Interactive Cinema

A major qualifying project
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by

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Abstract

Despite the success of a few novelties, attempts to add interactivity to cinema have largely been dismissed as disruptive and distracting by both filmmakers and audiences. In this project we created a method to add voluntary interactivity to a film, where audience participation is not necessary and does not disrupt the flow of the film. We used Unreal Engine 4, a modified screenplay, and original 3D models to achieve our goal. We believe we were successful in creating an innovative, and non-disruptive method of adding interactivity to a film.

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1 | Introduction

The goal of our project was to devise a method to add interactivity to a film in a non-intrusive manner. We considered previous attempts at creating interactive cinema, and found that user interfaces and menus distracted from the experience of watching a film, and decided to create a method of interactivity that does not use on-screen text or elements superimposed on the film itself. In this report, we first define key terms relevant to interactive cinema. Second, we discuss our narrative and artistic choices, including their significance and relevance. Third, we discuss our iterative process ranging from our earliest prototypes to our final prototype and demonstration film. Finally, we discuss the accomplishments and merits of our work, and discuss opportunities for future work with this technology.

Film is one of the largest entertainment industries in the world; in 2019 box office revenue alone reached an all-time high of 42.3 billion U.S. dollars (Watson, 2020). As a large industry filled with competition, film studios and distributors frequently look for features to stand out from their competition. Most of these features would be called "gimmicks", given their limited appeal, and often limited success and adoption.

Back in the early 20th century, filmmakers attempted various gimmicks to attract audiences. Notable among these was William Castle's *The Tingler*, a horror film released in 1959 where the draw was "audience participation" by means of randomly selected seats in the theater having small motors implanted in them; these motors would then vibrate at key points in the film, simulating the film's monster's attack (Heffernan, 2004). A year later *13 Ghosts* was released, also by William Castle, with a gimmick focusing on the use of "ghost viewer" glasses to watch the film that makes the ghosts visible (Besette, 2018). Neither of these gimmicks gained much traction outside their initial debuts. While ultimately most gimmicks were unable to

become mainstream film staples, stereoscopic 3D would see a sort of reincarnation in the late 20th century and early 21st century.

In the early 2000s, 3D had returned to theaters in force after a hiatus. While the technique of stereoscopic (overlaying images to create depth) 3D film had been explored before to limited success (notably with Andre de Toth's *House of Wax*), James Cameron's Avatar reinvigorated interest in the use of digital 3D with its 2009 release. Studios and filmmakers began adopting the use of simultaneously releasing 3D and 2D versions of films, which still continues to this day (Jones, 2020).

In 2018, Netflix released on its streaming platform the interactive movie Bandersnatch, which quickly found critical and commercial success (Kirke, 2020). In the film, the audience can select at times in which direction the story goes, usually after being offered a binary choice. Netflix has additionally released other films and series utilizing interactivity, and like many others, the flow of the film stops to allow for the user to consider their choices before progressing the story forward. One of the earliest attempts at interactive cinema was the film Kinoautomat, which like 2018's Bandersnatch, depended on stopping the film while the audience made the decision on how to progress (Hale, 2016). Like 3D, this gimmick of interactivity has been attempted before, yet has begun to find success and wider adoption in the 21st century (Kirke, 2020).

As the film industry continues to grow, and seeks new innovative techniques to advance the medium of cinema, it becomes increasingly difficult to find innovative techniques that do not intrude upon the experience of watching a film. Interactive cinema has to be a way of experiencing a movie with interactivity that does not detract from the flow of the film itself to

such a degree that the audience is taken out of the film or distracted. The goal of this project was

to create such a cinema experience.

2 | History of Interactive Cinema and Entertainment

Before covering the history of interactive cinema, it is important to make a distinction between interactive cinema and other interactive forms of entertainment, the most notable of which are video games. For the purpose of this project, we defined interactive cinema as an interactive piece of media in which the audience's experience is largely passive. Unlike narrative driven interactive media, such as the "walking simulator" genre of game, interactive cinema uses less input from the audience, and in some cases, audience input may not even be necessary to complete the experience. Most other interactive media requires frequent input from the audience to advance through the narrative. While interactive cinema in some interpretations does require the audience to participate at key moments, the amount of interactions the audience has with the film are considerably less than in other mediums (Veale, 2012).

The history of interactive cinema begins in the early 20th century, as some films were distributed in theaters with various gimmicks where the audience would be directly involved in how the movie progressed. Most notable of these was *Kinoautomat* by Radúz Činčera, which toured at World's Fairs from 1967 to 1970. The film had a moderator appear to the audience at key moments to encourage them to vote using buttons in their seats' armrests to decide how the film's narrative progressed and which scenes were shown (Kirke, 2020). Interactive films remained a niche type of film, and when digital mediums became more widespread, interactive films grew to use several tools including DVDs with menus, in-theater controllers, and web-services (Kirke, 2020).

Currently, interactive cinema has been propulsed into the limelight by the success of Netflix's *Bandersnatch* and other interactive projects (Kirke, 2020). *Bandersnatch,* a film about a game developer losing his grip on reality, utilizes several conventions from other interactive

media, especially video games. While it successfully adapted the meaningful branching paths for the narrative, *Bandersnatch* compromised aspects of interactivity and ease of viewing (Kirke, 2020). *Bandersnatch*'s interactivity is limited to often binary choices, displayed in large text boxes on the bottom of the screen, which must be selected with the tv remote, mouse, or touchscreen. These moments of choice halt the flow of the story for a limited amount of time, and introduce an interface the audience must interact with consciously, with a clock visibly counting down, to progress the narrative; otherwise, the film selects an option for the audience once the timer expires (Kirke, 2020). These moments break the flow of the film, taking the audience out of the story and saddling them with a timed decision, which curtails the film's ability to flow.

By most accounts, interactive cinema is still in its infancy, much like traditional cinema at the beginning of the twentieth century (Hales, 2016). Just as cinema in the past began adapting techniques from the theater and other live performances, interactive cinema has begun to adopt storytelling conventions found in traditional cinema, and interactive methods found in newer mediums, particularly video games. Taking these influences and precedents into account and utilizing them to create a storytelling medium distinct from both video games and films is the key to carving out a space for interactive cinema to develop as an independent, innovative medium (Hales, 2016).

While at their inception most video games lacked a central narrative, as time has progressed they have generally developed increasingly complex and compelling narratives, utilizing conventions from books, television, and films (Bogost, 2015). While utilizing storytelling conventions from other mediums, video games retain the key aspect that as interactive media, the audience is much more involved in the action itself, and drives the story

forward (Veale, 2012). Video games are built around the interactivity, and afford the audience the ability to advance the story at their own pace, and explore other aspects of the story (Bogost, 2015). While video games are able to capitalize on the conventions from other media, and explore their own artistic forms and conventions, films for the most part have struggled to integrate interactivity without compromising their own identity and strengths, particularly narrative flow.

For the purpose of our project, our goal was to create a piece of interactive media that enables the user to consciously choose to interact with the film, yet this choice is not forced on them, and the film flows organically regardless. By using game engine technology, and the lessons presented by other pieces of interactive media, we have created an interactive film with no obvious interface to distract from the cinema in "interactive cinema."

From the conventions of cinema we used most of the principles regarding camera placement and focus, such as using the camera's movement to draw attention to certain elements in a scene (Soules, 2015). The perspective and use of visual rhetorical elements afforded by film conventions were important to guide us in the process of constructing the scene and setting. Likewise, we adapted techniques from the videogame industry; we adopted the conventions of writing a script featuring interactivity, and how to handle interactivity and branching narratives. While there is no standard format for writing a script for video games, we were able to use a modified screenplay format favored by some studios (Despain, 2020). We selected this format because it would make production of the film itself easier down the line, as the dialogue was easier to read and clearly marked out for characters. The final iteration of the script can be found in Appendix B.

The interactive film we created allows the user to interact with the film at key moments, while signalling moments where interaction is possible. Hopefully this reconciles the interactivity afforded by games and the defining narrative flow of film.

3 | Narrative and Artistic Choices

In this section, we explore the reasonings that informed our artistic and narrative decisions when creating the project. We believe it is important to talk about these choices, and how they create synergy between the interactive film's technology and the narrative we created for use in the film. The purpose of the narrative was to convey a simple, relatable story with a satisfying conclusion and distinct characters; by creating a narrative that was easy to follow and relatable, we hoped that the interactivity of the film would shine through, and be showcased as a versatile tool that could work in other genres with other types of stories.

The film tells the story of Ryan Williams, a recent college graduate interviewing at Barotech, a weather instruments company. He is an adequately prepared candidate, albeit a bit nervous about interviewing at such a prestigious company. Williams is a young latino male, 24 years old. We selected this demographic because it was immediately relatable to us and we could then write and voice appropriate dialogue.

Williams is interviewed by Amanda Klein, the head of human resources at Barotech. Klein is an experienced employee and she is passionate about the company and her place in it. We chose to make Klein a young asian woman, 35 years old. We chose to represent this demographic because it is somewhat relatable to us, and it was important to us to represent women in STEM fields, specifically in positions of leadership.

The film takes place in the Barotech offices, specifically in Klein's private office. We selected this setting because it would convey the professionalism and respect we desired, while allowing us to decorate the space with items that would be critical to the film's interactivity and offer insight into Klein as a character. The office itself was inspired by many offices from our own life experiences.

Ultimately, we chose the neutral narrative and simple characters to showcase the technology behind the interactive film itself. The technology can be adapted for use in other genres and types of stories. We created this narrative as a "proof of concept" to show the fundamentals of the technology and how it can interact with the story and the delivery of the narrative to the audience.

