Why I Want to Become an Imagineer: Building an Experience

Paul DeBaun

Clemson University, pdebaun@g.clemson.edu

Follow this and additional works at: https://tigerprints.clemson.edu/all_theses

Recommended Citation
https://tigerprints.clemson.edu/all_theses/2831

This Thesis is brought to you for free and open access by the Theses at TigerPrints. It has been accepted for inclusion in All Theses by an authorized administrator of TigerPrints. For more information, please contact kokeefe@clemson.edu.
WHY I WANT TO BECOME AN IMAGINEER: BUILDING AN EXPERIENCE

A Thesis
Presented to
the Graduate School of
Clemson University

In Partial Fulfillment
of the Requirements for the
Degree Master of Fine Arts
Digital Production Arts

by
Paul DeBaun
May 2018

Accepted by:
Professor David Donar, Committee Chair
Dr. Eric Patterson
Dr. Victor Zordan
Abstract:

*Journey to Proxima Centauri* is an immersive VR experience where the user takes on the role of a special operative sent to uncover the mystery of the missing androids. The experience design is inspired by Disney Imagineering, and the experience story is inspired by the early 20th century adventures of Ernest Shackleton's Trans-Antarctic journey. We explore what it means to be human and what the value of life is through immersive storytelling. The production of this experience spanned over 9 months and involved the talents of 18 people. The experience was built in Unreal Engine and uses a custom-designed motion platform.
**Artist Statement:**

Humanity is quickly reaching a distinct moment of change in what our definition of "human" will actually mean. As virtual assistants advance to higher levels, our society will experience the emotional and physical evolution of artificial intelligence-driven devices moving towards a more humanlike form. We will soon face ethical challenges in deciding what characteristics constitute an entity as human. I believe that artificial intelligences must be given the same rights that we give ourselves. This change in thinking will be slow and painful, as all past civil rights movements have been, but it is unavoidable. It is essential that we introduce the concept of artificial intelligences as life forms of human value as soon as possible to help society address this transition as smoothly as possible.

This project is entitled *Journey to Proxima Centauri: Terror of the Mnar.* The experience is an ethical journey for the user. The topic addressed by the narrative is the value of artificial life. In the story the humans send sentient androids into dangerous situations without a giving a second thought to their safety, as if they are totally expendable. The artificial lives of the androids are ascribed to have no value beyond their utility. The story highlights this by putting the user in the shoes of an android that is treated as less than human, thus forcing the user to question the value assumptions of the human characters. The journey to understanding and empathizing with these androids leads the user to conclude that the humans are less “human” - lacking the capacity to care or empathize - than the androids in this scenario.
The story of *Journey to Proxima Centauri* was inspired by the perilous Antarctic adventure of explorer Ernest Shackleton in 1921. Shackleton risked his life to save his team when they were stranded on Antarctica by rowing a small boat to Elephant Island to bring help. He placed a premium value on human life and put himself in extreme danger to ensure the survival of all his crew.

The experience layout, visual aesthetics, and VR interactions were inspired by Tony Baxter from Disney Imagineering, modernist painter Lawren Harris, and romantic painter Cornelius Krieghoff. Baxter's use of compelling narrative and vivid imagery in an immersive environment inspired the overarching look of the ride. Harris and Krieghoff used different, yet equally beautiful styles to portray landscapes. Harris painted Canadian landscapes to inspire people to preserve the beauty of the land, while Krieghoff reflected his love and appreciation for the beauty of Canada and its people. I was motivated similarly to Krieghoff - to stir empathy for the androids struggle in the android characters throughout the experience by portraying their struggle to survive. Also, Krieghoff’s impressions of moving and solid ice gave us a framework for creating the ice in the experience. The color pallet and overall frozen feel of the ride was inspired by Harris. The more magical aspects of the ride’s environments were also influenced by Harris with the intent of elevating the user to highlight the mystical nature of the temple.

