A BRIEF NOTE

This thesis project is an exploration of cross-platform, multi-media story telling. It seemed only fitting that the paper be the same. Throughout, there are references to links that lead to video examples of relevant sources and of the project process. These links can be found in the “Link Index” at the end. These examples are not necessary for understanding the content of the paper but do provide additional context.

INTRODUCTION

Virtual reality, also known as VR, is a computer-generated image that a viewer can interact with and manipulate. VR takes on many forms, but, most commonly, when we say VR, we are referring to head mounted displays (HMDs). While HMDs are actually a relatively old technology, they are just now becoming more mainstream, primarily for gaming. However, with a level of immersivity unlike any we have seen in similar electronic forms previously, virtual reality has exciting implications for a more than four-thousand-year-old art form predicated on immersion – theater. How do the presences afforded to us by VR and the liveness of theater compare to one another? How can VR expand the reach of theater? What are the implications for accessibility? What does it mean to tell a story in VR?

I was first introduced to VR as a member of Electr(onic)a—a production seminar taught by Nathan Roberts and Elise Morrison in 2019. As a part of the course I attended a workshop with Elizabeth Hunter at Yale’s Center for Collaborative Arts and Media (CCAM). Hunter talked to us about her work on her project Bitter Wind, an AR (augmented reality) retelling of Sophocles’ Agamemnon as told through the eyes of his wife Clytemnestra (Hunter). AR is a cousin to VR, where computer generated images are overlaid on top of your real-world surroundings, rather than taking up your entire field of vision as in VR.
Hunter was director and manager of the project, with a team of designers and coders and engineers working for her. Her work was new and innovative, but it was something I admired, not something I ever believed I could create myself. Without my own team of programmers and with no coding experience, creating a work like Bitter Wind seemed totally out of reach.

This changed thanks to a second workshop at the CCAM. Bobby Berry (Project Lead of the Blended Reality Initiative) and Justin Berry (Innovation Fellow) of the CCAM demonstrated the capabilities the VR development platform, Unity, and of the Leeds studio- the center’s motion capture facility. It was at this workshop that I realized how user-friendly the software was, and how with a great deal of dedicated time, someone without a master’s degree in computer engineering (me) might be able to make something with it. Excited by the new medium, and its implications for the theater, I decided to create a VR adaptation of a play for my senior thesis project.

The decision of what play to adapt in this format was influenced by a number of factors. As most licensing companies can only grant rights for live performance, not the filming required for VR, I quickly decided to select a play in the public domain. For the purposes of this thesis, I wanted to select a work present in my own and many others’ theatrical consciousness. I wanted a work with a level of cultural importance, so that those who have been limited by issues of accessibility in the past would gain the most from now being able to share in that common knowledge. I decided a work by Shakespeare would best fit this bill, as his works are commonly known and deeply ingrained in our cultural consciousness. With the limitations of my lack of coding skills it made sense to choose a play with limited set changes so that would not be too complicated to build out of prefabricated asset packages on Unity. I quickly settled on A Midsummer Night’s Dream, a show that takes place almost entirely within the forest outside of Athens.

SCRIPT EDITING

The more theatrically knowledgeable of you reading this paper may be thinking, “But wait, A Midsummer Night’s Dream does not take place just in the forest, there are scene in the court!” You are correct, and this led to one of the first edits I made of the script. As I mentioned in the previous section, without any real experience in the software I would be using, I felt the need to keep the play to one setting. A Midsummer Night’s Dream was the Easiest to alter to this end. For the scenes taking place in the court, I adapted the script, both cutting and writing new sections in Iambic Pentameter so as not to break up the rhythm of the show. With these edits, the court scenes now take place in the forest as well.

