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Cross-Platform Methods in Computer Graphics That Boost Experimental Film Making

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Cross-Platform Methods in Computer Graphics

That Boost Experimental Film Making

by

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CONTENTS

Abstract

Computer graphics arts such as animations, video games, and special effects in live-action movies have become essential for people seeking entertainment and education. This study aims to explore the potential for experimental film in presenting scientific theory as well as assessing different production strategies in 3D image creation. To invite people into some abstract or complicated scientific topics more readily, non-narrative film form is a viable method to relay this type of information. It's crucial to look at how independent filmmakers employ various ways to fulfill their particular creative purposes. I'll be demonstrating how these processes worked in making my film, Discontinuity, a short 3-D animated experimental work that attempts to illuminate some of the mysteries of quantum theory for an audience. I plan to use my analysis of the film's production time, the overall quality and the feedback it received to build ideas for future research as well as an overall vision for computer graphics arts.

Introduction

In this paper, I will be examining how using Cross-Platform Methods in computer graphics can improve the workflow in experimental animated filmmaking and break the creative restraints that are often imposed by limited deadlines and budgets.

a. Introduction to The Subject

Computer-Generated Imagery (CGI) originally began in an animation created by John Whitney for the film, *Vertigo,* by Alfred Hitchcock in 1958. (Nedomansky). In this two-minute film, animation patterns generated by mechanical computers are projected onto an eye and continuously change, creating a unique, mysterious feeling. This is the first film that combined live-action footage and CGI animation. (Nedomansky).

Fig.1. Hitchcock, Alfred. *Vertigo,* 1958. Film. San Francisco. *VERTIGO: HITCHCOCK'S MYTH & SYMBOLISM.* By Christian Esquevin. 2020. Silverscreenmodes Web. Digital Image. < http://silverscreenmodes.com/vertigo-hitchcocks-myth-symbolism/>.

Another film created by John Whitney as his work demo in 1961 (Catalog) was wildly recognized as the first experimental computer animation film. This work inspired Douglas Trumbull's exceptional visual effect work in *2001: A Space Odyssey* (Miller).

When the film industry decided to turn its lens to CGI in feature films, many different examples of this type of film began to emerge. The first feature film that ever-used CGI was called *Westworld,* shown in theaters in 1973 (Formichella). By using 2D digital imagery, audiences were able to see through the evil robot gunslinger's point of view.

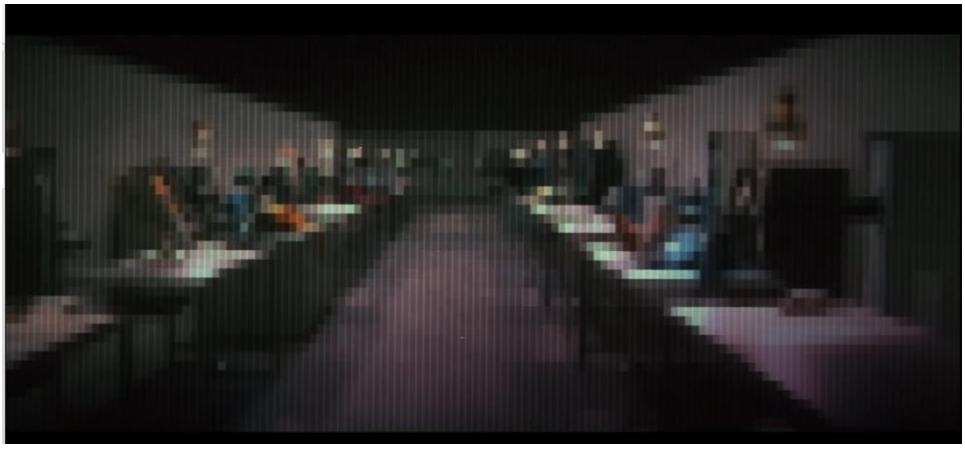


Fig.2. Crichton Michael. *Westworld.* 1973. Film. *Westworld (1973) - First Blend of CGI and Live Action in a Feature Film (HD)*. By Ultimate History of CGI. 2018. YouTube.com. Online Video Clip. < https://www.youtube.com/watch?v=nILKFlpOZi0>

In 1982 Tron was the first feature film released that combines CGI and live-action (Formichella). This was a revolutionary technological innovation in cinema at the time and is now regularly used by film producers today.

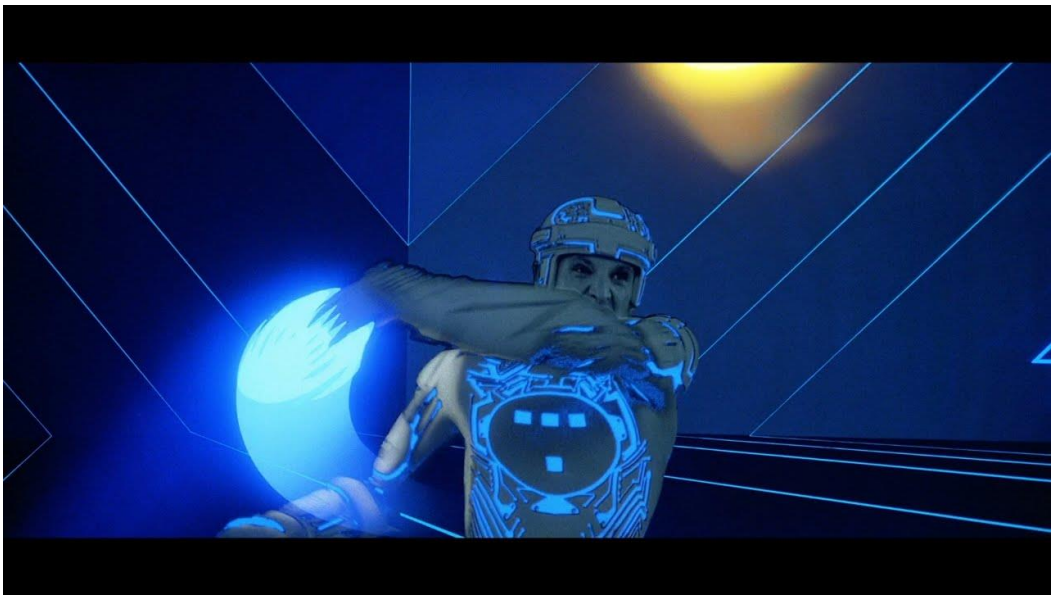


Fig.3. Lisberger, Steven. *Tron,* 1982. Film. *Tron - Disc Fight / Ring Game (1982).* By Iamthe80sguy2. 2021. YouTube.com. Online Video Clip. < https://www.youtube.com/watch?v=yYDVXWJf-_k>

Another landmark CGI film was presented to audiences in 1995 named Toy *Story, which* is the first fully 3D animated feature film produced by Pixar studios (Formichella). Feature-length 3D animation films have become commonplace today and started their journey from here.

Regardless of the fact that many filmmakers have strived to create realistic 3D CGI feature films in recent years, none have perfectly blended realistic CGI, live-action footage, and "stereoscopic 3D" like *Avatar* did. James Cameron, the director of *Avatar,* began to work on this film in the early 1990s. In 2006, his vision was finally realized thanks to advances and innovations in motion capture animation technologies.

The above examples demonstrate how technological advancement and the evolution of film are mutually beneficial.

b. Introduction to Traditional (Narrative) CGI Film

To comprehend experimental (non-narrative) CGI films, we should begin with what we are familiar with: traditional (narrative) CGI films.

"narrative films are simply films that tell a story. Movies like The Wizard of Oz, The Goonies, or Rocky are all examples of narrative films because they are driven by a story that has a particular structure" (White). Movies follow five essential storytelling components, the characters, the setting, the plot, the conflict, and the resolution. These vital features keep the story moving along smoothly and allow the action to unfold logically and understandably for the reader. To put it another way, narrative films are films that tell a story. Movies like The Star Wars, Citizen Kane, and Jaws are narrative films.

Narrative CGI movies are traditional films with CGI elements, whether a fully animated movie or a movie that uses computer-generated (CG) special effects. For example, *Toy Story, Frozen*, and *Up* are fully animated movies. In contrast, movies such as Iron Man, The Terminator 2, and the Lord of the Rings are considered movies that adapt CGI methods in their storytelling.

Aside from the CGI feature films described above, there are numerous digital animation short films such as game-opening cinematics, commercials, and short films that tell a small story where each can be considered traditional CGI films because they contain CGI components. For example, *Diablo III: Reaper of Souls* produced by Blizzard in 2013 is a fully 3D animated narrative film as game-opening, CGI Commercial: *HYPERDUNK* produced by NIKE in 2012 is a live-action commercial that contains CGI elements, 3D animation short film *One Small Step* produced by TAIKO Studios in 2018.

c. Definition of Experimental Films

"Experimental film, experimental cinema, or avant-garde cinema is a mode of filmmaking that rigorously re-evaluates cinematic conventions and explores non-narrative forms or alternatives to

traditional narratives or methods of working" (Pramaggiore and Wallis 247) . In other words, experimental film is used by filmmakers to experiment with new procedures, techniques, and styles of presentation. When it comes to CGI experimental films, artists have more options by including digital image aspects in their filmmaking arsenal.

d. Importance of Experimental Films

Experimental films have had a significant impact on the growth of the film business and cinematic art overall. This is because experimental film often presents new concepts, changes, and trends that demand an innovative visual method to present their ideas effectively. Experimental filmmaking allows filmmakers to focus their creative efforts fully on the statement they're attempting to make with their film, without rules and routines that come inherently within narrative filmmaking. Experimental films can also allow audiences to think in different ways from traditional storytelling. This, in some instances, makes for a more effective way to convey certain types of ideas, feelings, or experiences.

Viewers of experimental films are encouraged to question and challenge their assumptions about what they see. Some of these films address concerns, while others raise questions and communicate perceptions. The filmmakers' presentation of their seemingly unique films is founded on how they see the world or the subject matter. Without standard procedures or policies, the artist's presentation may have a better chance of catching the audience's attention, speaking to their emotions, and influencing their thoughts.

Pipilotti Rist, an installation artist and filmmaker, produced her legendary masterwork: *Ever is Over All* (1997), by using two projection screens to show two separate motion picture channels. A woman in a brilliant blue outfit strides down a city sidewalk at the left; the city environment is also composited in blue. With a large flower in her hand, she begins to smash the car glass as she walks. The video on the right syncs her tempo of movements and activity while showing flowers blooming. The protagonist, a happy and proud woman (Rist herself), is accompanied by a female police officer in uniform who approaches her from behind and salutes her.

violence and blooming, the authority and the outlaw all make for a fascinating contrast. “Rist first gained international attention following her selection for the influential Aperto’93” (Snell).