There is now potential that sentient androids are going to become a reality in the not so distant future. I think that we should figure out how we are going to
treat them before they become a reality. Once an android is sentient, can we
ethically order it to do what we want? Can we order it to end its life? Does it
even have a life? These are all big questions that are very important and we
need to grapple with them sooner rather than later because humanity has
historically had trouble with civil rights change. I believe that anything that can
display genuine compassion must be treated differently and be ascribed the
value of more than a machine - perhaps as much value as a human life. I try and
use this experience to make my point by putting the user in the shoes of an
android in peril. I hope that this experience will open people's eyes to what it
would be like to be an android and treated as less than human. I hope that the
user will see the injustice in treating artificial intelligence as advanced as the
androids in the game as disposable and will challenge their own thinking.
Acknowledgments:

I would like to acknowledge, first and foremost, my parents. I wouldn't be where I am now without their continued support throughout my life to pursue my dreams. I would also like to thank Professor David Donar, Professor Insun Kwon, and Dr. Eric Patterson for their great help throughout my time here at Clemson University. They believed in me and gave me the help I needed to make this project happen. I would also like to thank Dr. Victor Zordan for his long-running support from my undergraduate research days to his constant help here with DPA, including approving funding the construction of the simulator. I am so grateful that Victor saw potential in me and gave me the chance to take on ambitious projects even when I stumbled along the way. I would also like to thank Professor Todd Anderson for taking the time to talk to me about his book and paintings of glaciers. He really helped me when creating my glaciers’ design. Special thanks goes to my partner Alex Young for his invaluable help in making this project happen. He helped keep me focused, contributed huge amounts of time to this project, and created an awesome monster. My thanks also goes to my other partner, Sarah Martin for making the fantastic lighting in all of the scenes. I also wish to thank Thaddaeus Wassynger for his FX and construction help. Additionally, I would also like to thank Thad's family for opening up their garage and letting me build the simulator seat there. I would also like to thank my Grandpa for helping me build the platform base. I wouldn’t have been able to do it without the years of building experience you have given
me throughout my life. I would also like to thank the rest of my team - Chance Cochran, Erik Reed, Walter Fulbright, and Philip Hatfield for their great modeling; Katherine Crossan for her awesome concept art; and Cassidy Lamm and Zach Shore for their great surfacing, Dan Raitz for his awesome animations of the monster; and Christian Sharpe for the great rig that the monster used. I would also like to thank Tommy Bui for his help filming the intro segment of the game. Lastly, I want to thank Jennifer DeBaun for her colorful voice acting for the commander character. I hope everyone who worked on this project enjoyed the experience and takes pride in their excellent work.
Table of Contents:

Title Page........................................................................................................... I
Abstract............................................................................................................... II
Artist Statement................................................................................................ III
Acknowledgements............................................................................................ VI
Table of Contents............................................................................................. VIII
List of Figures.................................................................................................. IX
Background........................................................................................................ 1
Influences............................................................................................................. 5
Methodology....................................................................................................... 18
Conclusion.......................................................................................................... 35
References.......................................................................................................... 37
List of Figures:

Figure 2.1. *Montmorency Falls in Winter* by Cornelius Krieghoff [1] ......................... 7
Figure 2.2 Crystal Garden Waterfall from Back ................................................................. 7
Figure 2.3 Crystal Garden Waterfall from Front ................................................................. 8
Figure 2.4 *Lakes and Mountains* by Lawren Harris [3] .................................................. 9
Figure 2.5 Mezzanine, Journey to Proxima Centauri ......................................................... 10
Figure 2.6 “Black Foot Glacier” from *The Glacier Project* by Todd Anderson [4] .......... 11
Figure 2.7 Mezzanine Scene, Journey to Proxima Centauri ............................................. 11
Figure 2.8 *Indiana Jones and the Temple of Forbidden Eye* Artwork [7] ......................... 14
Figure 2.9 *Indiana Jones and the Temple of Forbidden Eye* Ride Vehicle [7] ............. 14
Figure 3.1. Main Arc Storyboards ....................................................................................... 18
Figure 3.2 Act I Storyboards ............................................................................................... 20
Figure 3.3 Act II Storyboards ............................................................................................... 21
Figure 3.4. Act II Storyboards .............................................................................................. 22
Figure 3.5 Unreal VR Editor Mode [11] ............................................................................... 25
Figure 3.6 Motion Platform Design I Referenced [12] ....................................................... 26
Figure 3.7 Motors Mounted to the Plywood Base ............................................................... 27
Figure 3.8 Motor Controller Array ...................................................................................... 28
Figure 3.9 Motor with Arm Attached .................................................................................. 28
Figure 3.10 Motion Platform Pivot Design ......................................................................... 29
Figure 3.11 Motion Platform with Exposed Components .................................................. 29
Figure 3.12 Motion Platform Assembled .......................................................................... 30
Figure 3.13 Motion Platform Seat Assembled .................................................................... 31
Figure 3.14. Motion Platform Fully Assembled and Powered On ..................................... 31
Figure 3.15 HTC Vive Headset Controllers [17] ............................................................... 34
Figure 4.1. *Road to Imagineering* from a blog by Kristin Ford [18] ............................. 36
Background:

I first went to Disneyland when I was about 2 years old. I don’t remember it, but it was the start of something big for me. I was exposed to Disney artistry and philosophy, and those concepts influenced my childhood interests and developing outlook. The overarching Disney ideal behind the storytelling and the artistry is to follow your dreams. It’s what Walt Disney did when he started his company and it was what motivated all of the characters that he enlivened. I embraced this belief - if he could do it, I could too. As I grew up, I really took this idea to heart and began experimenting with all sorts of creative endeavors in the areas of construction, circuitry, and computers. Somewhere around the end of middle school, I realized building the attractions at Disneyland was actually someone’s job, and I could potentially do that as a career. I lived about 30 minutes away from Disneyland and would go all the time with friends and family. I would come to visit the parks over 400 times, and my passion for the attractions grew stronger.

By the time I was in high school, I understood that I really wanted to build ride systems and design computer graphics to enhance the users’ experiences. I didn’t really understand how the practical details of this was done, but I knew I needed computers. I was very tech savvy for my age, both with software and hardware, but I wanted to learn about computer generated art. I had always wondered how special effects were made in movies, and this seemed like a great way to learn. With this in mind, I enrolled in my high school’s video production
class where I learned Blender and used it to make news graphics for the daily
student news video production, and I loved it! I found a direction for college - a
blend of computer science and electrical engineering with an added emphasis on
graphics. So Computer Engineering became the major of choice - Computer
Science with Electrical Engineering. That should do it, right? Unfortunately,
there is very little straightforward information available on how to become an
Imagineer. It seemed that a broad approach was the way to go.

I was accepted probationally into computer engineering at the University
of California at Riverside, among a few other state schools. In trying to decide
which college to pick, I researched what offerings the schools had within my
major that would allow me to combine the computer engineering with art. I
discovered that computer science professor Dr. Victor Zordan ran something
called the Riverside Graphics Lab at UC Riverside, and that seemed like the
place for me to be. I went on a tour at UC Riverside, and because I had been
admitted probationally and I got the acceptance pretty late in the season, I was
the only student on the tour. The tour guide took me to the computer science
department to show me around and while on the third floor, we turned a corner
ran into Dr. Zordan himself. Awkward and young me asked a few vanilla
questions of Dr. Zordan about his courses and the graphics lab, and then I said
thank you, and we parted ways. I knew I wanted to work in that lab now and my
big break would come 2 years later when I took an introduction to Maya class
that one of his PhD students taught. It was a small class, and I got to know her.
She told me that she needed help with some motion capture visualization and cleaning for a project at the Riverside Graphics Lab. I signed on, and I was in. Here is where I would run into Dr. Zordan again for the second time at UCR. I introduced myself again because I highly doubted that he would ever recognize me from a chance encounter from 2 years before. I still don’t know to this day. I started to help on various projects and a couple of years later also close to graduation. I applied for a summer internship at Imagineering for the summer between my BS and MS, and I came in as the runner up for the position. I was so close! I knew I needed more to prove to Disney that I was Imagineer material.

During the following year when I was getting my Master’s in Computer Engineering, I decided to enter the Disney Imaginations contest where teams from schools competed by designing original rides, and the winning teams would be awarded internships at Imagineering. During this experience, I realized that I had all of the technical skills I needed, but my artistic skills were lacking, and it showed in the project. My team was eliminated in the first round. Overall, it was a meaningful exercise and a good résumé builder, and it served to reinforce the idea that I needed more artistic training, but I knew I needed more than a standard arts education - I needed a school that offered a hybrid of art and computer engineering where I could master all the skills to create a great attraction in the Disney tradition.

At about the same time, Dr. Zordan told me that he was leaving UC Riverside to head up a department at Clemson University. Sad to see him go, I
looked into what he would be doing at Clemson on the department website. The DPA program at Clemson seemed like the exact hybrid of computer science and art training that I sought. With my computer engineering skills established and my MS almost complete, I decided to apply to the Clemson DPA program.