4 | Artistic Choices in the Character Roles

In the entertainment industry, many roles have been whitewashed. Whitewashing is when a white actor is seeked for roles that are meant for other races and ethnicities. In 2017, a popular Japanese manga called *Ghost in the Shell* was being made into a live action film. The lead role of Major Motoko Kusanagi was given to white actress Scarlett Johansson. In response, there were more than 100,000 signatures on a petition for a recast. People wanted the original role, who was Japanese, to be at least acted by an Asian or Asian-American. ABC News interviewed Johansson on how she felt about the response. She defended her role by saying that the character is a "human brain in an entirely machine body, she is essentially identity-less" (ABC News. 2017). Overall there was also a lack of Asian representation. A Japanese American actress named Keiko Agena said, "We're looking at these beautiful white bodies saying these Japanese names, and it hurt my heart a little bit" (Sun. 2018).

The more diverse the cast is, the more it will connect with a diverse audience. The University of California, Los Angeles (UCLA), studied diversity in Hollywood in 2019 and 2020. Hollywood knows that diversity makes more money, but it is unsure if it is only casting more minorities to please a diverse audience (Hunt, 2020). Biola University's School of Cinema and Media Arts's Nancy Wang Yuen, a sociologist, says "I think that what we're seeing here is some of the growing pains of Hollywood wanting to be inclusive in terms of storytelling, and yet behind the scenes are not able to or wanting to" (Yam. 2020). Disney made their animated 1998 movie, *Mulan*, into a live action film. Many people were upset at those behind the screen where white and that they were just using Asian actors as props. The animated movie had more female Asian writers, while the film had all four white screenwriters. The director and costume designer were also all white. "Since this has not [been] the case with Mulan, its white crew members need

to be more self-reflective about not being Asian, rather than speak out as if they are Asian experts," Yuen recommends. She adds "if Disney consulted Chinese national or Chinese American cultural specialists, they should have empowered them to speak on the project" (Yam. 2020).

There have been some white voice actors who have decided to stop being a voice actor for an animated character of color. This movement started to come into light in late May due to the Black Lives Matter protests. Some white voice actors that play biracial characters, have been stepping down from their job (Romano. 2020). Jenny Slate, a voice actress for *Big Mouth*, voice acted for a character named Missy. Slate explained Missy's mother is Jewish and White like her "but 'Missy' is also Black, and Black characters on an animated show should be played by Black people" (Marine. 2020).

According to UCLA's data, the race of lead roles by race and ethnicity from most to least in shows are: White, Black, Multi-racial, Latina, Asian, and Mena. To not misrole the characters, we got the voice actors to match the character's ethnicity. The female role is voicing an Asian-American and the model is an Asian looking character. The male role is voicing a young Latino from Puerto Rico, and looks like their character model too. Both models are least represented in film based on the UCLA data. This is to bring more attention to these types of minorities. We also wanted both characters to not only be diverse in race and ethnicity, but in body types too.

5 | Early Prototypes

During the opening weeks of the project, we began work by narrowing and refining the scope of our goals for the project, given the broadness of the initial pitch. To start, we discussed several angles in which we could approach the project as well as how we wanted to tackle certain elements of the project such as the presentation, the means of interaction, and how interaction will affect the film. From our initial discussions, we created a series of rough concepts that outlined different angles we could potentially approach the project from. Each of these concepts were then developed into individual prototypes that further flesh out each idea and gave us a glimpse as to what our final project could look like. After all were completed, we analyzed each option to see which prototype we thought encapsulated what we wanted. That prototype was then chosen to act as the framework our project would develop off of. For each of these initial prototypes, we developed them within the *Godot* game engine using assets that were both created by the team as well as borrowed from outside sources.

5.1 - 2D Prototypes

In the beginning, our concepts were limited to taking place in two dimensions. Scenes would consist of separate 2D layers layered on top of each other to create the illusion of a single image. Through interacting with the film, the view would be able to move the camera within the scene. As the camera moved, each layer would move at their own independent speed. This enables us to hide elements of the scene from the user by obscuring them using layers placed closer to the camera. As the view moves the camera, the layers shift in position, revealing these hidden elements.
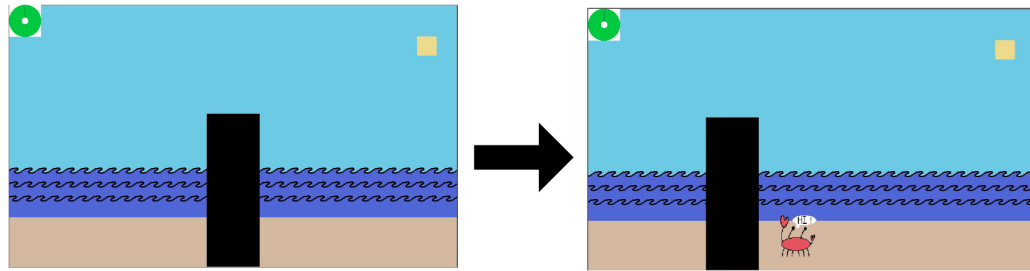
Figure 1: Screenshots from the first prototype produced, arranged to depict how the viewer's actions will affect the camera

The first prototype we produced was made to test and visualize how we imagined this effect to look. The prototype consisted of a single scene depicting a beach with a large black box in the center of the shot which was made up of several layers, as seen in Figure 1. The camera in the scene was controllable, with the viewer being able to move it left and right by tilting their phone. As the camera moves, the separate layers composing the waves of the ocean move at various speeds, giving a sense of depth to the whole scene. In addition, as the camera moved so did the black box in the center of the screen. As depicted in Figure 1, as the box moves, an image of a crab standing behind the box was revealed. Using the concepts explored in this prototype, we then went about further fleshing out the idea in our next prototype.

A goal we had for the film was to have the interaction be completely optional. If the viewer chose, they could watch the film as a traditional film without feeling as though they are missing out. To prevent this, we wanted to avoid gamifying the film, that is, avoiding adding elements such as, "good" and "bad" endings or any elements that incentives the user to interact as to "win" the film. From this goal, we went about developing our second prototype, building upon the first. We created a scenario that more closely mimicked a potential scene we might develop for our project with a story portrayed through images.
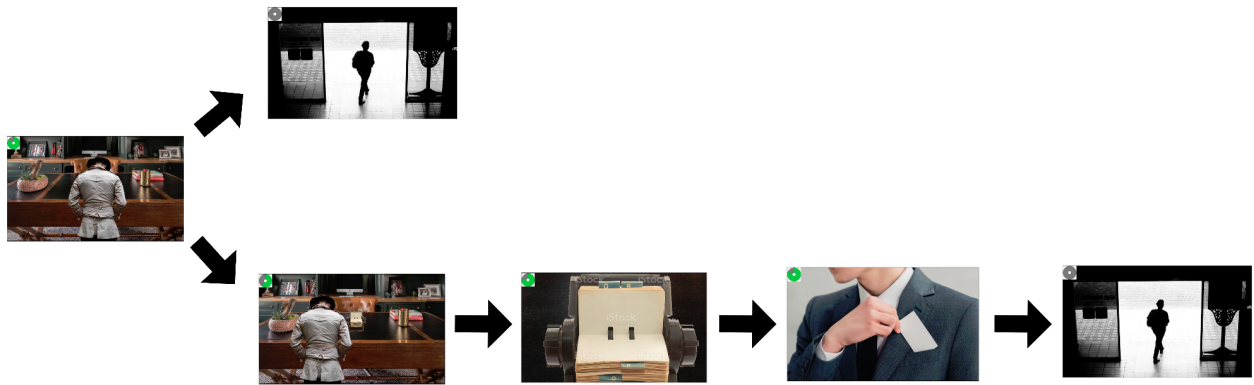
Figure 2: Screenshots from our second prototype, arranged to depict the multiple paths the viewer can experience

The scene we created focuses on a detective with whom we can only see the back off at the start of the scene. By letting the scene play out, the scene will automatically advance to another shot showing the detective leaving the building. However, by tilting their phone left or right, the user is able to peer around the shoulder of the detective. This would reveal what the detective was looking at, in this case, a rolodex. This would then trigger a scene where the detective picks up a card from the rolodex, transitioning back to the same shot of them leaving the building mentioned previously. If the user chooses not to interact with the film, the story will still progress the same way as if they did. Interacting with the film only leads to additional scenes that provide more context and information for scenes that follow while altering the flow of the story. Figure 2 visualizes the different possible ways the scene can progress, with the top branch representing a situation in which the viewer does nothing and the bottom branch representing a viewer who chooses to interact with the film. This structure was one that pleased us and became our aim for the goal of the project.
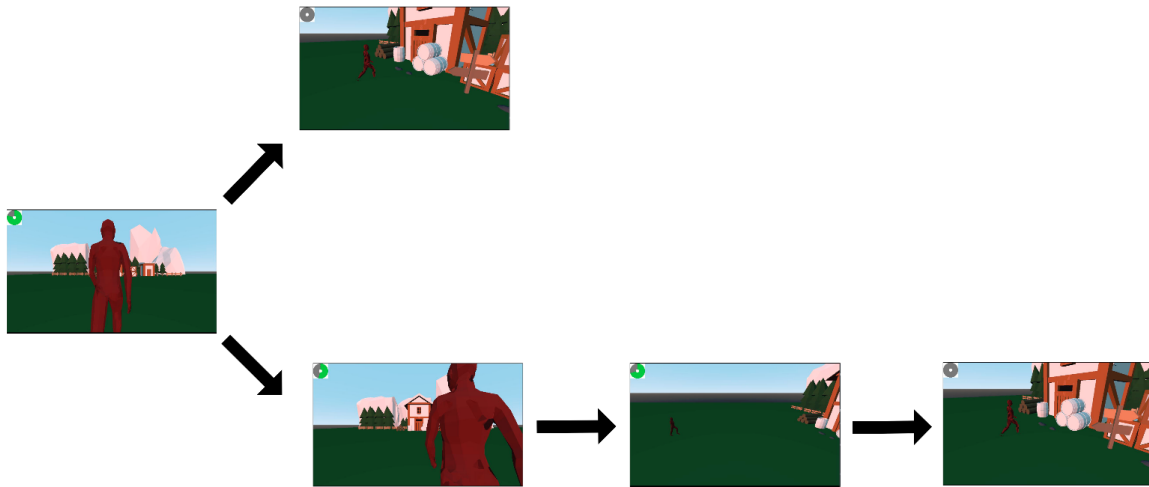
Figure 3: Screenshots from our first 3D prototype, arranged to depict the multiple paths