The unique video production used in this type of filmmaking shows its impact in many ways, once such way is how the music video was produced in later years. For example, many think that Beyoncé's *Hold Up* (2016) was inspired by Pipilotti Rist’s work (Weisberg). By 2021, this two-and-a-half-minute experimental film (*Ever is Over All)* has received over 460K views on YouTube (YouTube.com).

Review of Research

I started my research by utilizing various online materials to help me grasp the Dual-slit Experiment in the early stages of my film concept, such as Philip Ball’s “Two slits and one hell of a quantum conundrum”. I discovered the concept and core idea for my thesis film by refining and evaluating articles and videos of this type over time.

There are also many interviews and instructive videos provided by scientists in this field of study online that reveal their theories and arguments on this subject. These were of great help in assisting me with creating a chronology of quantum theory’s development. Some examples of these are YouTube videos such as “Delayed Choice Quantum Eraser Explained” by Danny Rey. “Does Consciousness Influence Quantum Mechanics? “from PBS Space Time channel. “Down the Rabbit Hole of The Delayed Choice Quantum Eraser | Answers with Joe “by Joe Scott.

Both feature films, and short films I’ve watched online, can also be considered essential assets for my filmmaking as well. Feature Films such as *Terminator 2: Judgment Day,* directed *by* James Cameron in 1991, have inspired me to look at how new filmmaking tools and technologies can push the film industry forward. As well as films with experimental elements and creative CGI images, such as 2001: *A Space Odyssey*, directed by Stanley Kubrick in 1968, have done the same. In the next section of this paper, I'll discuss how these films have influenced my stylistic choices as well as books and articles on traditional, experimental filmmaking and photography in order to evaluate these distinct filmmaking options. Some articles cited are more general for filmmaking; for example, *A Philosophical Enquiry into the Origin of Our*

Ideas of the Sublime and Beautiful by Edmund Burke has helped me understand the relationship between art and emotion. While in other cases, I will cite articles and videos from the internet and the library (for example, when I explain the production approach later in this paper). These articles will focus on animation production and game engine techniques to support my position; examples of these resources are: *What is Virtual Reality* by VRS Website and the Unreal Engine Official Website.

Process

a. A Case Study About New Visual Methods to Support Traditional and Non-Traditional Storytelling in Film Industry

In general, filmmaking is more accessible to independent filmmakers thanks to a slew of new technologies emerging in recent years. Smartphone filming, Digital Re-creation, CGI Simulation, Virtual Monitor, In-camera Visual Effects, Virtual Environment, Virtual Reality, and other cutting-edge methods are examples. For both vast organizations and individual filmmakers, these methods are being used to minimize costs and get the job done faster and better. Some of the above technical terms may sound similar to one another and be confusing, but here are some examples that can help you understand these terms more clearly.

1. CGI Simulation

When a new notion is offered in the film industry, there may or may not be appropriate technology available to make it a reality. In many situations, the producers' unrivaled inventiveness has resulted in technological breakthroughs. Although computer-generated imagery has been employed in the film business for a long time, the advanced requirements continue to grow. CGI is increasingly being requested by directors to replicate natural phenomena such as water, fire, and smoke. James Cameron, the director of *Terminator 2: Judgment Day* (1991), came up with a brilliant concept to make the villain robot T-1000 an advanced killing machine that can transform between human form and liquid metal; he brought this idea up to George Lucas's visual-effects studio Industrial Light & Magic (ILM). Back then,

Dennis Muren, the Visual Effects Supervisor of ILM, and his team utilized advanced computer-generated imagery to create this ground-breaking CGI character, mentioned by Ryan Lambie in his article "Dennis Muren interview: Terminator 2's VFX". Terminator 2 is considered a watershed moment in computer graphics since it was the first time the main character in a feature film was generated, at least in part, using computer graphics. This movie also won the 1991 Academy Award, Winner for Best Visual Effects, and 1991 BAFTA Award, Winner for Best Special Visual Effects (ILM.com).

2. Virtual Monitor

James Cameron's film Avatar (2006) featured several unique techniques. He did not only "use" existing technologies but also dedicated a significant amount of time and money in pushing things to upgrade. The invention of a virtual monitor in *Avatar*'s setup allowed the director to examine the motion capture results in real-time, as they were filming, instead of waiting for the post-rendered results (Johnson). This visual camera concept could very well inspire other filmmakers to incorporate real-time CGI results into live-action filming for years to come.

3. Virtual Environment (In-camera Visual Effects)

New "In-camera Visual Effects" technology allows filmmakers to evaluate the CGI outcome in real-time, which is akin to James Cameron's Virtual Monitor to some extent. In-camera Visual Effects utilize Unreal Engine 4 (UE4), a quicker render engine as well. Instead of the motion capture preview process used in Avatar, UE4 offers a lightning-fast landscape render. For this process, the filmmakers construct an LED stage with a UE4-generated real-time environment that allows actors to walk inside the LED virtual volume (Kadner). You may already be aware of the "Green Screen" approach, which involves an editor erasing a single-colored backdrop from a shot in order to insert otherworldly scenes or effects. The Greenscreen was and continues to be primarily employed in filmmaking during post-effect composites prior to the appearance of the Virtual Environment. The Virtual Environment, on the other hand, is a game-changer for CGI filmmaking.

The real-time, final pixel in camera preview is one of the major advantages of employing a Virtual Environment rather than a green screen. "What you see is really what you got…." Says Rachel Rose, the

R&D supervisor of The Mandalorian, “That’s something that really means a lot to filmmakers, especially to those who work more traditional approach in the past” (ILM.com).

Another strong point of this technology is the interaction of the light and colors produced from the LED screen, as they will reflect and interact naturally with any character or object in the shot, making the composite incredibly believable. The third and most mind-blowing advantage of this process to filmmakers is that they can change the environment flexibly anytime, whether indoor or outdoor, sunny or snowy, almost any variation is possible.

The Disney film Mandalorian (2019) and HBO’s Westworld season 3 are two recent instances of successful films that used in-camera visual effects (2020). The Mandalorian (2019) utilized Unreal Engine’s real-time algorithm and LED panels’ immersive capabilities to pioneer a totally new way of representing interior or exterior spaces in filmmaking. Their team even further evolved this process with breathtaking effect by installing a prop spaceship on the LED stage when shooting(Wood). The external landscape of Delos headquarters in Season 3 of Westworld was shot on location in Spain. Still, the interior images were constructed on a stage in Los Angeles utilizing a 22-foot LED wall (Mayeda).

In my thesis film, I used Epic Games’ Unreal Engine and was pleasantly surprised by its real-time fast render capabilities and realistic quality; I’ll take you through the possibilities of adapting game engines to low-budget CGI filmmaking in later sections of this paper.

4. Virtual Reality

Although there are a few historical early forms of virtual reality (VR), the term now refers to a computer-simulated experience that might be related to or wholly different from reality. Virtual reality headsets, multi-projected environments, or omni-directional treadmills with special gloves are currently used in standard virtual reality systems. These are intended to simultaneously activate our senses in order to create the illusion of reality with complete immersion.

In the above discussion about the usage of UE4 in Virtual Environments and Virtual Reality, I hope to have established a sense of how game engines could feasibly play an important role in filmmaking in the future.

b. A Case Study About New Cross-platform Methods to Support My Thesis Filmmaking

9. Origin and Rationale of My Thesis Film

"The fairest thing we can experience is the mysterious. It is the fundamental emotion which stands at the cradle of true art and true science" (Einstein 7).

My film style usually attempts to explore themes pertaining to the world, as well as the origin of its existence.

Since childhood, I have been fascinated by Sci-fi novels, video games, and movies, so I instinctively feel the impulse to combine scientific elements into my art. I also like to communicate these questions and ideas to my audience through my films.

When I first read about the Duel-Slit Experiment (in quantum level), it blew my mind.

The theory simply presents that when there is no observer, the interference pattern appears wave-like; however, when an observer is introduced, the interference pattern appears grainy. That is strange, right? I cannot stop comparing the "reality I perceive" with the simulated reality I see in video games generated by a computer. When I think of this idea – a question continuously comes to my mind: "Is the world still the same world we perceive if we are no longer observing it directly. Another question that comes to mind, "Is the world fully 'rendered' when nobody's observing?" For this question, I do not yet have an answer. What I do have, is an urge to bring this unique phenomenon up to others in hopes that it might evoke similar feelings and discussion… and possibly even bring us all closer to a universal truth.

10. Pre-production (1): My Thesis Film Concept Design and Brainstorm.

Utilizing solid graphic design, my film seeks to deliver this scientific phenomenon to the audience. I was also excited to take advantage of this opportunity to investigate alternative techniques in animation films production, mainly because I had the opportunity to work with my professors, who are specialists in so many different fields of filmmaking.

In February 2020, I remembered talking to my thesis advisor Peter Murphy for the first time about this notion. I initially suggested three quite diverse topics and ideas, including the one I just described

and the other two associated with linear narrative. It was a bit tough for me to decide on what idea to pursue. This is because I typically prefer the narrative approach, as it would have provided me with a clear storyline and feels like a safer route in terms of the production. Professor Murphy, on the other hand, encouraged me to pursue what I really wanted to do and venture outside of my comfort zone, which ultimately helped me decide to do just that. As I progressed in my production journey with this film, I realized it was the right decision since I already possessed the desire and motivation to challenge myself with an original movie. That, combined with my passion for communicating what's on my mind, helped me overcome many of the obstacles and challenges that I faced during this production.

The first phase of Pre-production was brainstorming and proposing my idea, which was the most difficult for me personally because my concept was still not very polished. Over the first few weeks, we reviewed and polished it until I had a workable Thesis Proposal which is the outline of my thesis film. For the first time, I found difficulty communicating the visions in my mind. Still, thanks to the help and patience of my classmates and teachers, I was able to evolve my communication and describe what I wanted to.

The second pre-production phase was thumbnails, which is easier for me to represent complex concepts than simply using words alone. This technique offered me the opportunity to visually display how the major shots should appear and assess the overall continuity of the film. 2D illustrations are pretty handy at this stage since it allows me to quickly get the composite and color of each critical picture. Despite the thumbnail picture format being rough overall, this presentation style allowed me to present the film's overall aesthetic style more clearly.

Fig.4. Zhang, Yue. *Thumbnails from Thesis Film Pre-production,* 2021. Digital Image.

The animatic was the third stage of pre-production. When it comes to 3D animation pre-production, some call it the "layout." The ability to represent the dynamic flow and composite of shots is a primary strength of the animatic. To utilize the inherent strength of this step, I needed to select the most effective solutions available. A 2D sketch is an effective approach to portray a close-up shot such as a character's emotion or movement. When this is used in addition to text descriptions, it can help avoid confusion (for the most part) and clarify the shot, even though the pictures are still unrefined.