I made several other edits to the text. The largest was initiated by repeated advice from my advisor that doing the entire play was far too much work to complete in the year that I had for the project. I still very much wanted to attempt to create a coherent and complete plotline. For those without a great deal of experience in Shakespeare, the vast majority of his works include an A and a B (and occasionally C) plotline. For A Midsummer Night’s Dream those plotlines, while deeply intertwined, can be boiled down to A – Hermia and Lysander’s flight into the woods (and Demetrius and Helena subsequently following them), and B – Oberon instructing his servant Puck to bewitch Oberon’s wife Titania into falling in love with someone or something else so as to distract her so Oberon could steal the servant boy they are fighting over. Arguments could be made that either plotline is the primary one, however given my cast and what I personally feel is the more interesting of the two plots, I decided to cut the second plot involving Titania and her lover, Bottom (whose head Puck turns into that of a donkey). This, of course, greatly changed the shape and duration of the play, and allowed me to complete all of the rehearsal, audio recording, and motion capture filming required for the project while maintaining a full and complete plot.
The final major section of script edits that I made were in the interest of adapting the story for a modern audience. One element that always struck me with *A Midsummer Night's Dream* is that Shakespeare never explains why Hermia’s father Egeus forbids her from marrying Lysander. It is never explained in the plot, and Lysander is shown to be of equal financial and social standing as Demetrius, Egeus’s choice for Hermia’s husband. This is the inciting incident and a key plot point of the play, as without Egeus’s refusal of Lysander and threat upon Hermia’s life should she choose him, no one ever runs off into the woods. I began to think of why, in today’s society, Egeus might be so strongly against Lysander. It felt immediately obvious – Hermia and Lysander would be two women, and Egeus’s hatred of the match would be rooted in homophobia and bigotry. This carried into my thinking about Helena and Demetrius. Why does Demetrius leave Helena so abruptly? What if it is because Helena is a man, and Demetrius is dealing with an implied threat from his own father, potentially combined with his own internalized homophobia? A lack of acceptance is something far too many LGBTQ+ youth face today, and adapting the play in this way allowed me to talk about an issue I care about greatly, to create representation for the queer community in a traditional story, and to update the classical play to better connect with a modern audience.

This awareness of my modern audience also led me to alter the reversal of the curses at the end of the play. In the original, Lysander is un-bewitched, and returns to his true love Hermia, but Demetrius remains under the spell and stays with Helena, presumably for the rest of his life. For myself, my cast, and for a young audience, this has very unsettling implications, as a man is given something to alter his mind and made to love someone he truly does not. Demetrius’s inability to give consent in this situation is deeply reminiscent of the all too common horrors of date rape. As this is deeply disturbing, I wrote a new section of verse, spoken by Oberon in his instructions to Puck, in which the latter fairy is to remove the spell from everyone, and Oberon will send Demetrius a dream, helping him to come to the realization that he truly loves Helena on his own. In this way, I hoped to edit one the most problematic aspects of this plotline and make it less horrifying to myself and to a modern audience.

**FOUNDATIONAL RESEARCH**

Virtual reality is a simulated environment created electronically through the use of computers and similar technology (Bardi). Mujber et. al. categorize the wide variety of VR systems into three general categories; non-immersive, semi-immersive, and fully-immersive. The term “VR” is most often used colloquially to refer to HMDs (Head-Mounted Displays). HMDs utilize a headset with two small screens in front of each of the user’s eyes to mimic our natural binocular vision. Sensors in the headset track user’s head movements and shift the perspective of the scene they are viewing. (Dixon 365)