I settled in at the DPA, and when it came time to do my thesis, I wanted to make an attraction of some sort. After talking with family, friends, and my project partner Alex Young, I settled in on an alien ice theme. Alex and I went to Disney World for a week to survey the landscape and get ideas. Once we got back, we were brimming with ideas, and we set out to make an attraction *Journey to Proxima Centauri* is the result.

Building an attraction was very important to me because I wanted to experience what it is like to complete all of the steps involved in making an attraction from concept to completion. I wanted to test myself and confirm that I wanted to create immersive attractions as a career. Thankfully the experience turned out to be everything I hoped it to be. I learned a lot, and I confirmed my career goal.
Influences:

I drew inspiration from many different places for the creation of Journey to Proxima Centauri, including adventurer stories, painters, engineers, video games, Disney attractions, set designers, TV shows, and more. This process was all consuming, and I took in all I saw and read about through the lens of how it might inform my art and design. Painters Cornelius Krieghoff and Lawren Harris inspired me with their art and their motivations behind their art [1,2,3]. Artist Todd Anderson’s works on ice and glaciers influenced my art style [4]. I identified personally with Imagineer Tony Baxter and his life story [5]. His work on the Disneyland attraction Indiana Jones and the Temple of the Forbidden Eye was an inspirational predecessor for the concept behind my attraction [6,7,8]. The social commentary within the narrative and experience of my ride was influenced by Star Trek [9]. And my adventure story was inspired by the Antarctic expedition of Earnest Shackleton [10].

Cornelius Krieghoff was a famous painter of the Canadian landscape during the 19th century. He learned to be an artist in Canada, and Canada was his adopted home. He wanted to convey the story of the people and the beauty of Canada with the goal of encouraging others to visit and perhaps immigrate there. To do this, Krieghoff portrayed the Canadian settlers in a charmingly simple and relatable way within a grand and imposing Canadian natural scene.
This is seen in Krieghoff’s 1852 painting *Montmorency Falls in Winter, Quebec*. In this painting, Krieghoff uses cool, subdued tones to highlight the beauty of the snowy landscape without overwhelming the viewer. Krieghoff expertly includes a few warmer tones in the painting to also lessen what could be an overbearing landscape of desolate ice. He also includes the people that live in Quebec in this image in sleds and on horseback. They are depicted idyllically, having a pleasant time playing in the snow. The perspective is level with the top of the mountains in the distance to make the mountains seem manageable while making the townsfolk seem quaint and small-town relatable. All of these choices were made to humanize settlers and soften the icy Canadian landscape with the goal of making it seem more inviting to a foreigner [1].

Additionally, Krieghoff does an beautiful job of portraying ice and atmosphere. He painted both still and moving ice in the form of lakes and waterfalls in a realistic, yet romantic style to impress the viewer with their natural beauty. The color and feel of the ice in his scenes are mirrored in the attraction’s ice. Krieghoff also has a realistic sense of fog in his paintings and we used the same approach on the haze in our experience.

When designing the Crystal Garden scene of the experience, I was particularly inspired by *Montmorency Falls in Winter, Quebec*. First, I really liked the curvature of the waterfall with its motion and strength [2]. It also prompted me to imagine what it would be like to be under it and looking out through it. This conjured a powerful image in my mind, and I wanted to capture that in the scene.
as well. As a result, I designed the Crystal Garden room with a waterfall that has a similar shape and appearance to convey a mood of power and awe. This was important specifically because I wanted to conjure these feelings in the user in this scene because it is the first time that the monster is revealed in full form. Below is a picture of the waterfall in the experience.

Fig 2.1 Montmorency Falls in Winter, Quebec [2]

Fig. 2.2 Crystal Garden waterfall from back
Lawren Harris was born in 1885 in Brantford, Ontario and was one of “The Group of Seven” - a group of Canadian painters that helped shape the Canadian artistic style in the early 1900’s. Harris was a modernist painter who focused on painting the beautiful landscapes found in Canada. Harris’ motivation was to encourage the viewer to value the land. His goals are similar to mine in that I am trying to show the attraction user the value of sentient lives in all forms by giving them a stirring emotional experience. [1]

In Harris’ painting, Lake and Mountains, he simplifies and elevates the landscape to highlight its beauty by reducing it to its most simple form and color. His low, upward angle highlights the size of the mountain landscape. He also frames the mountain with even larger clouds, further heightening the landscape [1]. I also wanted to add a sense of largeness to the top of the caves in my attraction to mirror the impact found in Lakes and Mountains, and we included
fog near the top of the caves to do so. Additionally, Harris uses very cool and pure tones in his drawing to highlight the ice and snow. My scenes ended up with a less simplified form than Harris’ style, but is still borrows heavily from the color pallet and intent. The blues in both scenes are prevalent and they both encourage the viewer to look upwards. This effect elevates the viewer and puts them in the right mindset to receive the story I am trying to tell in the experience’s narrative.