Fig.5. Zhang, Yue. *MFA Thesis film 2D Sketch from Discontinuity Pre-production,* 2021. Digital Image.

However, because my film is mainly created in 3D rather than 2D, it is prudent to begin blocking scenes and shots with basic 3D models. This provided me with a view showing the depth and scale of my shots in 3D software, as well as a general estimate of the workload required in production. Another major advantage of the animatic is that it allows one to determine the film's timing. I've observed that I occasionally become obsessed with a single shot (or even a single frame) and lose sight of the overall continuity of my film. I recall the professor reminding me to put what I already had together and double-check the timing a couple of times. In this, the animatic phase, I discovered that the film was starting to feel “alive” for the first time. In this phase, there were also several noticeable places where I needed to speed up or slow down the pace, which could not have been seen by looking at static frames. For example, connecting the image sequences assisted me in reviewing my film's transitions and attempting to make the frames connect more fluidly. I had some of these transitional adjustment ideas at the thumbnail stage, but in the animatic stage, they became more apparent and I could test them out with the adjacent shot in real-time. As an artist, I have to push my work further and better all the time, but this experience has also reinforced to me the importance of jumping out of what you are working on from time to time and focusing on the overall timeline of the film as well.

My final step in the pre-production stage for this animation was to incorporate the soundtrack with the visuals. I made the stylistic choice not to include dialog in my thesis film simply because the dialog adds too much complexity to animation production. Instead, I can use body language and facial expressions to get similar results. Although voice is a crucial story element in other types of film, the

choice to not include it here did not retract from the overall effectiveness of sound in this one. This video blends scientific studies with subjective interpretation in content while varying between abstract and realistic visuals in terms of images. For me, the challenge was figuring out how to incorporate and balance those aspects of the film with the music and sounds so that that sound would become a significant story element.

At this point, the visuals were still too basic to proceed into authentic sound or musical creation with a composer. I found it was a good idea to use some free sound clips and insert them into the image sequences temporarily to see how it worked. During this process, I began to contact potential composers. In these conversations, I would demonstrate my work process and explain my timetable in an attempt to find the ideal person for future cooperative work on this project. At this point, the vibe of the film had improved quite a bit once I added some rough music.

11. **Pre-production (2): Experimental elements as communication tools in my thesis film.**

In this section, I'll explain why experimental components are so vital in this movie. Quantum theory is a complex subject in and of itself, so the use of experimental elements allowed me to focus on the visual refinement of my ideas without explaining the scientific theory in detail. At first, I found it challenging to convey my message to the audience. Due to this, I drove myself deeper into the subject with more in-depth research, brainstorming sessions, and discussions with the Professors reviewing my storyboard. During this process, I realized that the complex theories and ideas that I have been working with could be extracted and simplified as visual symbols. To clarify that point, the collaboration of experimental aspects used in this film allowed me to communicate with the audience more effectively.

In order to sufficiently portray my vision, I had to consider abstract designs and characteristics at a few points during the preproduction stage. One example of this is the symbolic “observer’s eye” or “God’s eye,” which is intended to represent an intelligent being’s observation.

As seen in the pictures below, I planned to communicate this message with a simplified circular design that developed into an animated eyeball shape later in the development stage. The symbolic eye's design evolved over time, as shown.

Fig.6. Zhang, Yue. *Eye's Design from Discontinuity,* 2021. Digital Image.

Thumbnail (1), Animatic (2), and Animation (3) of "observer's eye"

This design not only presents an abstract notion but also connects all the related shots while also becoming an emotional clue for viewers. This seemly obscure symbol was also intended to raise questions for viewers.

Later in the Production chapter (Production (4)), I will talk more about how the cross-platform workflow impacted the experimental part of my filmmaking, as well as how this experimental approach helped me communicate my perceptions with the audience clearly.

Summaries of Pre-production:

In the pre-production stages, when I started to brainstorm about these ideas, I realized it was likely to be a challenge both graphically and narratively, especially considering the body of this work could not be represented in a traditional way. I realized that I had all the support I needed in each meeting and discussion, moving closer to production to bring the film closer to its intended goal. It has been an invaluable experience to go for want you really want to make, enjoy the process, and learn from others along the way. The pre-production approach requires the ability to be quick and flexible and respond to those changes appropriately. This is shown in adapting as any ideas come to mind or receive brilliant feedback from your teammates. Using whatever tools and approaches you have at your disposal is the key to accomplishing this step effectively. First, working in 2D for the thumbnails stage and then combining 3D blocking and the 2D images for the animatic stage, in my opinion, is the

direction to go. After this is complete, you then place the rough soundtrack into the movie and start talking to the composer. Following these steps makes you more prepared overall and moves the film itself closer to a more fully realized and "complete" feeling.

12. Production (1): Research on Conventional 3D animation software. Research on Animation Filmmaking in The Game Engine (Unreal Engine 4).

By "conventional 3D animation software," I mean the 3D animation software that has been widely utilized by both large corporations and small studios in recent years. These include Autodesk Maya, Cinema 4D, Pixologic ZBrush, Pixar's Presto, Disney Hyperion, and others, among the most popular and sophisticated 3D animation software suites on the market. These software packages specialize in different aspects of 3D animation production. Still, they all have one thing in common: they are all built on a post-processed algorithm for simulation or rendering. Some might argue that there are current software packages that also have the ability to do “real-time” render rather than “post-render,” such as Octane in Cinema 4D, and I would agree. However, one must keep in mind that while the "real-time" render function in these software packages may feel fast enough for animators to check the images instantly (or with an insignificant delay), the images can only be presented to audiences after they have been fully generated. Furthermore, even though the render is much faster, the downside is that cameras must be set up, and the audiences or animators cannot interact with the shot as freely as they would do in, for example, a video game.

Game engines, on the other hand, can prove to be a real game-changer, as this technology can help redefine “real-time” in film creation. When I use a game engine like Unreal Engine 4 (UE4), I can freely browse the scene by controlling my point of view, with no restrictions on whether I was moving or standing still as well as the whole time seeing the finalized graphics in real-time. The most significant distinction in using this method is that similar to a gaming experience; the render process allows anyone using it to see the final outcome of all elements in their current final state. This opens a far more realistic and detailed world during the initial stages to work and build off of. The feeling of

“Immersion” is an experience that Traditional or Conventional 3D Animation Software cannot deliver as effectively. Virtual Environments (In-camera Visual Effects) utilizing UE4 was employed to assist with the film production of *Mandalorian* (ILM), as I indicated earlier. Although I did not employ in-camera visual effects in my film, I did take advantage of UE4's immersion creation process to assist in creating my 3D world, which I'll go over in more detail in the Production (3) part.

13. Production (2): Modeling, Texturing, Rigging, Animation of My Thesis Film

3D models are similar to the bricks used in the construction of a building in that they are fundamental but at the same time essential. From the point of view of a modeler, even if we've nailed the concept and design, we still need to be mindful that each model being used has its own unique "levels" or complications. Due to this a modeler must decide how many features should be included in each model (or each type of model) while creating it.

The complexity of a model is usually determined by its importance in the scene. When modeling plants in the sea, for example, I chose to start with the most iconic plant designed for my underwater shots and sculpted it with plenty of details (Fig.7). While for the rest of the plants used in the shot, I simply gave them fewer traits or used generic 3D plants from online marketplaces or libraries (as long as the corresponding legitimate licenses were provided).

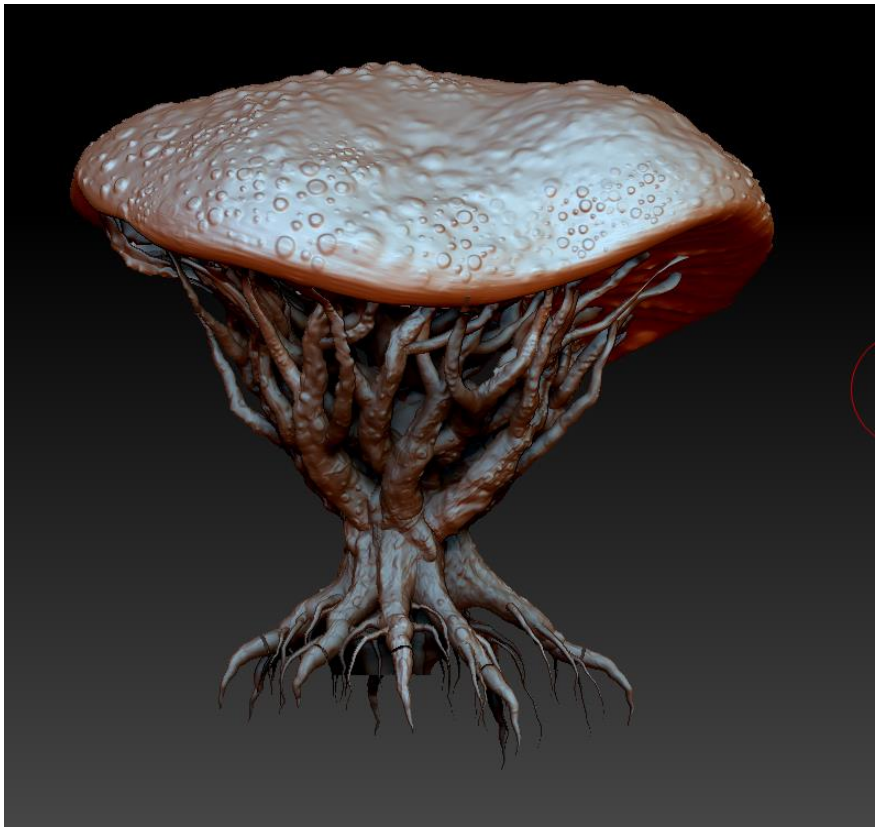


Fig.7. Zhang, Yue. *3D Modeling of Detailed Plante,* 2021. Digital Image.

In organizing the 3D models by their importance to the shot, I was able to invest more of my time and effort into the models that were essential and gave the best result to the shots.

Unlike landscape and prop modeling, character modeling can often prove difficult and time-consuming because it usually involves complicated animation, distinct expressions, and the dynamics in fur or hair. All of which I had to consider before I began the character modeling. For instance, the stag character required walking movements and fur dynamics. To accomplish this, I had to draw lines and faces around his joints in regular quads and keep the topology as neat as possible to avoid any animation or fur dynamic issues (#3 from Fig.8). I also had to use relatively dense faces around them to achieve the intended “blink” movements (#2 from Fig.8) and use a less organized topology on the antlers to save time because they would not be animated or include any fur dynamics (#1 from Fig.8). I felt that this movie would benefit greatly from a solid basis provided by strong models.

