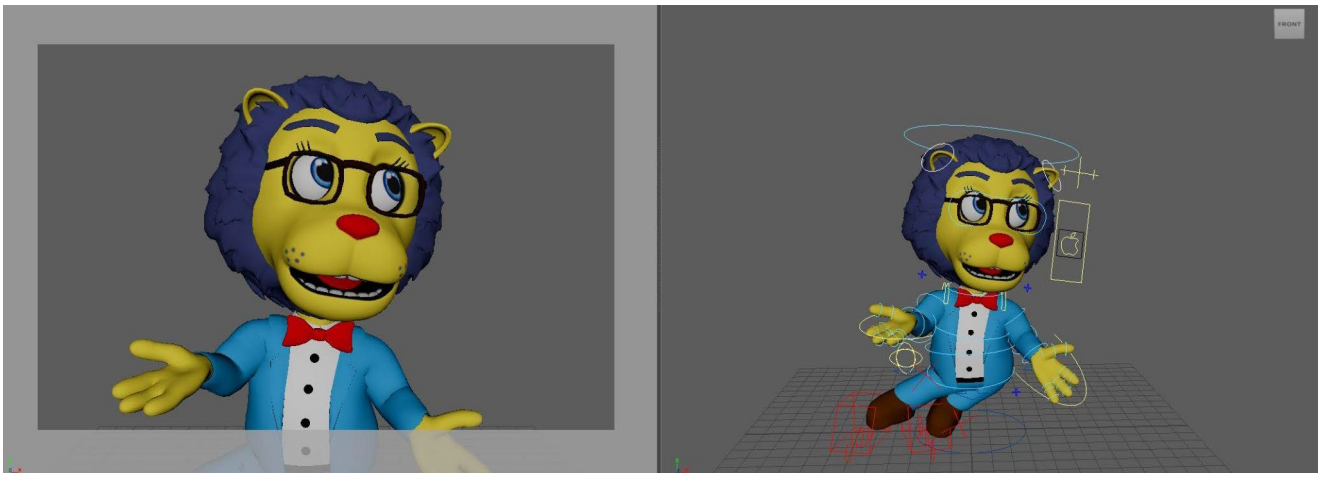

Figure 2 Lionstein in Maya (Bubbles and Friends)

Since this shot was only chest up and the camera didn't move, I could leave the feet alone and not animate them at all. For this example, I exaggerated the feet placement in the right image of **Figure 2**. This type of viewer interaction gives the most control to the animators and allows them to work more efficiently, polishing only what matters to the viewer.

The background is usually just a transparent background, similar to a PNG file. This will allow the artist to position and focus the object/character in the foreground, giving it its own frame. Unless the character is directly interacting with another character or object, the focused character is typically set up in an empty scene like in **Figure 2**. For example in **Figure 3**, the little boy, Braden, is holding a water hose ready for it to be turned on. To properly animate this shot, I still need to frame the shot up, but because Braden is directly interacting with an object, in this case, the hose, I need to have the hose in my scene as well to line up the correct hand positions and constraints. In this scene, it is implied that the hose is connected to the barn for its water supply, but because the audience doesn't need to see the connection to know it's connected to the building we can just bring in a hose prop that is shown going off-screen. As we can see in **Figure 3** what the camera will see on the left image, and what the animator sees on the right image.