the viewer can experience

5.2 - 3D Prototypes

After the completion of the previous prototype, new concerns amongst the team surfaced. We lack an artist for a portion of the project and didn't know if a 2D film was viable given this. In addition, the 2D scenes were limiting in how we could use the camera's movement to create compelling and visually interesting shots. For our next prototype, we created another scene with the same philosophy to the last except this time, we implemented the scene in a 3D environment. The use of 3D would allow us to reuse assets and therefore saving time on asset creation. With our 2D prototypes, the camera was limited to only moving left and right, up and down or rotating the camera. With the move to the 3D environment, we were able to create more varying and compelling camera movements, free of the restrictions that are present with only two dimensions. The scenario we created has a similar framing to that of the first with the opening

shot being placed behind the back of an individual. By tilting their phone to the left and right, the user is able to control the camera, swinging it in an arc around the shoulder of the person in frame. Moving the camera reveals a building in the distance that was once obscured by the foreground. Without any interaction, the scene will cut to the character who's back the camera was facing standing in front of the obscured building. However, by moving the camera to reveal the building, the scene will instead cut to a shot of the character walking towards the building before cutting to the scene of them standing in front of it. Similar to the previous prototype, regardless of how much the user interacts, the story will still progress in the same direction and interaction will only yield supplemental material. Figure 3 visualizes the different possible ways the scene can progress, with the top branch representing a situation in which the viewer does nothing and the bottom branch representing a viewer who chooses to interact with the film.

We were satisfied with this prototype and the advantages the shift to the third dimension brought us. Moving to 3D opened a wide array of different camera techniques to improve the cinematics of the final output. In addition, there is a large repository of free 3D assets that we could use to help supplement our lack of an artist which could then be reused throughout the course of the film. Using this prototype as the base for our final implementation, we began planning for how we wanted to demonstrate our idea to the world.
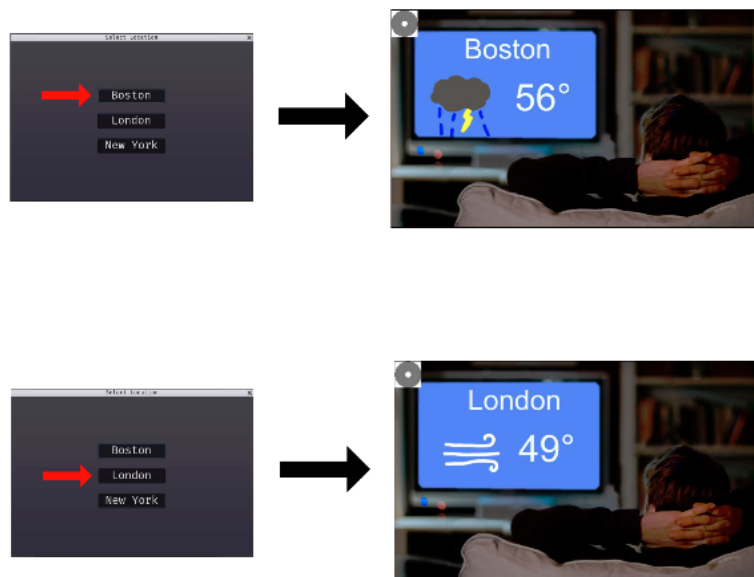
Figure 4: Depiction of the viewer's location would alter elements of a scene as implemented in our prototype

5.3 - Continued Experimentation

While we had the main structure and formula down for how we wanted to shape the project, we still had some ideas we wanted to experiment with. One concept we toyed around with was methods in which the outside world could affect the world of the film. While we knew that we wanted users to directly interact with the film, we experimented with how the world around the user could passively affect it was well. From this, we created one more prototype that simulated how the film would change depending on the user's location. Once again, the prototype aimed to mimic a scene we could imagine appearing in our film. As depicted in Figure 4, the scene we created centers around someone sitting in their living room watching television. Before the scene starts, the user is asked to select what city that they live the closest to from a small set list. Depending on which city they selected, the television would display the weather

forecast of said city. In the prototype we use a television to demonstrate the concept though we imagined the idea having a wide array of uses such as the weather in a scene changing depending on the actual weather outside or newspapers changing to reflect real world events happening around the user. While we have the user select the city from a set list, outside of the prototype we would use other tools such as GPS location to get the information we needed automatically. Despite our enthusiasm about the technology and the many applications it could have, we ultimately deemed it outside of the scope of the project and cut it out of our plans. After this decision, we felt that we narrowed down the scope and goals of the project to a point where we were almost ready to begin full production of the final implementation.

5.4 - Final Prototype

With our scope narrowed and pin pointed down, we started working towards figuring out how we wanted to implement the final version of our concept. We decided that it would be best to switch development from using the *Godot* game engine to using *Unreal Engine 4* due to more familiarity across the team and the presence of a larger variety of free assets available for use. To test out the engine, we remade our 3D prototype in *Unreal Engine 4*. We recreated the entire prototype from scratch, however, we also started work on creating what would later become an entirely new and robust camera system that we would use in our final project. Since we were just recreating one of our prototypes, no new additions or changes were made. We were able to reproduce all of the scenes and functionality of the original prototype which would then lay the groundwork for our upcoming work. With our change of engine and practice implementing our ideas, we were ready to take the final step into creating what would be the final iteration of the project.

6 | Project Implementation

With the starting foundation of our project completed, we began planning how we wanted to structure our film as a whole. After some planning and discussion we ended up with the plan of having the film be divided into two different types of scenes, interactive scenes and non-interactive scenes. Non-interactive scenes would function like scenes in a traditional film experience while interactive scenes would be where the viewer is given control and is able to influence the course of the experience. During the interactive scenes, we would allow for the camera to move along predefined paths. Once the camera passed over a specified location on the path, the alternate scene would trigger. Additionally, in our prototypes we limited which axes of the device could affect the film to titing the phone left or right. In our final implementation, we wanted to have every axis of tilt usable. To achieve this, in addition to creating predefined rails for the cameras to move along, we also need to define how each axis of the device's movement would affect the camera as well. These were the two major challenges we had to overcome to achieve our vision of a new type of interactive experience.

As our film was unlike anything created before, we couldn't rely on pre-existing tools to fully fulfill our vision. To achieve our goals, we began work on creating a whole new camera system within *Unreal Engine 4* to assist in creating our new type of film. *Unreal Engine 4* has a plethora of cinematic tools built in that can be altered and built on top of to create something entirely new. *Unreal Engine 4* has a tool called the *Camera Rig Rail* which is a camera attached to a virtual rail line; the movement of these cameras are limited to only moving along these rails. This tool would form the base in which we would create our own tools to drive the entirety of

our project. Using the built in tools as a base, we were able to integrate our project into the native

Unreal Engine 4 utilities effortlessly and take advantage of its advanced features and tools.
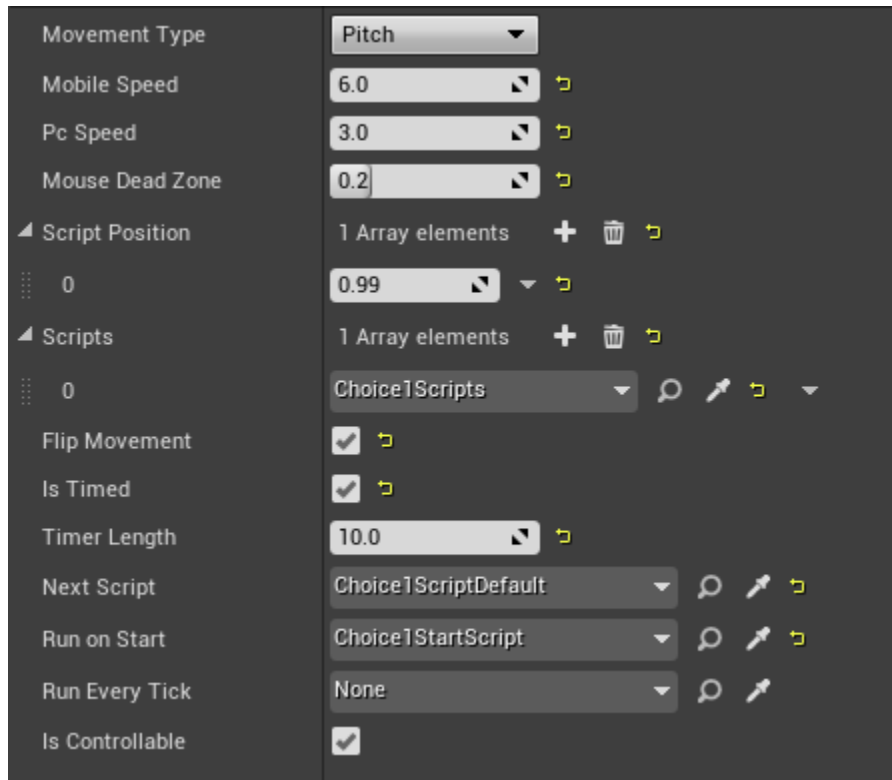
Figure 5: Screenshot of all of the changeable variables of our custom cameras, taken

from a camera used in one of our project iterations

To create one of our custom cameras within *Unreal Engine 4*, no additional steps are

required besides dragging the camera into the scene like you would any other premade object for

the engine. Once placed into a scene, the user is able to define the path the camera will follow by

using the same rail generation and customization tools one would use when using a *Camera Rig*

Rail. From there, the user can customize several aspects about how the camera will behave, such

as the speed at which the camera will move along the rail or which axis of the device's

orientation will affect the camera, simply by altering variables within *Unreal Engine 4*'s *Details*

Panel. All of the variables that can be altered by a developer from within this panel can be seen

in Figure 5. Appendix C features detailed documentation on the code that runs the project, detailing the inner workings and purpose of each individual function and variable of the camera and *Script* systems. With this tool solely, a developer is able to create a camera that the user is able to move along a predefined path by tilting their phone along the axis of the developer's choice. Although we didn't implement it into our project, this camera system could also be used to replace every camera in a film. Allowing every camera to be interacted with and moved even if they don't affect the current scene or flow of the experience, replacing traditional camera work altogether.