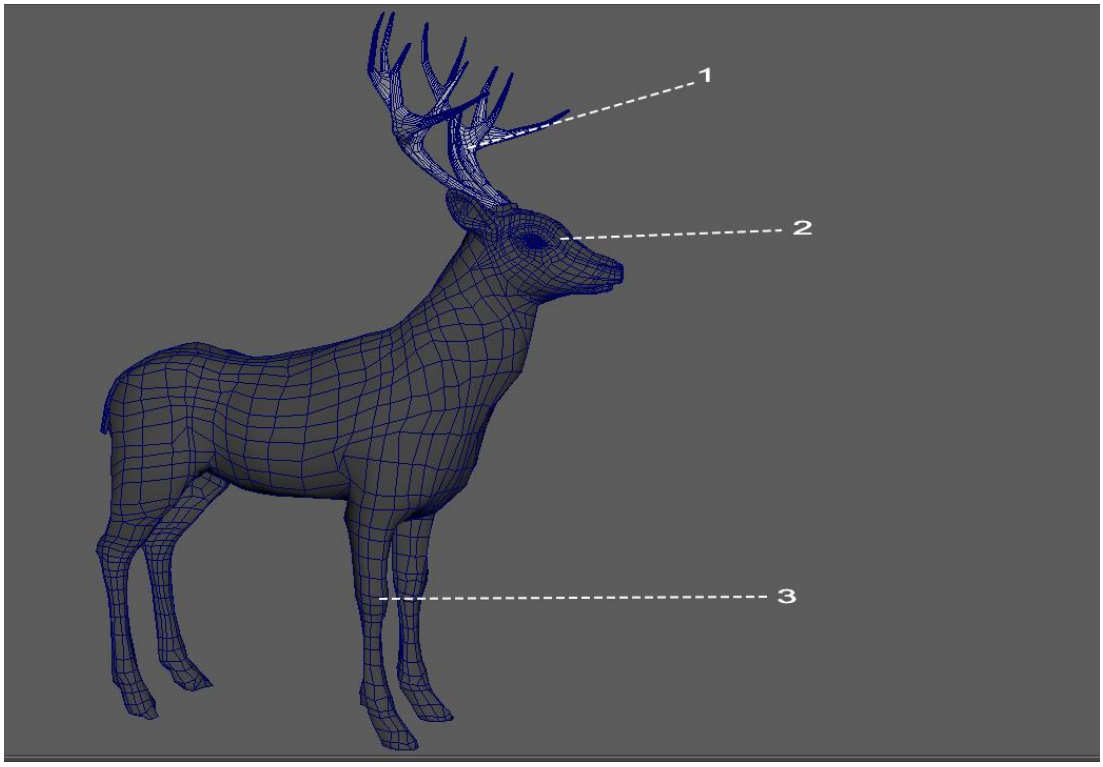


Fig.8. Zhang, Yue. *Stag Character Modeling,* 2021. Digital Image.

Once I completed the cleaning up of the models and verification of their format being correct, I moved on to UV Mapping and Texturing. UV mapping (commonly known as UV unwrapping) is the 2D unfolding of a 3D model's surface in preparation for painting. The “U” and “V” in “UV” refer to the 2D maps horizontal and vertical axis, which are comparable to the coordinates on a map. There are many approaches for unfolding a UV map correctly, and the process itself can be discussed in great detail, but the result will always be to unfold the UV into a uniform 2D pattern with an as little stretching and overlapping as possible. The checkered texture is used to assess if there was any major stretching when the 3D stag (left) was unfolded to the 2D UV pattern (center) as shown in the image below. The texture map I painted based on the UV map seen below is shown on the right side in the same image. To achieve this, I used a digital drawing tablet to paint the primary color block by hand and projected the fur details onto it.

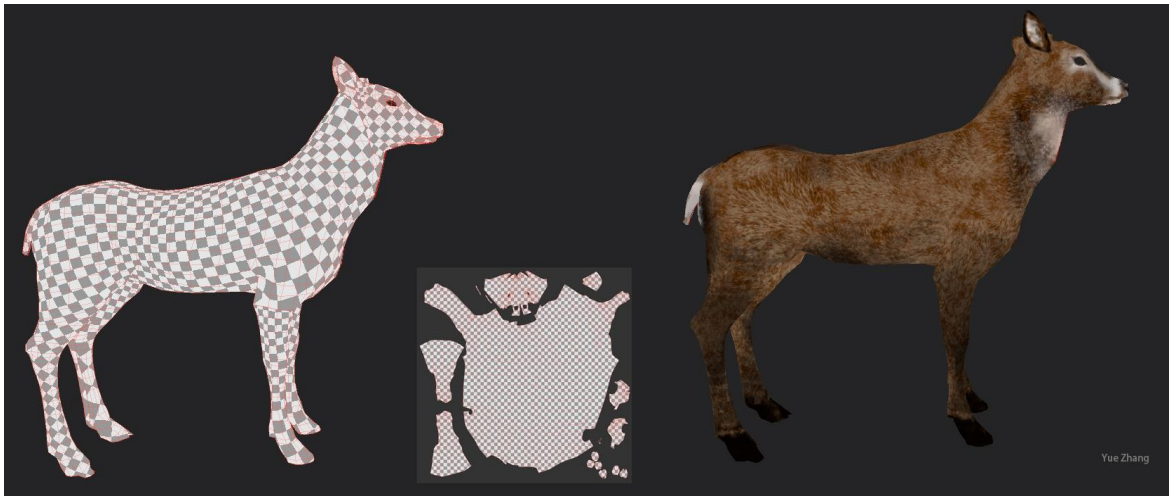


Fig.9. Zhang, Yue. *Stag Character UV Mapping and Texturing,* 2021. Digital Image.

The purpose of texturing is to give the model a stylized or natural texture that can be used later in the process and rendered out. In my case, this texture is a base color for my future fur effect. The following two steps are Fur Effects and Rigging, and they both prove to be challenging in their own ways.

Some believe that fur effects are unnecessary in the typical independent filmmaking process because brushing and rendering can be time-consuming. Despite this being true in many situations, I chose to use the process in my film because I predicted the results to be significantly better, including it, especially in close-up shots.

Much like a 2D animation character or a stop-motion puppet, rigging is the first step in the animation process. For the model to be animated correctly, a 3D character also requires a mechanism to manipulate the model's surface. Like other 3D animators, I set up a skeleton system in Maya that would interact with the mesh points that the viewer will perceive as "muscle and skin." I then employed a variety of curves (as shown in the image provided below) that corresponded to certain joints on the skeleton to assist in manipulating them. This subsequently made the process of animating the object easier. My Stag character's Fur and Rig are shown in the image provided below.

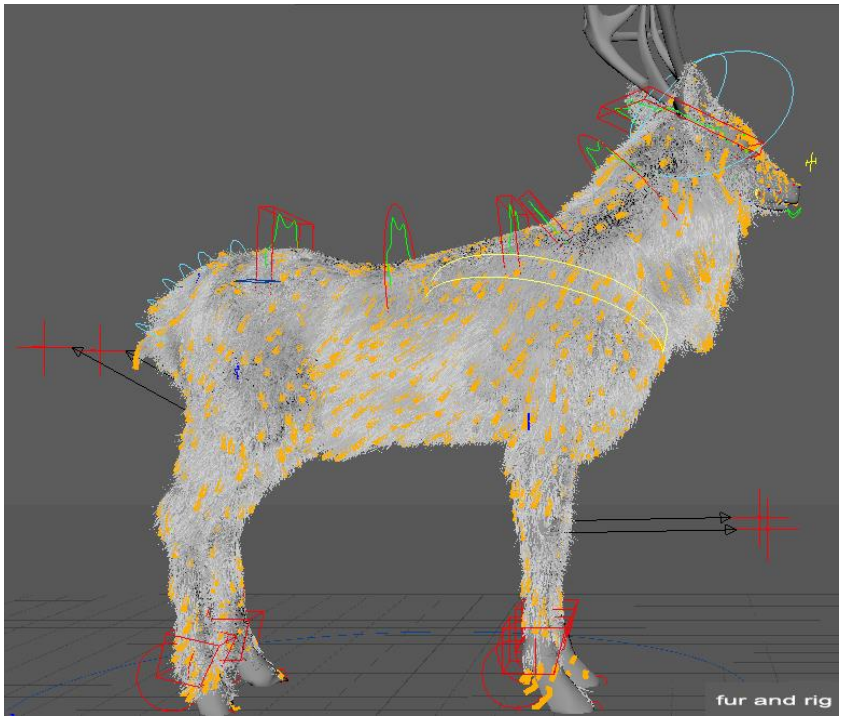


Fig.10. Zhang, Yue. *Stag Character Fur Preview and Rig,* 2021. Digital Image.

The actual animation was created in Maya and then exported to Cinema 4D and Unreal Engine 4. The body movement animations went smoothly overall because the movement of each model was limited to basic walking and turning throughout the film. The truly challenging aspect of this step in the process proved to be the facial animation.

Eyes are an essential symbol in this film, demonstrated in the close-up shot of the stag's eye. This shot serves as an important symbol in the film and performs a transitional function between shots. I took extra time and effort to construct the ringed lines around the eyeball because of this, as well as paid close attention to the eyelashes and hair. The shots might have worked if only the texture were used, but with the addition of the fur effect, it became even more powerful.

Fig.11. Zhang, Yue. “Stag’s Eyes.” *Discontinuity.* 2021. Author’s Screenshot

In this portion, I used a variety of applications, including Zbrush for sculpting and Substance Painter for texturing, in addition to Maya and various plugins. I also started a test animation between Maya and UE4 to ensure that my render method would work as I progressed.

To make it work in UE4, I had to pay close attention to the axis direction and scale of these two different platforms. Thankfully, the solution was to use the FBX file format as an import and export method to link the two programs and make them work together.

14. Production (3): Compare Simulation, Rendering, And Compositing in Traditional 3D Animation Software and Game Engine

Before diving into the actual rendering, let me show you my shot-list for this film during the filmmaking.

SHOT #	LENGTH OF CLIP	LOCATION /Description
Scene02-shot01	35”	Deer Forest Opening Abstract Lines
Scene02-shot02	15”	Caption
Scene02-shot03	15”	Universal Eye forming
Scene02-shot04	2”	Deer Forest Deer blinks

Scene02-shot05	10”	Deer Forest Deer’s POV
Scene02-shot06	30”	Deer Forest Deer’s field of view against the outside of field cone. Deer disappears in the scene
Scene03-shot01	4”	Universal Eye
Scene03-shot02	50”	Underwater Long take the whale’s field of view effects on the sea.
Scene04-shot01	12”	Car Scene Snow, car moving towards the camera.
Scene04-shot02	3”	Car Scene Close-up shot of the reflection of man’s face in the rearview mirror.
Scene04-shot03	4”	Car Scene Close shot of audio playing boring song.
Scene04-shot04	12”	Car Scene Close-up shot of the reflection of man’s face in the rearview mirror. Getting tired.