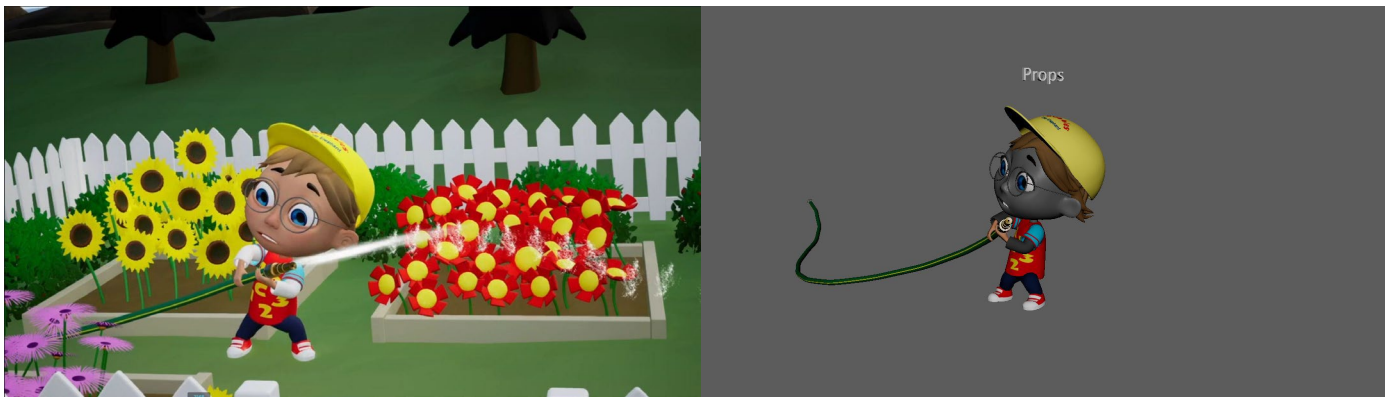

Figure 3 *Braden holding water hose (Bubbles and Friends)*

An aspect of passive viewing that is very different from some of the other mediums, is looping animations. Looping animations are made by making the first pose on the first frame of an animation and the last pose on the last frame identical. Then when played back on repeat the character looks like it is doing whatever action infinitely. Typically, passive viewings, such as TV and film, is a compilation of different camera shots. So given that the next shot will most likely be a different camera angle, animations can get away with being as long as that camera shot. These types of shots do not need to loop, so they are allowed to start and end with completely different poses. However, it is important to keep in mind if that character or object is in the immediately following shot, it will need to be in a similar pose. For example, if a character is sitting in shot 2, and in shot 3 the character is posed standing upright, you will lose the illusion that the scene is one long shot with multiple cameras. It is important to keep in mind what the previous shot looks like so your first frame can start with that same pose and so on.

There are some cases in Passive Viewing where characters can break the fourth wall. For this example, I'm referring mostly to children's shows that speak directly to the viewer. Many of these shows will make eye contact with the camera and ask the viewer a question and wait a few seconds for a response. Since the viewer choosing to respond or not respond ends with the same outcome I still include this type of shot as a passive viewing experience. For example, in this shot **Figure 4** from Bubbles and Friends, the elephant, Bubbles, starts the episode by asking the viewer what the object in his hand is. Then waits a few seconds, and an audio clip of children saying "a soccer ball!" plays, and Bubbles responds positively. So because this shot is directed at the viewer, it is important to make sure the eyes are pointed directly at the camera, to give the illusion of eye contact with the viewer. However even though this style of acting choice

encourages viewer interaction and response, the viewer's actions or lack of actions will not change the outcome of the piece.

Figure 4 *Bubbles making eye contact (Bubbles and Friends)*

CHAPTER 4. INTERACTIVE CAMERA VIEWING

To define interactive camera viewing media, the viewer gets control of where the virtual camera is within a 3D computer-generated space. One example of this is Virtual Reality, used in video games. Virtual Reality, commonly known as VR, is typically viewed with goggles that have a screen for each eye, and once shown together give the illusion to the viewer that they are inside of the virtual space. Some Virtual Reality experiences also give the viewer the option to move around within the 3D space using a game controller in their hands, while wearing the headset. So when creating animations for Virtual Reality, animators need to make sure their work can be viewed at any angle as well as loop correctly because there is no limit for how long the viewer/player may take to interact with the animations or simply look at the animation.

To create an animation that loops, the first frame and the last frame of the animation need to be identical poses, without any differences, so when the animation is played back it can play for an infinite amount of time without the animation looking like it has ended. A type of animation typically used in video games is often referred to as an Idle. Idle animations are played when the isn't receiving player input and are made to make the character look alive even when not performing. These movements range from being slightly subtle fidgeting and breathing, all the way to bobbing back and forth to a beat, depending on the game style. These animations are very important because the animators don't know how long the player will wait before interacting again.