Besides our custom cameras, another major element our camera system relies on is what we refer to as *Scripts*. *Scripts* is a general term we use to refer to any *Unreal Engine 4 Blueprint* that extends the *Script* class we created. A *Blueprint* is a visual programming language that exists within *Unreal Engine 4*, intended for more intermediate programmers, that allows for developers to program in a simpler and easier to understand language. Since a *Blueprint* must only extend the *Script* class to work with our cameras, we are able to code with all of the tools given to use by the engine and aren't limited to what a *Scrip*t is able to do. Once a *Script* is created and placed into the current scene, the user is able to connect one of our cameras to a *Script* by altering variables within the *Details* panel of said camera. Once a camera and a *Script* are connected, the camera will call functions of the *Script* certain specified conditions are met. Some of the conditions that can be assigned are more straightforward, such as calling a *Script* when the current camera is transitioned to, when it is transitioned away from or calling the *Script* every in engine tick. However, there is another, more complex, condition that can be assigned that increases the flexibility of our system. The user can assign a *Script* to a certain position along a camera's rail, if the camera then moves over that point, the *Script* will be called. In our project,

Scripts are used for various purposes such as transitioning to another camera or scene, controlling the environment and characters, or displaying on screen prompts. These two tools are what control and drive a great majority of our project.

Apart from our custom camera and script system, no additional custom code was used as all of the remaining elements were composed using pre-existing features within *Unreal Engine 4*. Using the built in *Level Sequencer*, we composed all of the non-interactive segments where characters talk and move. Composing each shot as their own individual animated segment, they can then be played in order to construct the whole story. When a segment ends, the camera then transitions to one of our interactive cameras and the user is given control. The user is able to move the camera along the defined rail by tilting their device to see more of the environment then they could previously. After a certain amount of time, the camera will change once again and transition into a new segment. Depending on how the user interacted with the camera in the interactive segment, the scene transitioned to next will change. By chaining together traditional film segments and interactive segments we were able to create our own new form of cinema.

7 | Project Iterations

Throughout the lifespan of the project, two major iterations of the final product were produced. Of the two, the first was created as a submission for an event held by WPI's IMGD department, *AlphaFest*. At *AlphaFest* we were able to show off and have attendees try out our early iteration of the idea. Using the feedback we received from *AlphaFest*, we created one additional iteration, implementing improvements and further fleshing out the concept.

Figure 6: Screenshot of our AlphaFest interaction used to advertise the experience to attendees

7.1 - AlphaFest Iteration

AlphaFest is an event held by WPI's IMGD department designed to show off work in progress projects. Students are able to show off their projects to their peers, whether those projects be personal projects, projects for classes or MQPs. This event is helpful for conducting

playtesting and getting early feedback on projects before developing further. At *AlphaFest*, we wanted to see how people responded to our new form of cinema, how easy the cues for interaction were to read and overall if people could see themselves watching a film in this format.

For our *AlphaFest* submission, we produced an abridged version of what we envisioned the final product to be. At this point in development, we did not have an artist on our team so we had to construct the demo using free art assets we found online. Hyperlinks to all the assets borrowed from outside sources over the course of the project's life can be found in Appendix E. In Figure 6 the screenshot used to advertise the experience shows what the film looked like using the free assets were able to obtain. Using the camera system we built thus far, we created a demo that would run the user through an abridged version of the full story we wanted to tell. The script for this iteration can be viewed in Appendix A. This iteration contained two points where the user could interact with the film with the entire experience taking just over three minutes to playthrough, start to finish.

Due to limitations in the resources we had access to due to COVID-19 restrictions, this and future iterations were produced to only work on Android smart devices, though internal code for an iPhone release is present. Upon installing and loading up the application, the user was presented with a simple black menu presenting them with two options, *Start* and *Quit*. The *Quit* option would close out the application, while the *Start* option would start the film. Once the film concluded, the user was brought back to the menu where they could either watch the film again or close out the application. Thanks to all of the gracious people who tested our project, we were able to gather valuable feedback that fueled many of our decisions when creating the final iteration of the project.

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7.2 - Final Iteration

After *AlphaFest* concluded, we went through all of the feedback we received and tried to find what aspects of the project could be improved up to enhance the user experience. A common point of confusion we found was that users who didn't know how to interact with the film simply wouldn't interact at all. These users would sit through the entire film without interacting at any point. Some users did recognize which points of the film were meant to be interacted with, however, none attempted to interact by tilting their device but instead attempted to interact using more traditional methods such as tapping or swiping on their screen. After explaining to them the intended way to interact with the film, the testers were easily able to recognize and interact with the film in the intended ways.

After seeing that people needed a push in the right direction before they were able to figure out how to interact with the film, we concluded that it would be best to add a short instructional section to teach new users the ropes. We then went about creating a new *Tutorial* section to the experience which could accessed through an optional button added to the main menu. In this optional segment, the user is run through a series of simple interactions that show them all of the ways in which the film will expect them to interact, demonstrating the use of all three axes of tilt of their device.
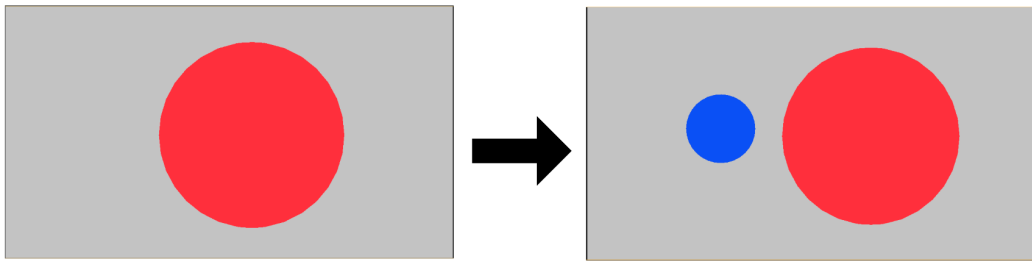
We decided that the *Tutorial* segment should stand by itself, separate from the rest of the film in terms of content, theme and visuals. We felt that having the tutorial tied to the rest of the film would make the whole experience feel less like a legitimate form of film and more like a gimmick. An issue we wanted to prevent from the start was to present our concept for our interactive film using a story and setting that didn't make the viewer feel as if the concept as a whole was limited in what types of stories it could enhance. We felt that having the *Tutorial* segment take place within the same context as the rest of the project might result in that issue occurring as well as potentially making the whole experience feel more "game like", something we wanted to avoid. To achieve this goal, we created a tutorial that is entirely abstract, devoid all ties to any and all stories and settings. Taking place within a white void, the only thing within the user's view is a red sphere, as depicted in Figure 7. Behind the red sphere is a smaller blue sphere which can only be seen if the user tilts their device to move the camera around the red sphere. The *Tutorial* segment will go one by one through each axis of rotation, requiring the user to tilt the device until the blue sphere is within view and then back to the starting point before moving on to the next axis. After a certain amount of time, if the user is unable to move the camera, an on screen prompt will appear in the corner of the screen, demonstrating what the user must do to continue. Once the user is run through each axis, they will be brought back to the

main menu where they may proceed to view the film. By using solely visual icons to instruct the user, we were able to create a truly universal teaching tool that is able to communicate the concept of interaction independent of any narrative setting or language barrier.

Besides the addition of the new *Tutorial* segment, the rest of the main film saw a major revision to it. Starting with the script, the script was extended to include two more points of interaction, doubling the previous amount up to four. The script for this iteration can be viewed in Appendix B. To accompany the change in the script, all of the dialogue was rerecorded using professional grade microphones to increase the sound quality of the film. These changes saw an increase in the runtime of the film from three minutes, up to just about five minutes.

Figure 8: Screenshot of scene from our final interaction

During the beginning of the production of this final iteration is when we saw the addition of Nicola to the team, who would act as the project's dedicated artist. Now with an artist, we were able to create brand new assets for the characters and the environment. Since these assets were made by the same person for this project were able achieve visual consistency between all of the film's visuals. An example of the visuals present in the final iteration of the project are depicted in Figure 8. Since we had to outsource all of the assets for the *AlphaFest* iteration, there was little visual consistency between the assets as they clashed in visual styles, ultimately

leading to a less immersive experience. The visual consistency and higher quality assets enhance the film's production quality and led to a much more immersive viewing experience. We feel that the final product produced for the project truly envisions our original concept. Through our efforts, we were able to create a proof of concept for a whole new kind of film with interactive elements that feel truly unintrusive.