While the technology itself is now more than fifty years old, having been invented in 1986, virtual reality still has not entered into mainstream ubiquity. Commercial HMDs – such as the Oculus Quest and Oculus Rift – are available, but they are still prohibitively expensive, with the Oculus Quest currently retailing at BestBuy for $499 (“Oculus Quest”). There are cheaper alternatives, like Google Cardboard, currently retailing for $15 (“Google Cardboard”) (Figure 1). However, Google Cardboard does not actually contain any software itself, it serves only as a lens through which to view a smartphone operating the software. There are only a small selection of games and experiences created for use with the Google Cardboard. These limitations have kept the Google Cardboard from being adopted by the gaming community to which VR has been largely relegated, and so it has gained even less popularity than the Oculus.
If VR has been relegated almost exclusively to the world of gaming, how is it relevant to a thesis in theater? Theater is a medium that prides itself on its creativity. Theater is an intrinsic part of who we are. Storytelling is a primary human trait; it is how we make sense of the world around us and forge interpersonal connections (LaMothe) (Gainor 2). It generates a shared common cultural background and understanding for a culture (Stokes). The theater is an entire tectonic plate of the bedrock of any culture. Even if you do not go to the theater regularly, or have conversations about the theater, it is hard to escape references to theatrical works (if you have ever said the word “bedroom”, “eyeball”, “lonely”, or “elbow”, you have unwittingly quoted Shakespeare). Those without knowledge of theater and the theatrical canon have greater difficulty connecting to the majority members of their society who do have this knowledge.

However, not everyone has equal access to the theater. There are those who, because of financial, locational, and mental and physical health barriers preventing them from attending the theater. The COVID-19 pandemic has provided us with another clear example of when access to the theater is limited. As theaters are shut down and people must stay at home to prevent spreading the virus, the vital importance of live theater is cut off. A person could watch a filmed version of these plays, but one of the key aspects of theater is the presence of it in communal space (Gainor 1). A film cannot compete with the presence of live theater, but theater cannot compete with the convenience and accessibility of film. Here is where VR can come in.

The brain reacts to virtual reality in a manner entirely different from how it reacts to either film or live theater. An experiment performed by Jacqueline M. Fulvio and Bas Rokers asked participants in HMDs to “hit” a virtual ping-pong ball using their paddle. In initial tests, participants came out with incredibly low scores, similar to those working with only a standard two-dimensional screen. The binocular effect of virtual reality did not seem to be mimicking our natural binocular response systems in any way. However, when visual feedback was added to signify to players that they had successfully hit the ball, participants’ success rate doubled. This seems to imply that while the brain does not instinctively process binocular input from virtual reality in the same way it does in real life, it can with minimal training. (Barncard) (Fulvio 1-13)

Many VR makers attest to the realism experienced in VR. Betsy Eble, a Senior User Experience Designer at Lenovo, says, “Virtual reality is a Fully-immersive experience. What you’re seeing and what you’re listening to so closely emulates the real world that your brain perceives it as real,” (Lenovo). Jack Black is Head of VR at Create Advertising, who made The Walk VR Experience, to promote the film The Walk about Philippe Petit’s walk between the twin towers of the World Trade Center in 1974. Black claims that VR “triggers the primal parts of fear in your brain” and “brings up a really interesting tension between your primal brain and your rational brain. Evoking a sense of danger and fear within a virtual reality experience,” (“Walking on a Virtual Tightrope”). Black says that a quarter of users are so frightened, they refuse to step out onto the virtual rope, even knowing that it is not real. (“Walking on a Virtual Tightrope”).

Other applications of VR are also finding great success. The most explored application for VR is professional training simulations. One study finds that use of VR in safety training can improve performance anywhere from seventeen to forty-

### Figure 1: Comparison of Oculus Quest and Google Cardboard

<table>
<thead>
<tr>
<th></th>
<th>Oculus Rift</th>
<th>Google Cardboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price</td>
<td>$499</td>
<td>$15</td>
</tr>
<tr>
<td>More Experiences Created</td>
<td>More</td>
<td>Fewer</td>
</tr>
<tr>
<td>Self Contained</td>
<td>Self</td>
<td>Requires Smartphone</td>
</tr>
</tbody>
</table>
nine percent (Norris 37). In terms of retention of material, VR learning’s seventy-nine percent is seconded only to ninety percent from “learning by teaching others” (Norris 38). A virtual reality simulation mimicking the symptoms of schizophrenia was tested on a group of psychology students, and students going through the experience demonstrated greater understanding of the diagnosis, as well as displaying a greater level of empathy for those suffering with the disease (Formosa 57-62).