For the sake of simplicity, however, I will be going more into the differences when it comes to Augmented Reality animations. Augmented Reality, commonly referred to as AR, is an interactive experience that typically combines real-world environment and computer-generated assets. The launch of Pokémon Go in the summer of 2016 was a huge success for both the

gaming industry and Augmented Reality (Javornik, 2016). This game combined the use of the real world using a cell phone's GPS and camera to make a mobile Pokémon-catching game. The game used the phone's camera to play transparent-background animations in a real-world environment to give the user the experience of catching Pokémon in their own home or town. This game's phenomenal success demonstrated AR's potential to be adopted by mainstream culture (Javornik, 2016).

In 2022, I had the opportunity to help create an augmented reality experience in collaboration with Stingray Studios and UNC Blue Sky Innovations for the NFL team the Atlanta Falcons. This experience was meant to be played in the Mercedes-Benz Stadium in Atlanta Georgia for their 2022 football season. This project had multiple deliveries with the first rendition having a turnaround time of about two weeks. The initial plan for the first version was for their game against the Jacksonville Jaguars. The concepts for the first animation were a QR code would be played on the 63,000 square foot 360-degree HD screen for fans to scan from their phones. Once scanned, the QR code would take the viewer to a website that once given access to your camera would play the Falcon mascot to bursting down through the ceiling, swooping from stage right and landing on top of the Jacksonville Jaguars logo, grabbing it with the Falcon's talons and carrying it off into the dome of the stadium. The initial concept can be seen in **Figure 5.**

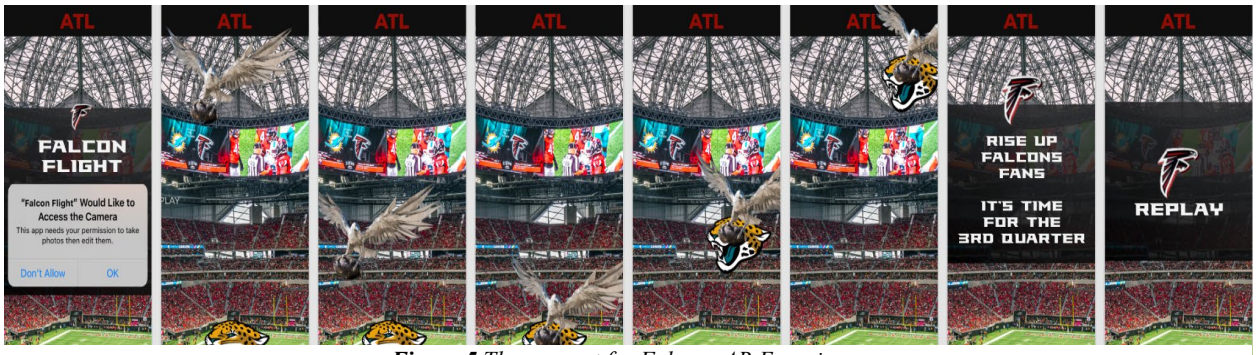

Figure 5 *The concept for Falcons AR Experience*

What made this animation more challenging than typical passive viewing is, much like games, it needed to be visually pleasing from any angle because the user would have full control of the camera, as well as the animation needs to be compatible with the real-world stadium it would be played in. The falcon itself is measured to be roughly the size of an elephant if it were to be in the stadium, and we had to measure the height of the stadium so that the flight path would be accurately timed. Mercedes-Benz Stadium from ceiling to field is about 305 feet. However, most 3D computer-generated programs don't use typical conversion units by default, so that had to be converted into using feet as a unit of measurement. I then animated the falcon movement without posing it to get the flight pattern right, as well as the height and length of the animation, this process involved a lot of testing back and forth with UNC and the Atlanta Falcons as I was working remotely in Tennessee and UNC was based in North Carolina. Once we were able to nail down the right flight pattern, I was able to start working on the body mechanics of the animation. Once I got into body mechanics, I had to keep in mind that the animation still needed to loop, so in case the viewer may have missed it, the animation would start again.