8 | Public Testing and Improvements

As our project was about venturing out into an entirely new form of cinema, it was important to us that we understand how people would react to the experience. We wanted to make sure that our structure and format was both engaging and intuitive. However, due to restrictions placed due to COVID-19, the amount of testing we were able to perform was severely limited. The main event we used for receiving feedback, WPI's AlphaFest, itself had to be held entirely digitally. This limited how many people we could test using as well as how effectively we could observe each testing.

As AlphaFest was held entirely remotely, this meant that distribution, installation, instruction and subsequent feedback all had to be performed remotely by the participant. With these circumstances, we felt that the best way to receive feedback from testers was to design a short survey to be filled at *AlphaFest* after participants experienced the film. To perform more effective testing, we incorporated the A/B Testing methodology into our *AlphaFest* iteration of the project. The reason being that we wanted to test how individuals responded to certain camera perspectives when an interactive scene occurred. To achieve this, two versions of the film produced for participants to experience, the difference between the two being that one featured interactive cameras that exclusively depicted camera angles from a first person perspective while the other's interactive cameras all featured third person perspective camera angles. For distribution of the film, we produced two .APK files for Android devices, each containing a different version of the test. We then packaged each into their own .ZIP file, alongside instructions for how to install the film onto their device. These ZIP files were then distributed for the testers to download. Each tester was instructed which version of the film to download and install onto their Android device. Before each tester was allowed to download the film, however,

they were required to fill out an informed consent form and send it to us. The informed consent form was approved by WPI's Institutional Review Board (IRB), and can be seen in Appendix F. Before the IRB would approve our project for testing, we were required to submit to them a plan of study, which can be viewed in Appendix G.

Once the film concluded, each tester was then sent a survey, asking them various questions about their thoughts on the film. All of the questions featured in the survey are available to view in Appendix D. As the medium of interactive cinema is niche and still in its infancy, we felt it appropriate to begin the survey by asking the participants about their experiences with other interactive films, such as Netflix's Bandersnatch. Further questions in the survey focus on the general feel and fluidity of the camera used in the project as well as how it was integrated. We also asked a few additional questions after they took the survey in order to get any necessary details needed for our project.

Thanks to all of the generous participants in our testing, we were able to gather data that assisted in guiding the project forward. From the information gathered, which can be found in Appendix H, the main takeaway our team took from the surveys and questions was the importance of some sort of instructional segment. We found that the act of interacting with the film via tilting of the device by itself was not intuitive enough for the audience to pick up on by themselves.

Another effect that COVID-19 had on the testing process for the project was the number of attendees available at the event available to test the film. Due to overall low attendance numbers, the number of participants for this build was low, limiting the amount of feedback we could receive. Our team concluded that a combination of requiring an Android phone, the nature of the event, as well as the naming of the project might have dissuaded potential participants.

While these unfortunate numbers affected how much usable data we were able to receive, it also allowed us to reflect on certain elements of the film we might not have otherwise and strongly focus on fixing the issues we saw in the responses we did get.

9 | Conclusion

With how large the film industry is, it comes at no surprise that efforts to create an interactive film has been attempted before. Over the years, there have been many successful attempts at creating interactive cinema, however, most of these attempts failed to make a large impact in how films are made, being relegated to novelties of the era they're from. A common factor between said films is that they attempted to add interactivity on top of a traditional cinema experience. In the modern era, technology is evolving rapidly, changing how we live our day to day lives. Through the use of modern smart devices, we aim to change cinema at its core by altering the entire watching experience, creating a whole new form of cinema.

9.1 - Accomplishments

We began this project with the goal of creating a new form of cinema, to create a film that invited the viewer to interact with it without taking them out of the experience. To make our aspirations a reality, we developed a set of guidelines to follow that would allow our film to match our expectations. First was that interaction must be optional, if the viewer desired, they must be allowed to watch the film as if it was a traditional viewing experience. Second was that interaction must only yield supplemental material and should not result in the altering of the plot significantly. This decision came from the desire to remove elements such as alternate endings deemed as the "good" and "bad" endings. With such elements present, the viewer would treat the experience more like a game that they could win, instead of a piece of cinema.

Another way in which we wanted to evolve the format of a traditional film was through the incorporation of modern technology. With the use of smart devices becoming more and more

prominent as the medium people chose to view media, we wanted to take advantage of the technology to enhance our film. With a host of many possible features present in modern smart devices to take advantage of, we chose to focus on the use of gyroscopes as the means of interacting with the film and incorporated it into our film's design. Through the act of tilting, the viewer can take control of the camera during specified scenes, allowing them to view the scene from a new perspective as well as being given access to new supplemental material.

Using the power of the Unreal Engine 4 game engine in combination with our design principles we were able to make our film a reality. However, in the process we also create a set of easy to use and expand tools that allow for similar films to be created. As our tools natively interweave with the Unreal Engine 4's built in features, future creators aren't limited in what they can create. They can easily take advantage of all the engine's advanced and ever evolving cinematic tools.

9.2 - Future Work

Though our implementation of our core concepts were very fine tuned, the foundation we laid from our project can be built in many different directions. Throughout the course of the project, there were many ideas that we brought to the table that we were sadly unable to use due to them not fitting within our scope. One of the early cuts from the project that we still feel has great potential is having outside elements alter scenes within the film. While we experimented with the concept in early prototypes, we felt that the scope of this concept alone was so large that it could even warrant its own project alone. We thought of many ways in this concept could be implemented into a film seamlessly. In a similar way to how we aimed to take full advantage of the devices people had sitting in their pockets at almost all time, we would use the many features

and data available from one's smart device. Using the geolocation of the device, we can grab information about their surroundings to place into the film such as a newspaper in the film featuring local news or having the weather of a scene change depending on how the weather is around the viewer. Additionally, information from other applications on the device can also be incorporated into the film such as having a character watching whatever last show/film the viewer watched on a particular streaming service. Besides grabbing preexisting data from the device, the device's features can be used to generate new information for a film to use. An example of such could be done through use of the camera of a device. Using the camera, new information such as the faces the viewer is making in response to scenes could be captured and used to alter the course of the film. By incorporating these elements, each viewer would watch a one of a kind film as the watching experience would be unique solely to them.

While some ideas never made it past the conceptual phase, others were implemented into our system even if they went unused or were removed later. A feature that is allowed by our system is the replacement of all cameras with our custom camera system. By using our cameras instead of *Unreal Engine 4*'s traditional cameras, a filmmaker could allow for every camera to be interactable. Even if interacting with the scene doesn't alter the flow of the film, filmmakers could still allow the viewer to look around the scene or even move the camera just slightly. Using this technique, a filmmaker would keep the audience engaged at all times, even if interactions don't yield a specific effect. On a similar note, a feature that was partially implemented into our system but removed later down the line was the ability to connect multiple camera rails together into one sequence. This system allowed for filmmakers to create a form of branching camera paths for the viewer to follow. For example, when the scene shifted to an interactable camera, if the viewer tilted their device left and right they would be taken along a predefined path as

normal. However, if the viewer were to tilt their device up or down, they would instead be brought down an entirely separate path. These branches could be set up anywhere along a predefined camera path such as at the ends of the path or somewhere in the middle. While we decided to cut this feature as it felt out of our desired scope, filmmakers could use a system similar to this to create even more branches in how the film is viewed then the current system allows.

      While these are just some of the concepts we conceived while producing our film, there are many different ways in which a filmmaker could build upon our core concepts and foundation. The system we constructed is versatile enough that filmmakers who use it don't need to follow our designs goals or principles. By adapting the medium of cinema to interconnect with and incorporate modern technology, we've laid down the foundation for which could possibly become the next generation of cinema history.

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Appendix A: AlphaFest Iteration Script

SET UP: It is 2020. Ryan Williams is heading to a job interview at Barotech, a tech firm focused on developing tools to measure atmospheric changes, weather patterns, and similar phenomena. After a brief wait in the reception area, Ryan is let into the company HR rep's office. The space is decorated with several personal effects, and the desk is neat and tidy, with a printed copy of Ryan's resume placed squarely in front of the seat. Behind the desk sits Amanda Klein, one of Barotech's senior HR staff members.

1.Amanda: Mr. Williams, it's a pleasure to meet you. My name is Amanda Klein, and I work here in Human Resources at Barotech.

2.Ryan: Thank you, Ms. Klein. It's great to be here. I'm very excited for this interview.

3.Amanda: I'm happy to hear that. This interview will probably be a bit different from others you've had in the past. Our company is pioneering a new "Speed Interview" technique, which will cut down our total interview time to about 5 to 10 minutes. The questions are designed to help us understand what your views are on topics of interest to the company. Your resume was very impressive, and we're interested in hearing what you have to say on some of these subjects.

4.Ryan: Thank you, I understand. Well, I'd say I'm ready for my first question.

5.Amanda: Good. Let's get to it. As you know, here at Barotech we design and produce equipment necessary to study our environment and atmosphere. What is your stance on the environment and our effect on it? (GO TO: VIEWER CHOICE 1)

VIEWER CHOICE 1: The viewer can tilt their device left or right to glance behind Amanda's shoulder to reveal that her screensaver is a polar bear looking quite sad on a drifting iceberg. If the screensaver is revealed, go to 1_1. If not, go to 1_2.