The brain does not process information from virtual reality in the same way it does either real-world information, or two-dimensional monitor learning. Virtual reality seems to inhabit a space in our brain someplace in between life and film. What does this mean for the theater? Is it possible to create a VR experience similar to watching a show live in a theater?

THE FILMING PROCESS

The next step in the process was casting and rehearsal. With a pre-recorded project such as this one, you are not working up to specific performance dates, so you can rehearse and record out of sequence, much as you might a film. Rather than building to a massive series of filming sessions towards the end of a year (similar to building towards a run in a theater), we would rehearse, record audio, and film motion capture (mocap) for different scenes and groups every week and entirely out of order (Figure 2).

![Figure 2](image)

Figure 2: To keep track of everyone’s varied schedules, I created a calendar of all of our other obligations. Here is the cast availability calendar for February, with notations of what scenes would be filmed each week.

During a typical week of filming, I would call the actors for an hour or so of tablework rehearsal, where we would review the language and do scene readthroughs, making decisions regarding action and intention. The second weekly rehearsal would be on our feet, running blocking (Figure 3)(Link 1). For the vast majority of scenes, I trusted the actors to feel their way through the space. However, because of the limitations of the motion capture studio, we could only record mocap of two actors at a time. Scenes with any more than two characters therefore had to be carefully choreographed to be identical every take, so no one’s avatar accidentally walked through someone else in final renderings. We recorded audio in the Crescent Underground Recording Studio (CURS) in the basement of Morse and Stiles colleges (Figure 4) (Link 2). The audio was recorded in separate sessions and edited together into a single track in Logic Pro.

![Figure 3](image)
The last thing we did every week was record the motion capture. We would meet in the Leeds Studio and I would calibrate the cameras in the space using a specialized “wand” that emitted light for that purpose. The actors would arrive and get into their mocap suits. The mocap suits we used consisted of a shirt, pants, a tight skullcap, and booties, all made of Velcro. This Velcro allowed us to attach detachable markers that reflect infrared light. A panel containing a unique array of dots must be attached to each suit, allowing for the system to identify and differentiate between separate bodies. The light from the suit markers is picked up by an array of twenty cameras arranged around the ceiling of the space. We would play the audio recorded in the Curs studio, and the actors would perform the scenes along to the track of their own voices (Figure 5). The program Vicon Shogun Live used the information from the cameras to triangulate the dots from the actors’ suits in three-dimensional space, generating a 3D rendering of their movements (Link 3).

Figure 3: photos from a tablework (above) and a blocking (below) rehearsal. For video of the latter, visit Link 1.

Figure 4: members of the cast in CURS. For video, visit Link 2.

Figure 5: members of the cast in the Leeds studio filming motion capture. For video, visit Link 3.

Filming scenes at the end of every week allowed me to experiment in all of the spaces and softwares early in the process, so that I had a clear understanding of how they worked before having to film the more complex action. Additionally, the manner in which we recorded audio first meant that actors never had to worry about memorization, saving them a great
deal of time and stress. One unforeseen benefit of this schedule was that, had we waited until the end of the semester to film, we very well could have waited until the semester was moved online (due to the COVID-19 pandemic of 2020), and would have completed no mocap filming, making us unable to complete the project.

WORKING IN POST

Fortunately, despite campus closing, we were able to complete the majority of filming. Next began the work in post. Opening the mocap recording in Vicon Shogun Post, I would scrub through the recording for rendering inaccuracies. It is very common to have Vicon confuse one dot for another; for example, if it confuses the dot at an actor’s sternum for one on their elbow, suddenly the avatar’s arm is inside their own chest cavity (Figure 6). The next step is to select the branch of each character and export them as object files that can be brought into other programs.