For the next iteration of the piece, the stadium director wanted the experience to be more interactive for the viewer and asked that the animation fly over fans' heads and make a couple of laps around the stadium before landing in the field in the center. The flight pattern was tricky as well because we didn't want the animation to fly too far overhead and make the viewer bend in odd ways to track the falcon. I made some flight patterns in circles without any body motion, and we used that for testing to scale the flight path in or out depending on how it looked on the phone screen. This part was difficult to predict because the flight pattern was in the shape of a circle

and needed to play in a stadium that was oval-shaped and had to look correct no matter where the fan would be sitting in the stadium.

We also had to take into consideration the age of the fans and the availability of technology when we created this experience. So, for viewers who maybe didn't know how QR codes worked or maybe their phones were too old to have a QR ready built into them, we wanted to make sure all the fans could enjoy the animation and be a part of the experience. So after the QR code was shown on the screen during halftime, UNC hooked up an iPad remotely to the TV from the stands and they screen recorded the AR experience from the tablet up onto the 360 screens so even without scanning anything fans could still enjoy the Falcon, it would just be more a passive viewing experience, as the person recording with the tablet was in control of what the camera was seeing. Overall, this experience came with many challenges I had not yet faced in my career at that point and put AR animation creation into its category, separate from Passive Viewing and Interaction Dependent Viewing.

Since working on this experience with the Falcons, Stingray Studio have created a scaled-down version of the AR experience to display in much smaller spaces. This QR code is the one displayed with this package of work and documents, so you can also experience this interaction without having a falcon the size of an elephant coming through the roof of your home.

Figure 6 *QR Code for Falcon*

CHAPTER 5. INTERACTION DEPENDENT VIEWING

Video games have been a key storytelling tool for many years, and unlike the Interactive Camera Viewing experience, it needs the player alongside decision-making mechanics to get the full experience. Throughout this document, I will be referring to video games as Interaction Dependent Viewing. The types of animations used for these experiences are solely based on player interaction. Depending on the complexity of the game could mean a variety of animations. Jonathan Cooper, a game animator based in Scotland has written a couple of books that go into heavy detail about what it takes to be an animator for games and why being a game animator is so different from typical film animators.

In terms of character animation, there are mainly two routes that determine the number of animations needed for a character. The first is referred to as a playable character. “The primary and easily the most challenging aspect of game animation is the motion of characters under the player's control” (Cooper, 2021, p.4). The next is a non-playable character also known as an NPC. The NPC has far fewer animations that are needed as the player cannot control them and only interact with them to a level of interaction decided by game developers. On the contrary, the playable character comes with a long list of animations needed to make the game more dynamic and gives the player more control. For this example, I’ve created a small game demo in Unreal Engine 5 to discuss how the animations differ from playable to non-playable.

The non-playable character example is one designed in collaboration with my friend and 3D modeler, Spenser Morgan. This character will be referred to as Elf Girl. This character was originally planned to be put into Unreal Engine, so once the model was complete it was time to rig. Rigging refers to the action of creating an invisible bone system inside a character that acts like a skeleton to allow the character to move and bend on certain joints **Figure 7**. After the

bones are in place, they are ready for controls **Figure 8**. These allow the animator to manipulate and pose specific parts of the model. Once the bones and controls are in place, the character is ready for a process called skinning. Skinning is the "long and thankless task of first attaching the mesh to the skeleton with a blanket pass and then working into the areas that deform undesirably" (Cooper, 2021. p.120). This process can take a very long time, and often includes multiple revisions on how it performs in Autodesk Maya versus how it performs in the game. Once the character is skinned and has working controls, she is ready for animation.