1_1Ryan: I think that our effect on the environment has been detrimental. We need to get our act together as a species and put in the work to reduce pollution and make sure there's a future for us, and life on Earth. It breaks my heart to see how we've negatively impacted so many habitats and lives. (GO TO: 6)

1_2Ryan: I think that our effect on the environment has been a real mixed bag. We've on one hand, created in a lot of places great conditions for human life to develop and flourish. In most other places, we've taken space away from animals, and polluted our own space. I think we need to ramp up our conservation efforts and environmental regulations.(GO TO: 7)

6.Amanda: I agree. I think that we owe it to the other life on Earth to provide a comfortable existence for ourselves only if we can ensure that they have a future as well. Here at Barotech our newest developments are focused on sustainability and renewing our commitment to measuring mankind's effect on our atmosphere.(GO TO: 8)

7.Amanda: I see. Here at Barotech our latest developments and projects are focused on sustainability and measuring mankind's effect on our planet. As an instruments company, we are poised to make meaningful contributions to the conversation regarding climate change. (GO TO: 8)

8. Amanda: So, on to the next question. Barotech prides itself on working with different contractors and government agencies to research our clients' needs and creating tools that fill those gaps. How would you describe your work experience on your resume interning for Senator Mitchell?(GO TO VIEWER CHOICE 2)

VIEWER CHOICE 2: The viewer can tilt their device up to glance a framed picture of Amanda receiving an award from a man in a bespoke suit, Senator Mitchell. If the resume is revealed, go to 2_1. If not, go to 2_2.

2_1Ryan: I think my experience with Senator Mitchel was very formative. He's remarkably down to earth and a good listener. A lot of my work involved taking minutes during his meetings with constituents and briefing him on what were common concerns they wanted brought up to Washington. While it wasn't an experience related to the day to day work here at Barotech, I feel that I really got to sharpen my interpersonal skills.(GO TO 9)

2_2Ryan: Senator Mitchel gave me a great experience. I feel that I learned a lot about public policy and government. He didn't really seem interested in environmental or corporate policy, but I was able to get an in depth look at the legislative process.(GO TO 10)

9.Amanda: That's good to hear. We believe that it is a benefit to have prior experience in an entry level position in our industry. However jobs that help you work on your interpersonal skills will always be valuable. Well, Mr. Williams, I think that's all the time we have for today. You will be hearing from us again regarding the status of your application. Have a good day. (GO TO 11)

10.Amanda: Interesting. Learning how a system as complex as government functions is a good experience to have, regardless of career path. I believe that's all the time we have today, Mr. Williams. We will keep in touch. You can see yourself out; have a safe trip home. (GO TO 11)

11.Ryan: Thank you for your time, have a nice day. I'm looking forward to hearing back from you.

Ryan stands, and leaves the office after shaking Amanda's hand.

Appendix B: Final Iteration Script

SET UP: It is 2020. Ryan Williams is heading to a job interview at Barotech, a tech firm focused on developing tools to measure atmospheric changes, weather patterns, and similar phenomena. After a brief wait in the reception area, Ryan is let into the company HR rep's office. The space is decorated with several personal effects, and the desk is neat and tidy, with a printed copy of Ryan's resume placed squarely in front of the seat. Behind the desk sits Amanda Klein, one of Barotech's senior HR staff members.

1.Amanda: Mr. Williams, it's a pleasure to meet you. My name is Amanda Klein, and I work here in Human Resources at Barotech.
2.Ryan: Thank you, Ms. Klein. It's great to be here. I'm very excited for this interview.
3.Amanda: I'm happy to hear that. This interview will probably be a bit different from others you've had in the past. Our company is pioneering a new "Speed Interview" technique, which will cut down our total interview time to about 5 to 10 minutes. The questions are designed to help us understand what your views are on topics of interest to the company. Your resume was very impressive, and we're interested in hearing what you have to say on some of these subjects.
4.Ryan: Thank you, I understand. Well, I'd say I'm ready for my first question.
5.Amanda: Good. Let's get to it. As you know, here at Barotech we design and produce equipment necessary to study our environment and atmosphere. What is your stance on the environment and our effect on it? (GO TO: VIEWER CHOICE 1)
VIEWER CHOICE 1: The viewer can tilt their device left or right to glance behind Amanda's shoulder to reveal that her screensaver is a polar bear looking quite sad on a drifting iceberg. If the screensaver is revealed, go to 1_1. If not, go to 1_2.
1_1Ryan: I think that our effect on the environment has been detrimental. We need to get our act together as a species and put in the work to reduce pollution and make sure there's a future for us, and life on Earth. It breaks my heart to see how we've negatively impacted so many habitats and lives. (GO TO: 6)
1_2Ryan: I think that our effect on the environment has been a real mixed bag. We've on one hand, created in a lot of places great conditions for human life to develop and flourish. In most other places, we've taken space away from animals, and polluted our own space. I think we need to ramp up our conservation efforts and environmental regulations. (GO TO: 7)
6.Amanda: I agree. I think that we owe it to the other life on Earth to provide a comfortable existence for ourselves only if we can ensure that they have a future as well. Here at Barotech our newest developments are focused on sustainability and renewing our commitment to measuring mankind's effect on our atmosphere. (GO TO: 8)
7.Amanda: I see. Here at Barotech our latest developments and projects are focused on sustainability and measuring mankind's effect on our planet. As an instruments company, we are

poised to make meaningful contributions to the conversation regarding climate change. (GO TO: 8)

8.Amanda: So, on to the next question. Barotech prides itself on working with different contractors and government agencies to research our clients' needs and creating tools that fill those gaps. How would you describe your work experience on your resume interning for Senator Mitchell? (GO TO VIEWER CHOICE 2)

VIEWER CHOICE 2: The viewer can tilt their device up to glance a framed picture of Amanda receiving an award from a man in a bespoke suit, Senator Mitchell. If the resume is revealed, go to 2_1. If not, go to 2_2.

2_1Ryan: I think my experience with Senator Mitchel was very formative. He's remarkably down to earth and a good listener. A lot of my work involved taking minutes during his meetings with constituents and briefing him on what were common concerns they wanted brought up to Washington. While it wasn't an experience related to the day to day work here at Barotech, I feel that I really got to sharpen my interpersonal skills. (GO TO 9)

2_2Ryan: Senator Mitchel gave me a great experience. I feel that I learned a lot about public policy and government. He didn't really seem interested in environmental or corporate policy, but I was able to get an in depth look at the legislative process. (GO TO 10)

9.Amanda: That's good to hear. We believe that it is a benefit to have prior experience in an entry level position in our industry. However jobs that help you work on your interpersonal skills will always be valuable. (GO TO 11)

10.Amanda: Interesting. Learning how a system as complex as government functions is a good experience to have, regardless of career path. (GO TO 11)

11.Amanda: Tell me, Mr. Williams, what do you think are some of the qualities you possess that make you a good fit for the job? (GO TO VIEWER CHOICE 3)

VIEWER CHOICE 3: The viewer can tilt their device to the left to find images of different Barotech workers in sportswear, kneeling together in a field holding a soccer ball, and a trophy. The picture is framed and mounted on the wall. If the picture is revealed, go to 3_1. If not, go to 3_2.

3_1Ryan: I consider myself to be a team player. I have the drive necessary to get work done on my own, but I know when I'm in over my head, and when I need to ask for help. Likewise, I'm always willing to help coworkers with their own tasks. I also work hard, and consider myself to be adaptable. (GO TO 12)

3_2Ryan: I'm a hard worker, and I get things done, usually on time. Once I set my mind on something, I do everything I can to make it happen. I consider myself to be adaptable as well. Every time I've had to make a significant change to my life, such as moving to a new city, or starting college, I've been able to quickly get the lay of the land, and get comfortable doing whatever I need to do. (GO TO 13)

12.Amanda: That's very admirable. We consider ourselves a close-knit family here at Barotech, and teamwork is a huge part of that. While a good part of the day to day here is independent

work, our bottom line is always composed of large collaborative projects. Having a teamplayer is always helpful. (GO TO 14)

13.Amanda: Punctuality and drive are good traits to have. Our projects have a lot of moving parts, and being able to consistently send out deliverables when they're needed is a great strength. Individual drive is important, but being able to coordinate and work with others is also critical to our work here at Barotech. (GO TO 14)

14.Amanda: Ok, Mr. Williams, we're on to our last question. Do you have any questions for me about Barotech, or the position? (GO TO VIEWER CHOICE 4).

VIEWER CHOICE 4: The viewer can tilt their device to the right to reveal Amanda's calendar on the desk. It seems relatively empty and free. If the calendar is revealed, go to 4_1. If the calendar is not revealed, go to 4_2.

4_1Ryan: I guess my only question is what happens next? Are we going to have another in person interview if I'm selected, or am I going to wait for an email? (GO TO 15)

4_2Ryan: No, I think I got everything, and I'm looking forward to hearing back from you. (GO TO 16)

15.Amanda: Well, I'll go over your file, and your responses to today's interview and we'll send you an email. If we wish to pursue your candidacy further, we'll schedule a final in person interview. (GO TO 17).

16.Amanda: Good to hear that everything was clear. (GO TO 17)

17.Amanda: Mr. Williams, thank you for coming in today. We'll be in touch regarding your candidacy. You should get an email sometime in the next two weeks. (GO TO 18)

18.Ryan: Thank you for having me Ms. Klein. I'm looking forward to hearing back from you.

Ryan stands, and leaves the office after shaking Amanda's hand.

Appendix C: Tool Documentation

Our project is built off of the use of two custom blueprints within Unreal Engine 4, *CameraRailWithControls* and *CameraRailScript*. A *CameraRailWithControls* is an extension of the built in *Camera Rig Rail* actor and allows you to use the same built in systems to build rails for the camera to move across. A *CameraRailScript* is an actor which has no physical presence in the scene and is only placed in the world for its blueprint. By linking a *CameraRailWithControls* to a *CameraRailScript*, the camera calls the blueprint of the *CameraRailScript* depending on how the two are linked. This allowed us to create a modular and flexible system where unique scripts can easily be added into the scene. To create a new "script", create a new blueprint class with a *CameraRailScript* as the parent, writing all the desired code with the blueprint of the new actor.