Scene04-shot05	10”	Cone POV
Scene04-shot06	7”	Car Scene. The man nod and sleep
Scene04-shot07	15”	Outside of the car. The cone disappears, the glitch happens to the road.
Scene04-shot08	10”	Outside of the car. Low angle close-up shot: Car bump into the glitch (sharp spikes)
Scene04-shot09	15”	Outside of the car. Car falls
Scene04-shot10	23”	Outside of the car. The chain reaction of the glitch happens, the camera pulls out
Scene05-shot01	35”	Outer space: Astronaut and Earth.

Blue： Test render done. (Some still need fix according to feedback)

Red： Test rendering is not complete

Green: Considered done but could be better

Total：307” (around 5’)

161” test render done so far.

The above list depicts the basic overview of my render; as you can see, the complete 3D animation is approximately 5 minutes total that needs to be rendered. The majority of scene02's render takes place in the forest and includes a detailed forest landscape; scene03 has a vast number of aquatic plants, rocks, and a foggy atmosphere underwater which proved to be a challenge to my timetable. According to my estimations, I had to render the film in its entirety in around 40-50 days in order to allow time for comments and revisions to the render, along with time for post effects. This was done completely with only the gaming laptop and a desktop workstation that I had available at that time. Traditionally, I'd use Arnold in Maya or Octane in Cinema 4D to render my scenes. According to Arnold's official website: "Arnold is an advanced Monte Carlo ray tracing renderer built for the demands of feature-length animation and visual effects." To put it another way, Arnold render capable of producing detailed, color-accurate, feature film-quality images using a CPU (the GPU version is still in the experimental phase). Octane render, on the other hand, describes itself as "the fastest unbiased GPU renderer"(Otoy.com). According to Octane's offical website, it offers outstanding real-time render capability with only a slight delay in preview and a significant advantage in render lighting. However, when there are a lot of models in a scene, the Octane renders start to slow down, especially when there's a fog effect. In my experience, the render time can be significantly increased using this platform in these cases. The difficulty for me was figuring out how to render those massive, intricate scenes in a timely manner.

Fortunately, I came across some articles and videos on Unreal Engine 4 that were of great assistance and decided to give it a shot while I was still in the early stages of development. The most important features to me are that the software can create photoreal images quickly and that the camera has the ability to be moved freely while maintaining full preview quality. This production experience felt exactly like playing a game, which is an experience I've never had with any other 3D animation tools. UE4 is a free and open-source software for non-profit filmmaking, which significantly benefits low-budget filmmakers. Take the forest scene, for example; as you can see, the pictures below are some test frames from UE4. Once the baking process was complete (taking around 12-14 minutes), it

took almost no time to preview the scene at any angle and direction. This also meant that I could output the frame sequence without having to render it one more time. Similar quality images rendered in Maya's Arnold would take as much as 8 minutes per frame at least, according to my test.

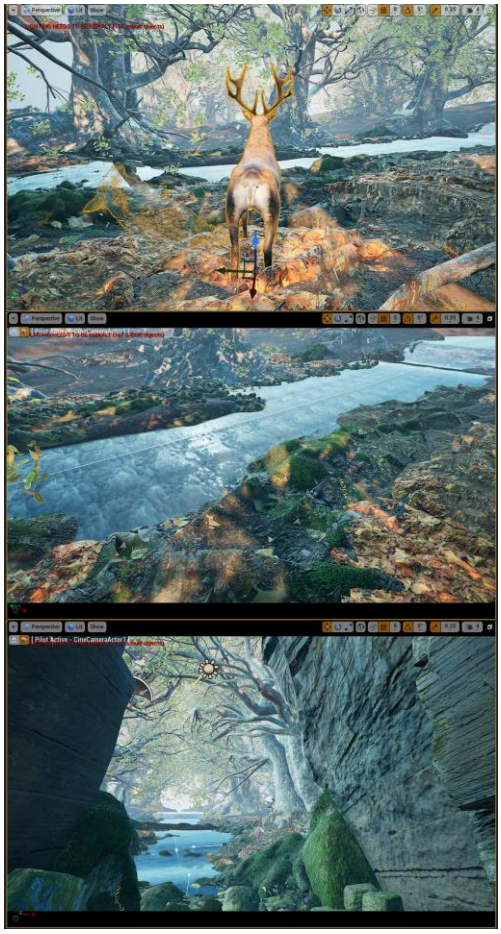


Fig.12. Zhang, Yue. *Forest Scene Test,* 2021. Digital Image.

Another example of this is evident in the underwater scene, which includes many sea plants, rocks, and other elements. It could potentially be a tremendous workload, but I was able to keep track of poly counts using UE4's Automatic LOD system. This system is capable of loading multiple levels of models based on the distance between objects and the player's (camera) position. Furthermore, an important feature of the underwater scene's atmosphere was established by including a volume fog effect which, as previously stated, could be difficult to render using the Octane render system.

Conversely, UE4 can be computed in real-time and have a realistic interaction with lighting and shadows (see picture below).

Fig.13. Zhang, Yue. “Underwater Scene Test.” *Discontinuity.* 2021. Screenshot.

15. Production (4): How the Cross-Platform Production Style Aids in the Creation of Experimental Components that Serve in the Communication of Perceptions

Given how excellent and fast UE4 is, it would seem an obvious choice to use it to render the entire film. I decided not to because this movie has a lot of abstract, symbolic, and dynamic elements in it that I felt were better simulated and rendered using Cinema4D and Maya.

It's difficult for me to draw a clear line between this film's experimental and narrative portions since I'd like to think of it as a “comprehensive” and "organic" progression. However, I believe the stylized visuals and symbolic motifs featured in my film are more of an "experimental" approach.

Rather than representing objects or characters in their physical, realistic forms, as mentioned in the preproduction section, the abstract visuals used in this film are meant to introduce ideas, raise questions, and connect emotions. The use of realism and abstract elements in this film are intended as two levels that work together to advance the plot. Below is an example of how realistic and abstract elements work together to communicate with viewers.

The basic idea of this film is that when the world is viewed by an observer, it is perceived to be normal, but when this same environment is not in view, it remains in disorder and emptiness.

That raises an important question: how can I effectively depict these two opposing states?

At first, I intended to animate the changes in a scene with an observer and then without, but Professor Jesse O'Brien, a member of my thesis committee, suggested a different way to present it, which I believe is more effective. He suggested that I draw a "cone of vision" to illustrate the observer's range (Fig.14) so that I can compare what's inside and outside the cone in one fluid scene.

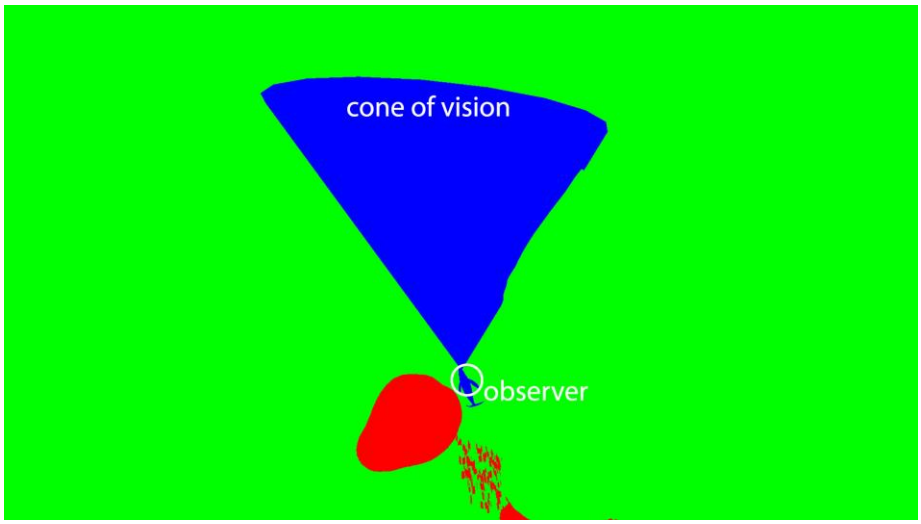


Fig.14. Zhang, Yue. *Test of Cone of Vision,* 2021. Digital Image.

Below you can see how utilizing the cone of vision and applying this idea looks in the final shot.

What's inside the cone of vision are substances and objects influenced by the observer, so they are clear. Correspondingly, what is left outside the cone of vision is abstracted because they are not visible

to the observer. We can also see how the cross-platform technique allows me to incorporate abstract and realistic imagery simultaneously into this frame, allowing for an experimental tone overall.

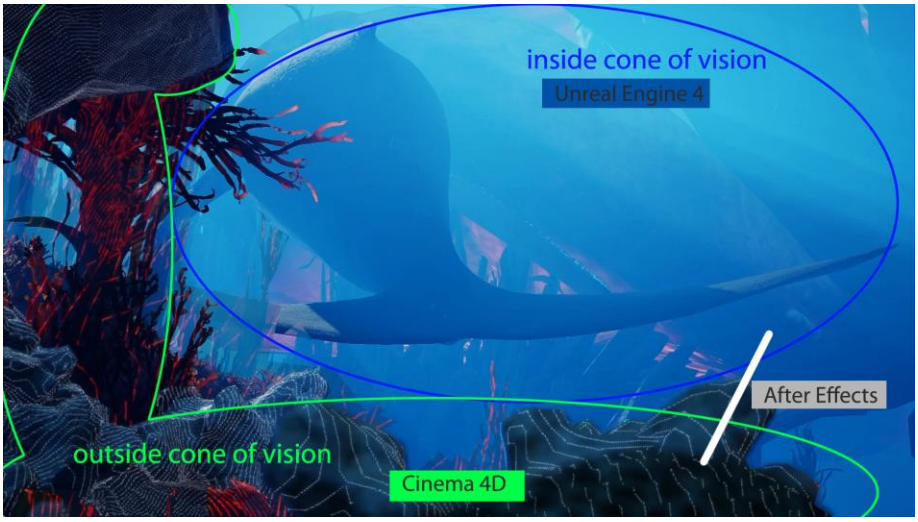


Fig.15. Zhang, Yue. *Cross-platform Image Result Based on Discontinuity,* 2021. Digital Image.

As can be seen from the same image, in terms of software, I utilized Unreal Engine to construct the interior of the cone of vision, while Cinema 4D was used to build the outside of the cone of vision. Then they were composited in After Effects.

This example depicts one situation in which the cross-platform approach was used as well as how the experimental aspects assist the viewer in comprehending the content of the shot.

Many aspects and features in the film are more efficiently simulated in Cinema 4D (C4D) and rendered within its native plugins. To demonstrate this idea, I have pictured below a scene from my film in which a symbolic eye, demonstrating a growing effect from the central part of the image out, can be simulated in C4D and easily rendered from it.