Figure 7 *Elf Girl Joints*

Figure 8 *Elf Girl Rig*

Since this character will be set up as an NPC her animation list is relatively small. She has three lines of dialogue she will use throughout the game demo. The first one asks the player to do this small quest for her to find her missing spell book. The next dialogue happens if the player returns without the book, reminding the player what they should be looking for. The last animation occurs when the player has found the book and returns it to her, ending the demo. The

first step is making an idle animation. Idle animations are one of the most important animations in games, as this will decide the beginning and ending pose of all other animations to make the animations seamless. Idles play when the character is standing still to give the illusion of life, while the character awaits player input (Cooper, 2021). Then each dialogue will start and end with the ending idle pose. These dialogues will be set up with a camera cutscene so we can use the same passive viewing techniques mentioned before to only animate the parts that will be visible to the camera. Once the Elf Girl has at least one idle and those 3 dialogues animated, she is ready to be implemented into the demo.

As for the playable character, I will be using a rigged character I found online by the artist Châu Võ Bá Trường known by his online tag Truong CG Artist. This character is known as Dragol, a smaller dragon rig **Figure 9**. To clarify the character found on his website is typically red, but for this demo, I changed the color to blue to fit the level better.

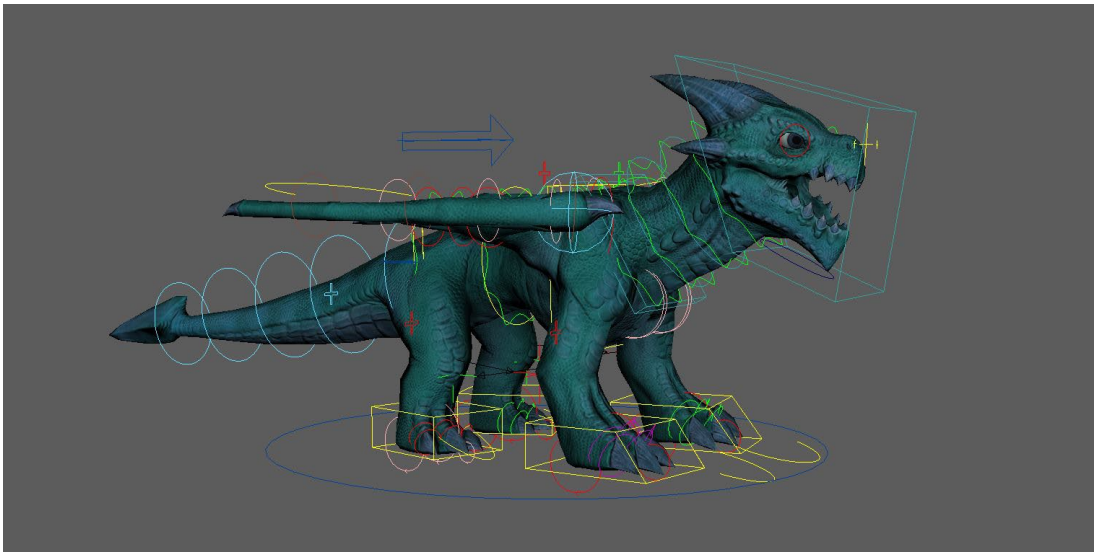

Figure 9 *Dragol Rig*

Since this character will be our playable character, there is a much longer list of animations to be done. For this demo, the character will need to idle, walk, run, and jump. Most playable characters tend to have a much more extensive list of animations depending on the depth of

gameplay. **Figure 10** is an example of a playable character's animation list and is common amongst most fully developed games.

	A	B	C	D	E	F	G
1	Count	Character	Group	Sub-Group	Animation Name	Complexity	Priority
2	1	Elf	Navigation	Idle	elf_idle	2	1
3	2				elf_idle_combat	2	2
4	3			Walk	elf_walk_forward	3	1
5	4				elf_walk_backward	3	2
6	5				elf_walk_left	3	2
7	6				elf_walk_right	3	2
8	7			Run	elf_run_forward	3	1
9	8				elf_run_backward	3	2
10	9				elf_run_left	3	2
11	10				elf_run_right	3	2
12	11			Jump	elf_jump	1	1
13	12				elf_land	1	1
14	13			Climb	elf_climb_050cm	2	3
15	14				elf_climb_100cm	2	3
16	15				elf_climb_150cm	2	3
17	16				elf_climb_200cm	2	3
18	17			Vault	elf_vault_100cm	2	3
19	18				elf_vault_150cm	2	3
20	19		Combat	Sword	elf_attack_sword_a	3	1
21	20				elf_attack_sword_b	3	1
22	21				elf_attack_sword_c	3	1
23	22			Axe	elf_attack_axe_a	3	2
24	23				elf_attack_axe_b	3	2
25	24				elf_attack_axe_c	3	2