Each character avatar was created in Adobe Fuse CC. In the interface of Adobe Fuse CC, you select from an assortment of pre-generated body parts and clothing items and customize them as needed. Costuming choices were greatly limited by the inventory of the software, as I could only select from a set of prefabricated clothing items. Most clothing items were modern, which dictated that the costuming, and therefore the entire production, be set in modern day. However, this already fit a great deal with my script editing and casting choices, so the limitation did not drastically alter the concept of this adaptation. I did, however, put Oberon in the only piece of non-modern clothing that was available. As king of the fairies, it felt right that he would look different from the other characters, from an older and more alien world. I also dressed Puck and Cobweb in more androgynous styles, as my discussions with the cast led us to the conclusion that fairies put little stock in gender, and Puck cannot even recognize it, leading him to confuse Oberon’s directive to bewitch “that man” for Lysander, a woman (Figure 7). The other characters I dressed according to their personalities, influenced a great deal by the personal style of their actors. After finalizing the characters in Fuse, I exported them as .obj files and imported them into the web-based program Mixamo, where I was able to add skeletons. Skeletons are essential for allowing Unity to apply the motion capture data onto avatar.

Figure 6: Kira Daniels (Lysander) modeling a mocap suit (left) and Shogun confusing mocap dots on her shoulder and chest causing warps in avatar (Right)

Figure 7: (left to right) Character designs of Oberon, Puck, and Cobweb
Unity is the software in which I built the set, lighting, and applied the animation to the avatars. Unity served as the space in which all of the separate pieces of the project came together to form a cohesive scene. To create the set, I downloaded several packages of prefabricated foliage as well as a skybox from the asset store and used them to create a nighttime forest set. I imported the avatars from Mixamo, placed them in the space, and added animation controllers to them, allowing the motion capture file to move them. Audio sources were added to each avatar playing the audio of the applicable actor in the applicable scene so that the voice of the actor sounds as if it is coming from the avatar speaking them (Figure 8). I then added and adjusted the main lighting source of the scene so that it was placed in the center of the sky, emitted a wide circle of light across the entire scene, and glowed a dim blue to emulate moonlight. I also gave it a glowing halo, so that it is visible and mimics a moon in the sky as the scene plays. Additional light sources were added and linked to each avatar (making the lights travel with the avatars as they move) so as to move with them and improve their visibility.

The final step was to add a “mouse look script” to the camera, which allows user to move the camera they are viewing through around the scene in real-time. The user can manipulate their view of the scene using a mouse. Moving the mouse rotates the camera on the X axis (rotating the view along the horizon) or Y axis (rotating the camera perpendicular to the horizon), thereby imitating moving one’s head and looking around.

With this, I had a finalized version of a short scene in *A Midsummer Night’s Dream*, which is the product you see now (Link 4). Unfortunately, due to the limitations of the processing power my personal computer and without having access to CCAM resources, I am unable to render and export a finalized scene for VR viewing at this time. However, Link 4 leads to a screen-recorded video of the finalized scene in Unity in which I operate the mouse look.

The rendered final product would allow a user to look independently around the completed scene visible by following Link 4. A user could access the scene posted on a webpage, manipulating the view with a mouse for a non-immersive – viewed on a standard two-dimensional screen or monitor – virtual reality experience that could be accessed from any computer (non-immersive here refers to the technical definition. I, personally, still believe this type of VR to be immersive, if less so than its more high-tech counterparts, through user’s ability to control their view of the scene). Ideally, this project would continue with some additional, altered coding so that the scene could be viewed through a headset like the Google Cardboard or the Oculus Rift for a fully-immersive virtual reality experience. The camera through which the user views the screen is currently locked in one location, but with more coding a user could “walk” through the space of the scene in addition looking around. In this instance, parameters could be put in place to keep a user within the area of the scene so that nothing