Fig. 2.4 *Lake and Mountain* [3]
Artist Todd Anderson was also a great inspiration for me in influencing my choices of color and the appearance of the ice in my experience. Anderson is a professor and the Director of Printmaking at Clemson University. In one of his most recent works called *The Last Glacier*, Anderson depicts the beauty of the glaciers in Glacier National Park in Montana. I was especially impressed with his piece called “Blackfoot Glacier”. His appealing choice of color and also the texture he gave the ice brings the image to life [4].

![Mezzanine, Journey to Proxima Centauri](image)

**Fig. 2.5. Mezzanine, Journey to Proxima Centauri**
As for personal role models, my career goals and my experience were both inspired by Tony Baxter. Baxter is an Imagineer and is famous for his work on many immersive rides at the Disney parks. I am inspired by his personal story and the attractions he has made which embody immersive storytelling. I find his
sense of pacing to be compelling and his staging to be artistically impressive, and I employed his style to better frame the scenes in my experience to make them as engrossing as possible.

Baxter’s personal story resonates with me. He first visited Disneyland in 1955, shortly after the park opened. He was only 8 years old but recalls the significant impression it left on him. Being from the orange county area, he visited regularly throughout his childhood. At age seventeen, the youngest age possible for a Disneyland employee, he took a job as an ice cream scooper in the park with the goal of being as close to the park’s development at possible. This close proximity paid off when *The Pirates of the Caribbean* ride was being constructed in 1966. During one lunch break, Baxter tried to get a sneak peek at the progress of the ride when he had a chance encounter with Claude Coats, a legend of Disney Imagineering. Instead of turning him away, Coats offered to tour him around the unfinished attraction. Baxter notes that this experience changed the course of his life as he would soon after change majors in college with the goal of becoming an Imagineer. Baxter became an Imagineer at age 23 and would then work for Disney Imagineering for his entire career, even remaining a consultant for Disney during his retirement [5].

During his tenure at Walt Disney Imagineering, Baxter designed many of their most iconic attractions including *Indiana Jones and the Temple of the Forbidden Eye*. This attraction in particular stands out the most to me, and it is the one my experience emulates. I believe this attraction contains the best
motion simulator ride ever created. It has beautifully detailed and rich environments, recognizable characters, a compelling plot, smoke, fire, and most importantly, a fantastically tuned motion simulator car. The ride system is a two degree of freedom motion simulator attached to the top of a car platform [6]. It is really an amazing ride system. Most simulators are programmed to recreate the action of the scene as closely as possible. For example, when the car turns tightly, the simulator tilts accordingly. When the car is supposed to be moving quickly, the car tilts up to heighten the sense of speed. Simulators rarely step outside those bounds. What sets Baxter’s simulator apart from other simulators is that it plays the role of a character in the experience in how it moves. The simulator jumps when it’s startled. It hesitates when the user is about to enter a dangerous room. It lowers close to the ground and scurries like a mouse when the user is in tight spaces. The effect of the simulator playing this role is that it heightens the immersion for the user, which is rarely found in other motion simulator attractions [7]. This distinction inspired me when building the interface of my motion simulator. Baxter’s innovative use of the simulator as a character led me to do the same in my design and implementation.
My story was inspired in great part by Ernest Shackleton, a British explorer that led three polar expeditions to Antarctica. Born in 1874, he was never very content leading a normal life and had a series of failed business ventures that never fulfilled him. Shackleton was a born adventurer. On his third
and final polar expedition, he attempted to travel across the Antarctic continent from coast to coast. On December 5, 1914, Shackleton set out on this journey. When they sail through the arctic pack his ship became trapped in the ice, jeopardizing the survival of the entire crew. After about 9 months of being trapped in the ice, the ship was destroyed by the pressure of the ice and the crew was forced to take the life boats to flee. They hoped that they could ride the ice pack out to sea over the following months and escape. When this did not happen, they fled to Elephant Island and setup a more permanent camp there. Shackleton and 5 of his crew then took one of the three life boats and set sail for the South Georgia whaling station, knowing that the mission was extremely risky. They eventually made the 720 mile trip, only to land on the wrong side of the island, which forced them to hike over the entire freezing island to the outpost. They made it to the South Georgia Whaling Station, secured help, and set out to rescue everyone on the team. Shackleton reached the crew’s camp just in time, and miraculously, no one died on this entire journey [10].