CameraRailWithControls

Variables

movementType - *movementType* is an enumerator type called *Camera Rail Movement Type* which has three possible values *Pitch*, *Yaw*, and *Roll*.

mobileSpeed - A float used for calculating the speed in which the camera moves across the rail when using a mobile device.

pcSpeed - A float used for calculating the speed in which the camera moves across the rail when using a PC platform.

mouseDeadZone - A float from 0.0 to 1.0 that marks a dead zone in the middle of the screen. The mouse's position of the screen is normalized to a number between -1.0 and 1.0 for its X and Y positions. The dead zone created will negate all mouse input when the mouse's position is within its boundaries. For example, if the dead zone number is set to *0.4*, a dead zone is created which will negate all mouse input if the mouse's X or Y position is between -0.4 and 0.4 depending on the *movementType* (**Figure A**).

scriptPosition - An array of positions on the rail in which you desire code to be run once passed over. The camera's position along the rail is stored as a normalized float between 0.0 and 1.0. When the camera passes over a position on the list, the *Enter* function from the actor in the same index in the *scripts* array is executed. For example, if at index 2 of the array contains the float *0.74*, when the camera's position along the rail passes over said point, the *Enter* function of the actor referenced at index 2 in *scripts* will be executed.

scripts - An array of references to *CameraRailScript* currently in the scene where the blueprint attached to the actor is run based on the positions marked in the *scriptPosition* array.

flipMovement - A boolean used for easily flipping the direction of the mobile controls. Depending on who the rail is built, sometimes you won't get the controls you want and you want to mirror them. Setting this to true will flip the logic for the controls, for example, tilting left is now treated as wilting right and vice versa.

isTimed - A boolean that stores if the camera is run on a timer, if true, a timer *timerLength* seconds long is started when the *Enter* function is run. When the time is up, the *Exit* function is called. This will in turn run the blueprint attached to *nextScript*

timerLength - A float that stores the length of the timer ran if *isTimed* is true

nextScript - A reference to a *CameraRailScript* currently in the scene where the blueprint attached to the actor is run when the *Exit* function of the camera is run. This is optional and can be omitted by leaving the reference blank.

runOnStart - A reference to a *CameraRailScript* currently in the scene where the blueprint attached to the actor is run when the *Enter* function of the camera is run. This is optional and can be omitted by leaving the reference blank.

runEveryTick - A reference to a *CameraRailScript* currently in the scene where the blueprint attached to the actor is run every tick. This is optional and can be omitted by leaving the reference blank.

isControllable - A boolean that keeps track of whether or not the camera should process any inputs. If false, the camera will stay stationary and behave like a normal camera. This is useful as in our implementation, every camera used is a *CameraRailWithControls* and we switch between cameras using scripts.

isCurrentCamera - A boolean that internally keeps tracks if the camera is currently in use. If false, the camera will skip over all of its logic and not process any inputs. The variable is only changed inside the *Enter* and *Exit* functions

Functions

Enter - Function that enables the camera by setting it to the current camera, enabling input if *isControllable* is true and running the *Enter* function of *runOnStart*.

Exit - Function that disables the camera by disabling input and running the *Enter* function of *nextScript*.

TimeOut - Function ran once the timer enabled by *isTimed* is set off. This function only calls the *Enter* function of *nextScript.*

SwitchCamera - Function that takes in another *CameraRailWithControls* and switches to said camera. To do so, the *Enter* function of the new camera is called and then the *Exit* function of the current camera is called. This should be called whenever a camera is switched as to avoid having any cameras from taking in inputs and therefore running scripts when they aren't supposed to.

PCControls - Function responsible for calculating the input of the camera when using a PC platform. A float is returned representing the amount the camera should move which will then be multiplied by *pcSpeed*.

MobileControls - Function responsible for calculating the input of the camera when using a mobile platform. A float is returned representing the amount the camera should move which will then be multiplied by *mobileSpeed*.

MoveCamera - The function responsible for moving the camera along the track. A float is inputted to determine how far along the track the camera should move.

CheckForScripts - Function responsible for executing the scripts attached to the *CameraRailScript*s contained within *scripts* and *scriptPosition*. Inputted are two floats representing the starting and ending position the camera has traveled within the last tick. The function then calculates if any script has been "passed over" within that movement.

Macros

getPitch - *getPitch* is a macro that returns the current state of the device's pitch orientation. The orientation is returned as a float

getRoll - *getRoll* is a macro that returns the current state of the device's roll orientation. The orientation is returned as a float

getYaw - *getYaw* is a macro that returns the current state of the device's yaw orientation. The orientation is returned as a float

CameraRailScript

Events

Enter - Enter is an interface which is empty by default and is expected to be created when subclassing the actor. As it is present in every *CameraRailScript*, it can be called by a *CameraRailWithControls* or *CameraRailScript*

Functions

ChangeToCamera - Taking in a name, the script will attempt to change the current camera to another *CameraRailWithControls* with the inputted name.

ToggleRyanVisabillity - For our demo, the character Ryan becomes invisible during a few camera angles. To achieve this, this function is called to change the visibility of Ryan, taking in a boolean to choose Ryan's visibility. Inputting True will turn him invisible an inputting false will make him visible

Figures
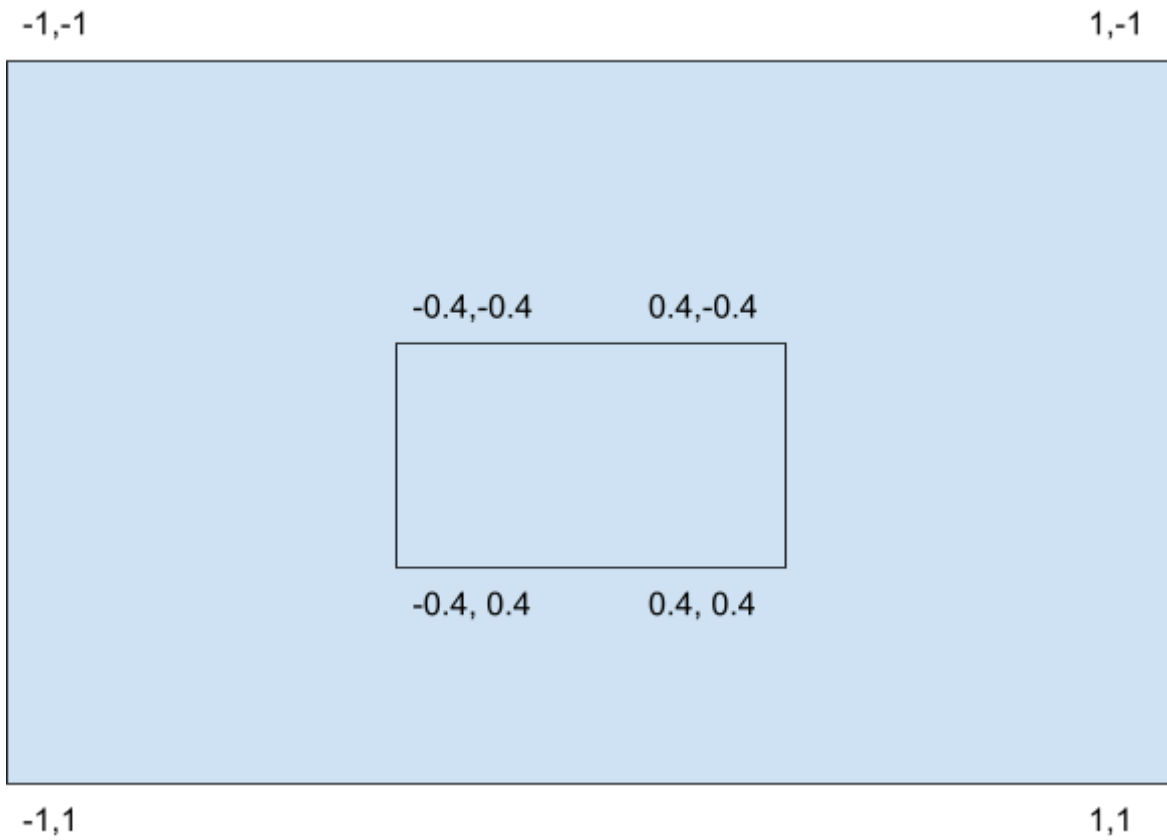
Figure A
Diagram showing how the mouse's position is represented in engine (outer box) as well as how dead zones behave (inner box)

Appendix D: AlphaFest Questionnaire

Experimental Cinema AlphaFest Questionnaire

Hello! Thank you for taking the time to demo our Experimental Cinema Technique. We hope your experience was enjoyable. Please answer the following questions regarding your experience with the film.

*Required

What version of the film did you experience? *

◯ Version A

◯ Version B

History with interactive films

Have you ever experience any of the following interactive films before?

☐ Bandersnatch

☐ Heavy Rain

☐ Lateshift

☐ Her Story

☐ Other:

Thoughts on the alpha

How fluid did the camera movements feel during the interactive segments? *

○ Too jittery

○ A little jittery

○ Very smooth

How did you feel about the speed of the camera during the interactive segments? *

○ Too slow

○ Kind of slow

○ Just right

○ Kind of fast

○ Too fast

How did you feel about the degree of tilt required to move the camera during the interactive segments? *

○ Too much tilt required

○ Just Right

○ Too sensitive

Thoughts on the technology

How clear were the interactive segments signaled? *

○ Signals unclear

○ Clearly Signaled

Do you feel that the camera system could allow for more dynamic movement? *

○ Agree

○ Disagree

How much impact did the interactivity have on the overall experience? *

	1	2	3	4	
It drags it down	○	○	○	○	It impoves it

How incentivized did you feel to interact with the film? *

	1	2	3	4	
Not at all	○	○	○	○	Very much

How well do you think this technique could be adapted to other films? *

	1	2	3	4	
Not well	○	○	○	○	Very well

How likely would you watch a feature length film with this technology? *

	1	2	3	4	
Not likely	○	○	○	○	Very likely

Final thoughts

What aspects of the film do you believe we could improve upon (camera angle, choices, etc.)? *

Your answer

Do you have any suggestions for other scenarios or scenes where this interactivity would be appropriate?