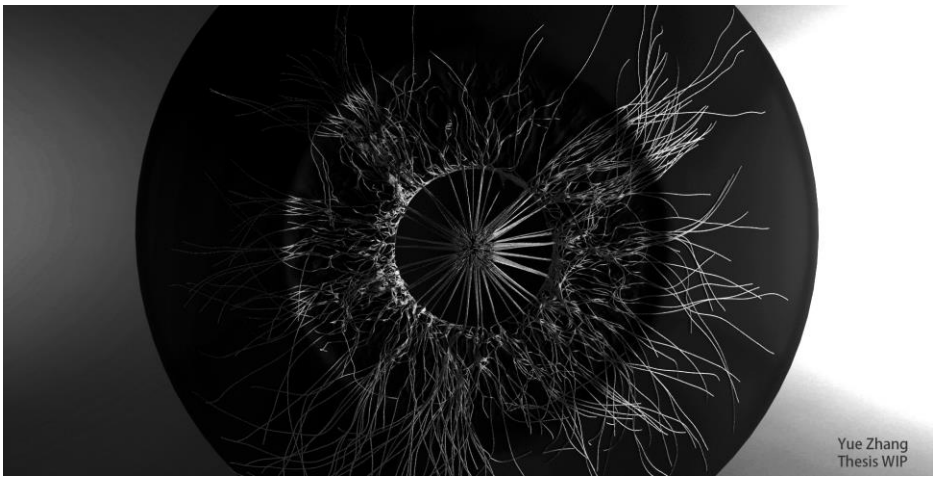


Fig.16. Zhang, Yue. *Symbolic Eye Test for Discontinuity,* 2021. Digital Image.

Also, particle effects like snow can be recreated in C4d quite adeptly. It is a more efficient technique to produce the scene in its entirety with the basic environment and interactive object (the vehicle) as pictured below.

Fig.17. Zhang, Yue. "*Snow, Car and Environment." Discontinuity.* 2021. Screenshot.

Another example of where C4D performs best can be seen in the scenes that include the graphic depiction of an environment that is "not being seen by intelligent beings"; these are highly stylized images that C4D simply creates better. This type of shot can be created and rendered natively in C4D or other traditional software. This type of shot has a lower polycount that the renderer can handle in a

reasonable period of time. To illustrate this point, as shown in the image below, the abstract lines and astronaut's figure were fully rendered by C4D:

Fig.18. Zhang, Yue. " Abstract lines effect and Character." *Discontinuity. 2021. Screenshot.*

I then incorporated this abstract effect into a large polycount landscape (Picture below). In this situation, I had the abstract effect generated in C4D and the realistic effect created in UE4. I was able to integrate them in compositing by matching the position and scale in these two platforms.

Fig.19. Zhang, Yue. "Abstract effect, and Landscape." *Discontinuity. 2021.* Screenshot.

Using the previous examples above, I have attempted to demonstrate the significant differences in render capability between traditional 3D render tools and gaming engines. It is also important to note the significant advantages of working across platforms for independent 3D animation. The secret to creating a 3D film with rich elements and no creative boundaries is to employ various software and fully exploit their individual strengths. Animation, modeling in classic 3d graphics tools, and more flexible strategic rendering in design software and gaming engines are just some examples of this idea. Keep in mind that working across platforms requires the development of a bridge 3D format that allows us to import and export various types of 3D data.

Working across platforms makes it possible to create more sophisticated shots and remove me from giving rigorous scientific lectures or sticking to a typical storyline, allowing me to raise questions and connect with the audience in a non-linear manner.

16. Production (5): The Goal and Production of Music and Sound

Music within a film establishes a rhythm for scenes and segments and commentary on the action being presented. This element is often integral to a scene's experience and in some cases, has become as iconic as the films themselves. In the Preproduction chapter, you may remember that I explained my choice of soundtrack. Let us now take a closer look at how the final music and sound interact with the graphic sequences.

First, it must be discussed what ~~is~~ the role of music and sound is in my film. I want people to feel something when they see my images on screen and music can definitely help serve this goal. As an integral aspect of the film, the music should flow as a whole but also be able to convey various moods based on different scenes. For example, in my film, the driving scene and the astronaut scene should both operate as a flowing motion sequence but still retain their own distinctive style. For example, to portray and retain the intensity of speed or the nothingness of deep space inherent in the scene’s imagery. Another objective of music and sound effects is to assist with the viewer’s comprehension of the picture or scene. I believe that a good soundtrack cue should correspond to an image cue, which is particularly meaningful in my film because it contains a large number of experimental components.

For example, when the "observer's eye" begins to develop the soundtrack feels odd and strange as if something mysterious and unknown is happening. Similarly, when glitches occur in each scene the music and sound effects provide a similar strangeness to heighten the sensation of the uncommon in the viewer.

As with any part of the production processes in a film, it was a good idea to plan ahead because we wanted to give some room for unexpected circumstances throughout the remainder of the filmmaking process. In low-budget filmmaking, the director's and composer's artistic styles and communication patterns are also critical to the successful integration of the two. Fortunately, my composer (Eastman School of Music's Joe Hagen) was available to participate in this film project. I have previously cooperated with him on other projects and am excited to have the opportunity to work with him again as the composer and sound engineer for this film. We started to communicate about some basic facts of this film early on and settled into a plan for proceeding with the intention of cooperation as needed later if it became necessary. Over the next few weeks, we discussed the film's concept and vision, as well as reviewed some concept music clips from my pre-production stage. He was fascinated because I already knew he was a "science fiction nerd" like myself, so we could easily share information and debate advanced knowledge on the subject.

Following the pre-production stage, we devised a strategy and determined that the composer should be brought in once the timing was generally established with the visuals. Also, we agreed that he would be kept informed as far ahead of time as possible of major changes in production or scheduling. When March of 2021 rolled around, two months before the film's premiere, I delivered Joe my demo and we both signed a contract to iron out some specific working details. This was a critical step that my thesis advisor insisted on taking to let us know that we should take this seriously. This proved to be an invaluable step because we both knew upfront that is adhering to rules like weekly meetings, soundtrack requirements and the outlined timetable was critical to the film's success. The result is rather good and I believe it speaks for itself as we were both satisfied with how well the music and sound performance in this film.

Evaluation

I had a couple of face-to-face sessions with my thesis advisor throughout the proposal stage. In these sessions, we discussed the subject and the expected working method going forward.

My original idea was to merge animation with live-action videos. Then, my thesis advisor Peter Murphey asked me questions about the story's plot and my live-action film experience. These conversations made me think more deeply about the time constraints and challenges that a live-action film might face, as well as how to tell the story more clearly and concisely. This was a crucial piece of input that led me to change the structure of my film to what it is now, which in turn made it more practical in production and allowed me to move the story along with a clear concept.

Once the concept and proposal details were decided upon, I submitted my proposal to a selection of RIT professors and teachers who provided great suggestions and constructive criticism. For example, I started with a simplistic and stylized method to illustrate the Duel-slit Experiment at the film's beginning. While initially, I thought this was visually appealing, several viewers found the opening and the rest of the film slightly disconnected. They suggested that there might be another way to visualize the beginning of the film effectively without showing the experiment itself. Then later, during my weekly meeting with Professor Peter Murphey, who suggested a more specific opening option of starting with landscape or creature. I decided his suggestion was a good and viable option, so I presented several different versions of the opening for meeting reviews until it had better plot consistency. This was very helpful in assisting me in realizing what would be confusing to viewers and what could be used as a potentially wonderful idea. These comments not only helped me streamline the film's structure but also helped me to eliminate some unneeded shots that proved to be too time-consuming or confusing. This then allowed me to focus on the important shots to give them the time and polish they deserved.

We started with the Pre-Production process and worked our way through the Production process after passing my thesis proposal. The feedback came primarily from my weekly meetings with Professor Murphey. When we started our weekly meetings, the feedback grew more detailed, whether on the

images or the plots. During these discussions, some of the input received did not seem immediately important, but after many trials and tests, these seemingly insignificant tweaks did make a noticeable difference in the shots. In this film, I included four quotes regarding quantum theory to provide more context to the audience. On the other hand, Professor Murphy thought there might be too many quotes that would disrupt the image connections. When I heard this comment at first, I was undecided because I believed this material would provide audiences with more background information. Do I want to risk losing the opportunity to clarify the content in order to have a smoother visual sequence? I realized that I'd never know unless I tested different combinations of quotes and images. After many reviews in meetings, it turned out that utilizing just one quote is sufficient to grab the viewer's attention and keep them engaged. I now see clearly that just a modest adjustment can have a significant effect in some cases.

Also, in Thesis Committee meetings with thesis committee members Munjal Yagnik and Jesse O'Brien, both being very knowledgeable in their fields, have provided invaluably helpful feedback from their various, unique perspectives as well. I took Munjal Yagnik's Cinematography and Lighting class was at previous semester and he has a depth of professional knowledge and experience. More significantly, he cares about his students and is willing to go above and beyond to assist them in overcoming the challenges in their filmmaking they may face. I consider myself fortunate that he decided to join my committee. I followed his advice on many occasions reading several articles and watching some movies at his direction before creating my thesis film. These suggestions helped me with my pace and camera usage in general, as well as how to frame large landscape shots and camera motions. During the pre-production stage, I was considering using something enormous at the end of my film, such as folding the landscape and presenting a world distorting itself, but I wasn't confident about the idea. We discussed this idea at one of our committee meetings, and he was enthusiastic about it, suggesting that I refer to Christopher Nolan's film: *Inception*. This was helpful for the visual reference and the concept because I was more assured that it would work. I'm grateful for his help with this shot, and through his support, I decided to use it in the film's final cut. Jesse O'Brien, also a member of my thesis committee, is a game industry

professional as well as an experienced teacher who assisted me in learning UE4 and fluid simulation plugins. His assistance and direction allowed me to adapt cross-platform methods more confidently in my production. Not only that, as I mentioned in the first chapter, his input on "Cone of Vision" made a tremendous difference in the storytelling of my film.

My friends and classmates provided me with some excellent criticisms as viewers because they were not involved in the filmmaking process. For example, Shanee Gordon, a classmate, provided me with some great input and assistance by revising my thesis proposal and sharing her knowledge of using UE4, which helped my further works. Due to this example and more, their feedback proved to be quite valuable.