Figure 10 *Playable Character Animation List (Cooper. 2021)*

An important part of character animation is determining the character's personality. In this demo, I scaled the Dragol down to be the size of a medium-sized dog, so I wanted its personality to be more dog-like, so I used a lot of reference videos of Great Dane puppies to give it a bouncier feeling. For the Dragol's idle, I went with a small bobbing motion to give it some bounce and some slight breathing to make it feel alive. As mentioned previously this is a looping animation so the first and last frames needed to be identical. Then moving on to the walk and run; these animations also needed to loop however these did not need to start and end in the idle pose. Since there are animation transition effects in Unreal Engine. These transitions are played quickly and transition the character from one pose to another, which is a handy tool when working with locomotive movements. The jump is one of the more difficult game animations because of its technical side of it. Jumping animations are usually broken down into three major

parts, the jump up, the jump mid-air idle, and the jump land. The jump-up starts from an idle (typically) and goes until the character is in the air fully. Jump mid-air idle is a loopable animation that plays until the player makes close contact with the ground. This animation needs to loop because the player will be able to jump from a wide variety of heights. The idle needs to be able to loop until the player is close enough to the ground. Once the player is near the ground it plays the jump land animation. This animation simply goes from the mid-air pose to an impact and back to the idle. Once these animations were complete, they were ready to throw into the engine and set up using what is called a state machine. “State Machines provide a graphical way to break the animation of a Skeletal Mesh into a series of States. These states are then governed by Transition Rules that control how to blend from one state to another” (Unreal 4.27 Documentation, *State Machines.* n.d.).

CHAPTER 6. CONCLUSION

Animation has come a long way from paper and cell drawings, and with the rise in technology, the art of creating animations has also become more technical. These animations known as CG have taken the world by storm. The viewer is the most important component when making an animation and understanding how the viewer will interact with the piece has a lot of control over how it's made. Passive Viewings such as TV and film allow animators to have the most control over how the animation is seen and what the viewer is allowed to see. These animators can use the camera to their advantage and focus the most attention on what is directly seen in the final layout. Interactive camera viewing, AR and VR, have less control over what the viewer can see, making the experience interactable. However, the animator has less control over how long a viewer may interact with their piece and need to make the animations They also have to consider what angles the viewer is going to see the animation, in most cases the viewer has access to this animation in any angle, depending on the depth of experience. Interaction Dependent Viewing or video games offer the most technical challenges with their interactions because the animations need to work with a series of other animations and be loopable while being viewed from any angle. While the twelve principles of animation apply to each of these categories of animation, the level of viewer interaction greatly decides the level of technical complexity in those pieces. Viewer interaction is the key component that defines the technical challenges that go along with creating animations.

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VITA

Megan Smith

Education:

M.F.A. Digital Media, East Tennessee State University, Johnson City, Tennessee, 2023

B.S. Digital Media, East Tennessee State University, Johnson City, Tennessee, 2019

Public Schools, Blountville, Tennessee

Professional Experience:

3D Animator, Barnstormer Media, Stamford, Connecticut, 2022-2023

3D Animator, UNC Blue Sky Innovations, Chapel Hill, North Carolina, 2022-2022

Freelance Animator, Blountville, Tennessee 2020-Current

Graduate Assistant Course Instructor, East Tennessee State University, College of Business and Technology, 2021-2023. Principles of Animation, Principles of Game Design

Publications:

Speaker at East Coast Gaming Conference 2022. “Lessons learned in VR training partnerships East Tennessee Children’s Hospital and ETSU.”