Your answer

Are there any additional thoughts you would like to share with us?

Your answer

Appendix E: Borrowed Assets

[Blender] Simple Medieval House - Fictional Inspiration

Broadcast Studio - Warren Marshall

Business man and woman shaking hands, Studio Shot - Matthias G. Ziegler

cropped shot of businessman in suit holding blank business card - LightField Studios

Detective walking in the city slums, view from the back - minervastudio

Eric and Claudia Models - RenderPeople

Framed Public Safety Award - Frame-it Utah

Herbert Avenue - W Design Collective

Human (with walk animation) - danielabbot

January calendar 2021 - Wolf Craft

Polar Bear screenshot - Eric Lefranc

Referees-2007-Gay-World-Cup.JPG - Loco085

Rolodex – Stock Photo stock photo - lioport

silhouette photography of man photo - Marcus Chen

Watch TV - D.Reichardt

Appendix F: Informed Consent Agreement

Informed Consent Agreement for Participation in a Research Study

Investigator: Professor Brian Moriarty

Contact Information: Email: bmoriarty@wpi.edu ; Tel. 508-831-5638

Title of Research Study: Interactive Cinema

Sponsor: WPI

Introduction: You are being asked to participate in a research study. Before you agree, however, you must be fully informed about the purpose of the study, the procedures to be followed, and any benefits, risks or discomfort that you may experience as a result of your participation. This form presents information about the study so that you may make a fully informed decision regarding your participation.

Purpose of the study: The purpose of this study is to obtain feedback on the project in order to facilitate design improvements and find/address operational bugs.

Procedures to be followed: You will be asked to play a brief interactable film, where you will make choices by moving the camera at pivotal moments, lasting less than ten minutes.
After completing the film, you will be asked to complete a brief, anonymous survey describing aspects of your subjective experience.

Risks to study participants: There are no foreseeable risks associated with this research study.

Benefits to research participants and others: You will have an opportunity to enjoy and comment on a new interactive film under active development. Your feedback will help improve the film experience for future players.

Record keeping and confidentiality: Records of your participation in this study will be held confidential so far as permitted by law. However, the study investigators and, under certain circumstances, the Worcester Polytechnic Institute Institutional Review Board (WPI IRB) will be able to inspect and have access to confidential data that identify you by name. Any publication or presentation of the data will not identify you.

Compensation or treatment in the event of injury: There is no foreseeable risk of injury associated with this research study. Nevertheless, you do not give up any of your legal rights by signing this statement.

For more information about this research or about the rights of research participants, or in case of

**APPROVED BY
WPI IRB 1
4/23/21 to 4/22/22**

research-related injury, contact the Investigator listed at the top of this form. You may also contact the IRB Manager (Ruth McKeogh, Tel. 508 831-6699, Email: irb@wpi.edu) and the Human Protection Administrator (Gabriel Johnson, Tel. 508-831-4989, Email: gjohnson@wpi.edu).

Your participation in this research is voluntary. Your refusal to participate will not result in any penalty to you or any loss of benefits to which you may otherwise be entitled. You may decide to stop participating in the research at any time without penalty or loss of other benefits. The project investigators retain the right to cancel or postpone the experimental procedures at any time they see fit.

By signing below, you acknowledge that you have been informed about and consent to be a participant in the study described above. Make sure that your questions are answered to your satisfaction before signing. You are entitled to retain a copy of this consent agreement.

_____ Date: _____

Study Participant Signature

_____

Study Participant Name (Please print)

_____ Date: _____

Signature of Person who explained this study

Appendix G: Plan of Study

Title of Research Study: Interactive Cinema

Purpose of study

To obtain user feedback in order to determine if experience goals are being achieved, locate operational bugs and identify opportunities for design improvement.

Study protocol

Participants are directed to a Web URL where they view the Opening Briefing (below), complete the Informed Consent Agreement and download the game software.

After completing the game, participants are directed to another URL and asked to fill out a short survey to characterize aspects of their subjective experience and solicit suggestions for improving the experience.

Opening briefing for testers (provided online)

"Hello, and thank you for volunteering to test our project. Before we begin, could you please read and sign this Informed Consent form? [Tester signs IC form.] Thank you. When your session is complete, we will ask you to complete a brief survey about your play experience. At no point during your test session, or in the survey after, will any sort of personal and/or identifying information about you be recorded. Please begin playing when you feel ready."

Appendix H - Survey Results
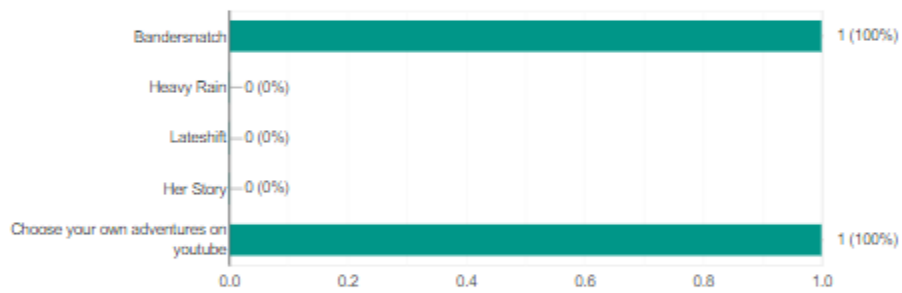
What version of the film did you experience?

2 responses
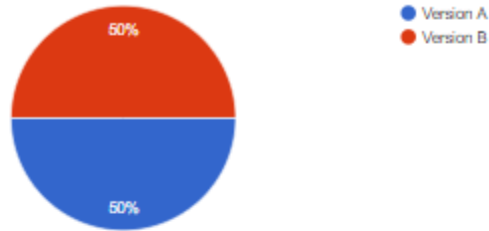
- Version A
- Version B

50%

50%

History with interactive films

Have you ever experience any of the following interactive films before?

1 response

Bandersnatch	1 (100%)
Heavy Rain	0 (0%)
Lateshift	0 (0%)
Her Story	0 (0%)
Choose your own adventures on youtube	1 (100%)

Thoughts on the alpha

How fluid did the camera movements feel during the interactive segments?

2 responses

- Too jittery
- A little jittery
- Very smooth

50%

50%

How did you feel about the speed of the camera during the interactive segments?

2 responses

- Too slow
- Kind of slow
- Just right
- Kind of fast
- Too fast

50%

50%

How did you feel about the degree of tilt required to move the camera during the interactive segments?

2 responses

- Too much tilt required
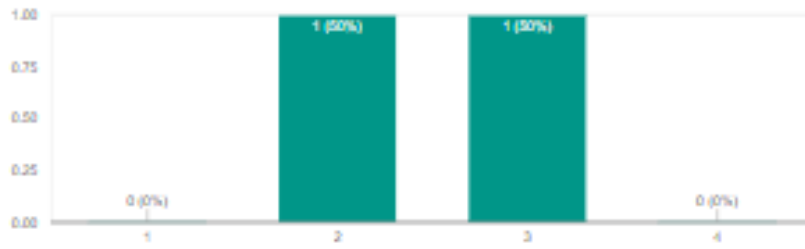- Just Right
- Too sensitive

100%

Thoughts on the technology

How clear were the interactive segments signaled?

2 responses

- Signals unclear
- Clearly Signaled

50%

50%
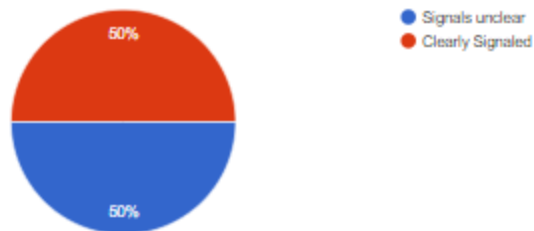
How much impact did the interactivity have on the overall experience?

2 responses

How incentivized did you feel to interact with the film?

2 responses

How well do you think this technique could be adapted to other films?

2 responses

How likely would you watch a feature length film with this technology?

2 responses

What aspects of the film do you believe we could improve upon (camera angle, choices, etc.)?

2 responses

I think sometimes when the woman was talking the camera angle would show both of them. Then when she was done it would focus on her but there would be no sound. This was a bit confusing and made the dialogue more choppy. Also, in terms of sound design there was white noise when characters were speaking which made the room feel more realistic but when the speaking portions were over there was complete silence which change my immersion.

I feel as though the signaling that something was supposed to happen was clear, but what the interaction wasn't clear. I was expecting a prompt instructing me what to do, but I feel as though that would take the user's immersion out of the movie.

Do you have any suggestions for other scenarios or scenes where this interactivity would be appropriate?

2 responses

If there were more interactive aspect I can imagine this being fun watching like a stand off or something more action filled where you are looking at people far away from each other who are negotiating or something.

Maybe something like a boat at sea in a storm. you have to look towards different objects around the room to "use" them to safely navigate the storm

Are there any additional thoughts you would like to share with us?

1 response

I was a bit confused about what I was supposed to do. It was truly a scene that I watched and did not interact with or alter. Sorry if I did not do what I was supposed to!