I got quite a bit of favorable feedback from viewers online during my screening at the end of the semester. Many people commented on how well the short blends science and art, which is precisely what I was going for. More crucially, a Professor provided positive feedback on the CGI techniques used in this video while simultaneously expressing his confusion regarding the overall story. I greatly appreciate his feedback and consider it to be beneficial to my future filmmaking endeavors. This comment made me think about how to make my film more accessible to everyone. I don't have an answer yet, but it has given me something to think about. Because this screening took place during the pandemic and was not shown on a large screen, some people expressed their desire to see it on a large screen which is a desire I share. If I have the opportunity, I will make changes based on the input I've received and improve it. Aside from the RIT screening, I showed the finished video to a few of my friends and former coworkers. The majority of them were impressed by the images produced utilizing the Cross-Platform Technology. Some individuals who were already interested in quantum theory thought it was a terrific short film. Those who are unfamiliar with the background theory, on the other hand, had varied reactions. While some were able to fully grasp the narrative, others offered suggestions on incorporating additional background information into the video to provide more clarity. I believe all of these suggestions will be extremely useful in my future work as a filmmaker.

Before making this film, I thought the most important things to include in a film project were aesthetics and technical prowess. After this experience, I have realized that learning and adapting information that can be transferred to the story is equally important, if not more. I see animation and film as a conduit to connect me to my viewers, so it is important for me to not only produce images that look beautiful but also tell a story that reflects my thoughts clearly to them. I feel lucky that I have found that animation can, to a certain degree, interpret science, fact and extend its benefits to explore something unknown.

Conclusion

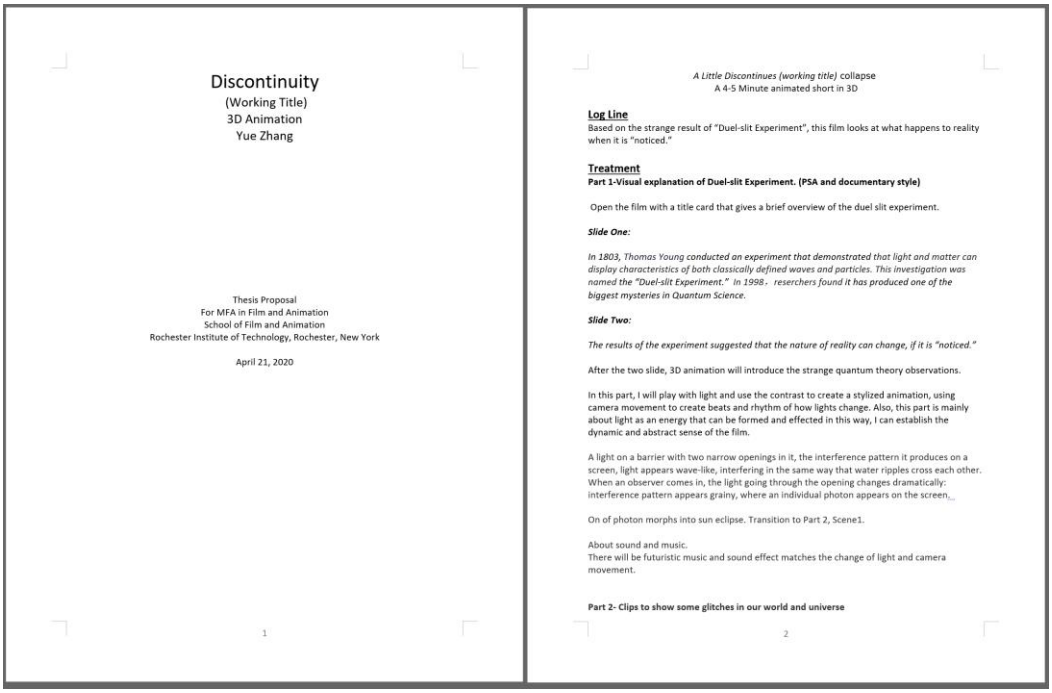
My research is aimed to find effective 3D experimental animation filmmaking strategies for independent filmmakers. Based on time investment, outcome, and different 3D platform comparisons, it can be concluded that cross-platform workflow in animation filmmaking is an effective strategy to consider. Especially when the film needs eye-catching images and refreshing visual elements that will still fully engage the viewer in a limited time frame and budget. My choice of an experimental film form helped me achieve my goal of bringing a complicated subject to a general audience and hopefully inspiring them to explore this topic further.

As I mentioned in the Process section, incorporating a game engine into my production process has saved me a lot of time when it comes to developing and rendering shots. This is most especially true when working on vast landscapes or shots with high polycounts. It also offers a lossless visual preview; real-time render results, and an interactive world-building experience. The open-source game engine not only helps to cut render time and improve workflow, but it also helps to lower filmmaking budgets which are particularly significant for indie filmmakers. Using different applications and platforms for different stages of production and visual goals is a highly effective approach that allows us to get the most out of each 3D tool and break an artist's development restrictions.

With the help of a Game Engine and a Cross-Platform Workflow, my thesis film produced decent animation shots and images that not only serve the purpose of the film theme but also successfully keep viewers engaged according to the feedback and reaction from audiences.

Appendix Pages

a. Thesis Proposal and Work-In-Process Asset List (Screenshots).



Discontinuity
(Working Title)
3D Animation
Yue Zhang

Thesis Proposal
For MFA in Film and Animation
School of Film and Animation
Rochester Institute of Technology, Rochester, New York

April 21, 2020

1

A Little Discontinues (working title) collapse
A 4-5 Minute animated short in 3D

Log Line
Based on the strange result of "Duel-slit Experiment", this film looks at what happens to reality when it is "noticed."

Treatment
Part 1-Visual explanation of Duel-slit Experiment. (PSA and documentary style)

Open the film with a title card that gives a brief overview of the duel slit experiment.

Slide One:

In 1803, Thomas Young conducted an experiment that demonstrated that light and matter can display characteristics of both classically defined waves and particles. This investigation was named the "Duel-slit Experiment." In 1998, researchers found it has produced one of the biggest mysteries in Quantum Science.

Slide Two:

The results of the experiment suggested that the nature of reality can change, if it is "noticed."

After the two slide, 3D animation will introduce the strange quantum theory observations.

In this part, I will play with light and use the contrast to create a stylized animation, using camera movement to create beats and rhythm of how lights change. Also, this part is mainly about light as an energy that can be formed and effected in this way, I can establish the dynamic and abstract sense of the film.

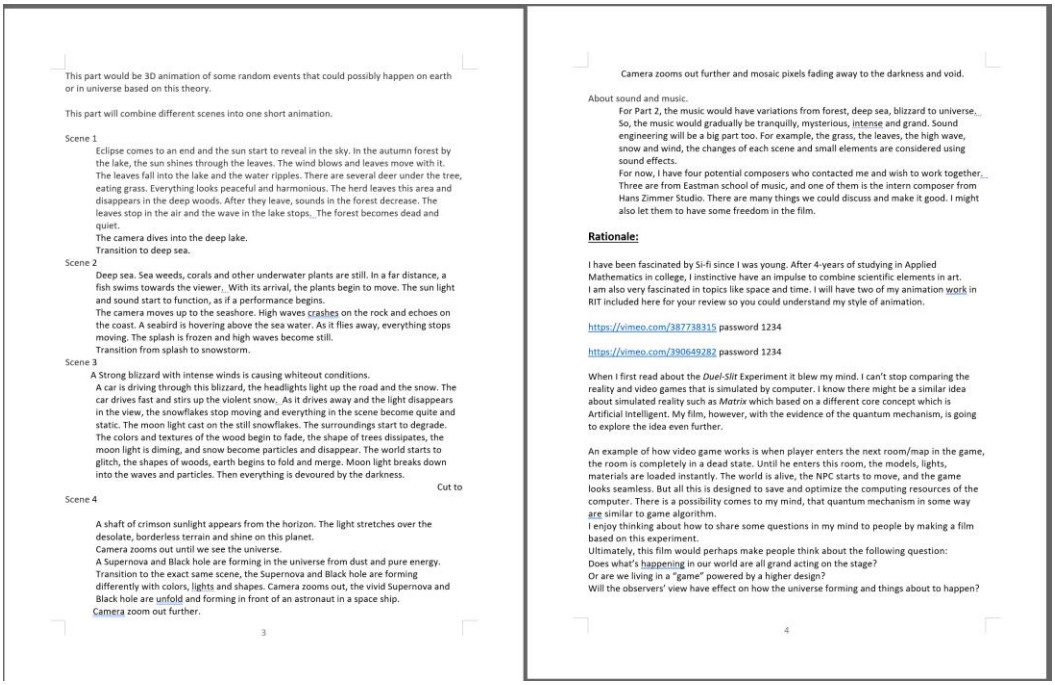
A light on a barrier with two narrow openings in it, the interference pattern it produces on a screen, light appears wave-like, interfering in the same way that water ripples cross each other. When an observer comes in, the light going through the opening changes dramatically: interference pattern appears grainy, where an individual photon appears on the screen.

On of photon morphs into sun eclipse. Transition to Part 2, Scene1.

About sound and music.
There will be futuristic music and sound effect matches the change of light and camera movement.

Part 2- Clips to show some glitches in our world and universe

2



This part would be 3D animation of some random events that could possibly happen on earth or in universe based on this theory.

This part will combine different scenes into one short animation.

Scene 1
Eclipse comes to an end and the sun start to reveal in the sky. In the autumn forest by the lake, the sun shines through the leaves. The wind blows and leaves move with it. The leaves fall into the lake and the water ripples. There are several deer under the tree, eating grass. Everything looks peaceful and harmonious. The herd leaves this area and disappears in the deep woods. After they leave, sounds in the forest decrease. The leaves stop in the air and the wave in the lake stops. The forest becomes dead and quiet.
The camera dives into the deep lake.
Transition to deep sea.

Scene 2
Deep sea. Sea weeds, corals and other underwater plants are still. In a far distance, a fish swims towards the viewer. With its arrival, the plants begin to move. The sun light and sound start to function, as if a performance begins.
The camera moves up to the seashore. High waves crashes on the rock and echoes on the coast. A seabird is hovering above the sea water. As it flies away, everything stops moving. The splash is frozen and high waves become still.
Transition from splash to snowstorm.

Scene 3
A Strong blizzard with intense winds is causing whiteout conditions.
A car is driving through this blizzard, the headlights light up the road and the snow. The car drives fast and stirs up the violent snow. As it drives away and the light disappears in the view, the snowflakes stop moving and everything in the scene become quite and static. The moon light cast on the still snowflakes. The surroundings start to degrade. The colors and textures of the wood begin to fade, the shape of trees dissipates, the moon light is diming, and snow become particles and disappear. The world starts to glitch, the shapes of woods, earth begins to fold and merge. Moon light breaks down into the waves and particles. Then everything is devoured by the darkness.