---

**Figure 8:** a screen capture of the scene in Unity. Visible are Puck, Oberon, and the “player” body the audience views from, which is a red cylinder. The characters’ spotlights can be seen as small white objects floating in front of them.
would be missed. In the scene, the user views the two avatars of Oberon and Puck, each giving their end-of-play conclusion speeches, and they can hear the voices of those characters originating from them as they move throughout the scene. They can pivot their view around the space to view the scene as if they themselves are in the clearing right alongside the characters. Around them they will see a dark, overgrown forest, and looking up they can see the moon shining, casting an ethereal blue glow over everything from its place in the starry, milky-way sky. They become fully enveloped in the world of one of Shakespeare’s most seminal works as they witness it firsthand like never before.

WHAT WAS LEARNED FROM THIS PROCESS?

Theater and the stories it tells are vital to the human experience. While virtual reality cannot compare to the immediacy and communality of live theater, in circumstances where live theater is not possible, such as for an individual with the inability to sit still for long periods of time, or during a global pandemic when all non-essential businesses have been closed, VR can provide us with a way to stay in contact with our favorite stories in a far more personal way. More than just a poor facsimile, however, VR also has numerous advantages over live theater. For those with social anxiety, a VR play such as this one can be accessed without ever coming into contact with a crowd of people. For those with concentration difficulties, experiences like this can be paused and returned to at a later time, something not afforded by a physical theater. For those trapped in hospitals or at home because of immuno-compromization or quarantining, virtual reality can be accessed remotely and safely, without coming into contact with a single other person.

While HMDs are still not widespread, adapting theater to these forms can serve to bring in new audiences who usually forego the theater for other entertainments, such as video gamers who are more likely to have HMDs. For those who do not, a cheap HMD can be purchased as an augmentation to their existing technology with the Google Cardboard costing far less than some nights at the theater (for those with existing cellphones), or virtual reality can be accessed through any computer with internet access for a less, but still deeply, immersive VR experience.

What has become more clear to me than anything over the course of this project is that, while I initially intended to explore virtual reality as a potential substitute for live theater in certain situations, it is far more effective to evaluate VR not as a stand-in for something already existing, but as its own unique storytelling medium. In VR, the audience has the ability to physically enter the story in a manner unlike anything before. VR allows us to explore classic stories like A Midsummer Night’s Dream in new and exciting ways, and thus to learn more about what such stories can mean and how they can speak to our modern human condition, even 400 years after the words were originally spoken. For me, working on A Midsummer Night’s VR revealed a great deal to me about Shakespeare’s work. I recognized the fear, confusion, bewilderment, excitement, mystery, and magic that is so inherently written into the text. I have intellectually been aware of these things, but never have they manifested so strongly as when I step into the forest with these young, desperate kids, and join in their story not simply as a viewer, but as a member of the same world. Virtual reality is only just beginning to be explored, but it holds so much potential to make us look at our stories like never before – from inside them.

CONCLUSION

VR can in no way replace all of the benefits of live theater, but it certainly comes a lot closer than anything else before it, and moreover it holds great potential as its own, exciting new technological frontier. VR can broaden the reach
of theater to a significantly wider audience, and allow for those who, due to a variety of reasons, may previously have been unable, unwilling, or uninterested in participating in the conversation. Story telling is a vital part of who we are as human beings. Stories teach and enforce moral systems for a society. They allow us to connect to one another. They provide opportunities for shared cathartic experiences. They create a shared cultural knowledge from which we can all connect. Now, VR is providing us an entirely new look at stories we know and love and holds the potential to shape our view of these classic plays, and even of our world, into something entirely new. All that we need to do is boot up our computers, or turn on our cellphones, or strap on our HMDs, and explore.

LINK INDEX

Link 1: https://youtu.be/-p5RRvIPhFU
Link 2: https://youtu.be/yAUFXcQ224
Link 3: https://youtu.be/ZQAjqepRIm4
Link 4: https://youtu.be/frXvzWjYew