Cut to

Scene 4

A shaft of crimson sunlight appears from the horizon. The light stretches over the desolate, borderless terrain and shine on this planet.
Camera zooms out until we see the universe.
A Supernova and Black hole are forming in the universe from dust and pure energy.
Transition to the exact same scene, the Supernova and Black hole are forming differently with colors, lights and shapes. Camera zooms out, the vivid Supernova and Black hole are unfold and forming in front of an astronaut in a space ship.
Camera zoom out further.

3

Camera zooms out further and mosaic pixels fading away to the darkness and void.

About sound and music.
For Part 2, the music would have variations from forest, deep sea, blizzard to universe. So, the music would gradually be tranquilly, mysterious, intense and grand. Sound engineering will be a big part too. For example, the grass, the leaves, the high wave, snow and wind, the changes of each scene and small elements are considered using sound effects.
For now, I have four potential composers who contacted me and wish to work together. Three are from Eastman school of music, and one of them is the intern composer from Hans Zimmer Studio. There are many things we could discuss and make it good. I might also let them to have some freedom in the film.

Rationale:

I have been fascinated by Si-fi since I was young. After 4-years of studying in Applied Mathematics in college, I instinctive have an impulse to combine scientific elements in art. I am also very fascinated in topics like space and time. I will have two of my animation work in RIT included here for your review so you could understand my style of animation.

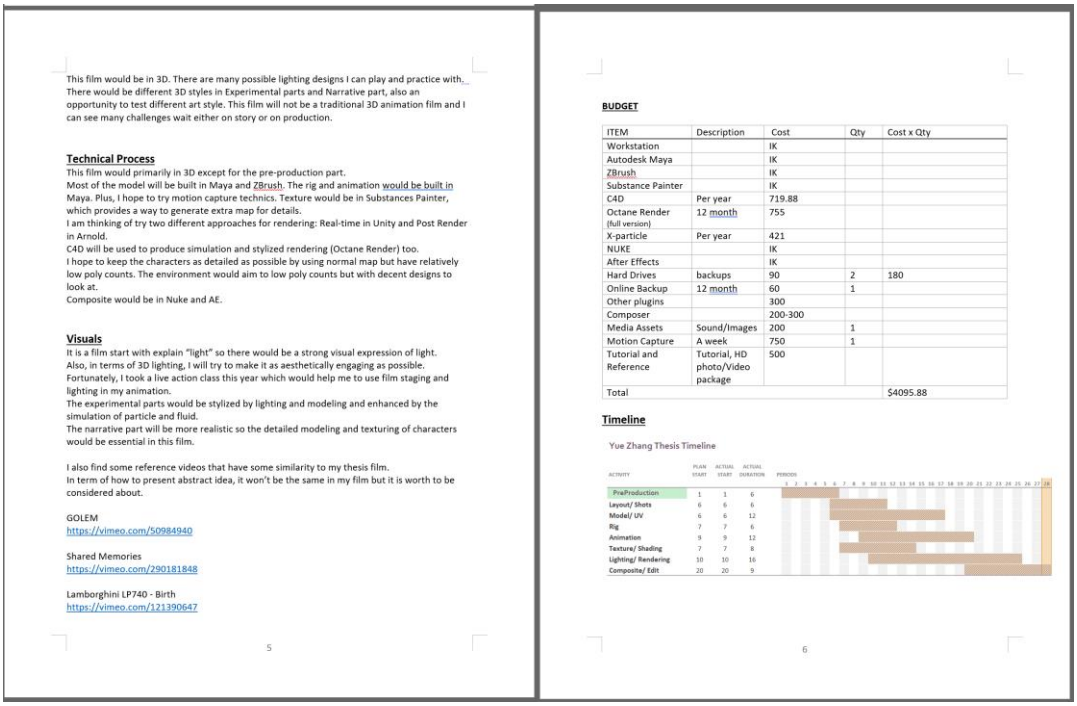
https://vimeo.com/387738315 password 1234

https://vimeo.com/390649282 password 1234

When I first read about the *Duel-Slit* Experiment it blew my mind. I can't stop comparing the reality and video games that is simulated by computer. I know there might be a similar idea about simulated reality such as *Matrix* which based on a different core concept which is Artificial Intelligent. My film, however, with the evidence of the quantum mechanism, is going to explore the idea even further.

An example of how video game works is when player enters the next room/map in the game, the room is completely in a dead state. Until he enters this room, the models, lights, materials are loaded instantly. The world is alive, the NPC starts to move, and the game looks seamless. But all this is designed to save and optimize the computing resources of the computer. There is a possibility comes to my mind, that quantum mechanism in some way are similar to game algorithm.
I enjoy thinking about how to share some questions in my mind to people by making a film based on this experiment.
Ultimately, this film would perhaps make people think about the following question:
Does what's happening in our world are all grand acting on the stage?
Or are we living in a "game" powered by a higher design?
Will the observers' view have effect on how the universe forming and things about to happen?

4



This film would be in 3D. There are many possible lighting designs I can play and practice with. There would be different 3D styles in Experimental parts and Narrative part, also an opportunity to test different art style. This film will not be a traditional 3D animation film and I can see many challenges wait either on story or on production.

Technical Process

This film would primarily in 3D except for the pre-production part.
Most of the model will be built in Maya and ZBrush. The rig and animation would be built in Maya. Plus, I hope to try motion capture technics. Texture would be in Substances Painter, which provides a way to generate extra map for details.
I am thinking of try two different approaches for rendering: Real-time in Unity and Post Render in Arnold.
C4D will be used to produce simulation and stylized rendering (Octane Render) too.
I hope to keep the characters as detailed as possible by using normal map but have relatively low poly counts. The environment would aim to low poly counts but with decent designs to look at.
Composite would be in Nuke and AE.

Visuals

It is a film start with explain "light" so there would be a strong visual expression of light.
Also, in terms of 3D lighting, I will try to make it as aesthetically engaging as possible.
Fortunately, I took a live action class this year which would help me to use film staging and lighting in my animation.
The experimental parts would be stylized by lighting and modeling and enhanced by the simulation of particle and fluid.
The narrative part will be more realistic so the detailed modeling and texturing of characters would be essential in this film.

I also find some reference videos that have some similarity to my thesis film.
In term of how to present abstract idea, it won't be the same in my film but it is worth to be considered about.

GOLEM
https://vimeo.com/50984940

Shared Memories
https://vimeo.com/290181848

Lamborghini LP740 - Birth
https://vimeo.com/121390647

5

BUDGET

ITEM	Description	Cost	Qty	Cost x Qty
Workstation		IK		
Autodesk Maya		IK		
ZBrush		IK		
Substance Painter		IK		
C4D	Per year	719.88		
Octane Render (full version)	12 month	755		
X-particle	Per year	421		
NUKE		IK		
After Effects		IK		
Hard Drives	backups	90	2	180
Online Backup	12 month	60	1	
Other plugins		300		
Composer		200-300		
Media Assets	Sound/Images	200	1	
Motion Capture	A week	750	1	
Tutorial and Reference	Tutorial, HD photo/Video package	500		
Total				$4095.88

Timeline

Yue Zhang Thesis Timeline

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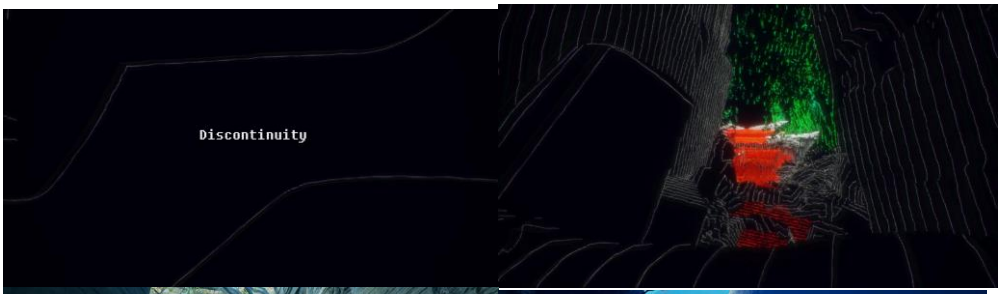
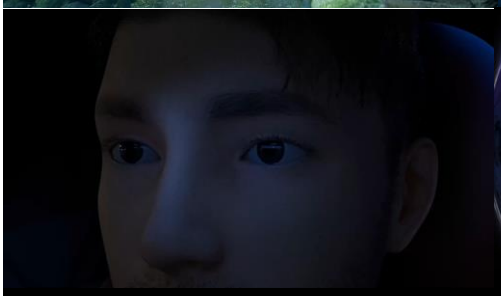
1	MODEL/TEXTURE/SHADER	EFFECTS/SIMULATION	Rigging/Animation	
2	Forest-Trees (many)	leaves (Wind dynamic)	Deer Walk/Blink	
3	Forest-Rocks (many)	Sea (Fluid Dynamic) (Cancel)	Whale	
4	Forest-Land	Sea Plants(Dynamic)	Human	
5	Forest-River	Sea (Fog-Volume)	Car	
6	Forest-Deer	Glitch	Landscape Bend	
7	Sea-Gaint Plants	Galaxy forming (Cancel)	Car rig	
8	Sea-Medium Plants	Car deforming (Cancel)		
9	Sea-Medium Plants	Glass shatter (Cancel)		
10	Sea-Small Plants	Snow (Simulation)		
11	Sea-Whale	Water		
12	Car (Inside, Outside)	Experiment (Light, Particle)		
13	Bridge	Deer Fur (maybe, fur or texture)		
14	Construction	Light decomposition effect		
15	Mountain	Dust		
16	Earth			
17	Astronaut			
18	Galaxy			
19	Snow flake			
20	Eye			
21				

b. Seven screenshots





Film by Yue Zhang

Music and Sound by Joseph Hagen

Faculty Advisor

Peter Murphey

Committee Member

Peter Murphey

Munjal Yagnik

Jesse O'Brien

Special Thanks

Tom Gasek
Vanessa Sweet

Family & Friends
MFA Class of 2021

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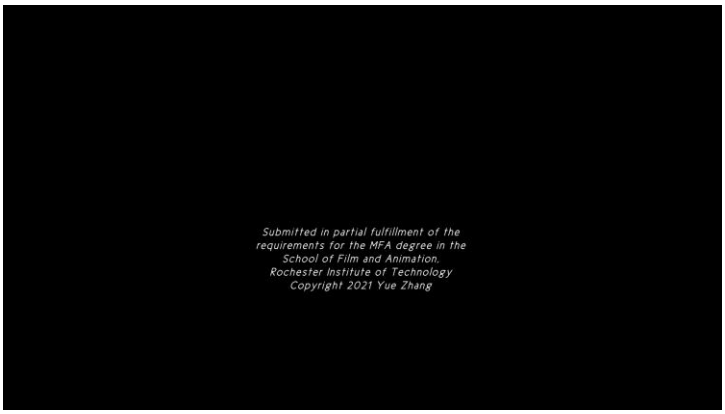

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