Shackleton is the embodiment of true hero and leader. In the face of almost certain death, he prevailed and made all the right choices along the way. And most importantly, he was successful in making sure that everyone on his team survived. Shackleton always put their safety first before his own, and he wasn’t afraid to make the tough decisions. I wanted to encapsulate the excitement of his adventure in my experience, especially the sensation of what it means potentially to sacrifice yourself for someone else. My experience reflects
this in the user’s story arc. The user is introduced to the Engineer and he offers to help the user find the black box they seek. Near the end of the ride, the user is about to be attacked by the monster that lives in the caves and the Engineer decides to use the last of his power to charge up a laser canon to vanquish the monster and saves the user. He effectively sacrifices himself to help the user survive and in doing so, the Engineer is a true hero.

The social commentary element of my story was inspired by the *Star Trek* franchise. *Star Trek* has a long history of making social commentary through its 29 seasons on television. Probably the most famous example of this was when in 1968 the first series featured the first interracial kiss on television between a white and a black person. Similar to the social commentary issue of my experience, Star Trek has spent time exploring the rights and value of artificial lives. The episode *The Measure of a Man* (1989) deals with these issues using its own android character named Data. Commander Data is the only one of his kind and cannot be replicated because the person who made him never explained how he did it. Starfleet command, the governing body of earth at the time, is very interested in making more Data-like androids for their fleet. A scientist by the name of Bruce Maddox claims that he could accomplish this with some additional study of Data. Maddox is given permission to conduct his experiments and comes aboard the starship Enterprise where Data is stationed. However, it is soon revealed that these experiments may in fact render Data non-
functional and effectively kill him. Upon this revelation, Starfleet decides to hold a hearing to determine whether Data is a man or a machine. It is established that there are three measures that define sentient life. The entity under question must be intelligent, self-aware, and have consciousness. Ultimately, it is determined that Data is intelligent and self-aware, and since the court had no good way of determining his consciousness, Data is ruled to be a sentient life form [9].

I believe that these concepts are very important, and we are now nearing a time where we will be facing these questions in the real world. *The Measure of a Man* story motivated me to include similar themes in my storyline. I wanted to make sure to comment on the value of artificial life as a main theme. I believe that artificial life must be identified quickly once it happens, and I believe that we must take care not to slip into patterns of oppression and slavery.
**Methodology:**

There are a few different arcs that I cover over the course of the game. The main arc of the game is:

- **Setup:** The user is tasked with retrieving the black box.
- **Conflict:** A big monster is going to attack the user and there is no way to escape.
- **Climax:** The user blows up the tunnel and traps the monster.
- **Resolution:** The user retrieves the black box, secures freedom out of the caves, and returns back to the surface of the planet.

![Fig. 3.1 Main Arc Storyboards](image-url)
I chose this plot because I thought it was both simple and compelling. Almost all adventure-based themed park attractions can be distilled into the following story: the rider travels to somewhere new, something bad happens, and now the rider has to escape. This is a tried and tested plot line that works because there is a degree of familiarity to this set up; it heightens tension quickly; it engages the rider; and it rewards the rider with a positive outcome. That is why I chose it for my experience, but I didn’t want to leave the plot as simple as that. I wanted to add something new and deeper to my story. This is why I added a plot line concerning the value of life to the game. I wanted to take experience story telling to a higher level and leave the user with something to think about.

Here is my plot line I am calling “the user’s arc”:

• Setup: The user wants to retrieve the black box.

• Conflict: The user needs the androids to help him to succeed, needs the androids to save them when they are in peril, and the user is moved to feel guilty because the androids are going to die.

• Climax: The androids are deemed worth saving.

• Resolution: The user treats the androids better and think more closely about what kinds of intelligence humans put in androids.

Next, I want to go into more detail about the main arc. The main arc can be broken into three distinct acts. They are the following:

Act I:
• Setup: The user is tasked with going underground to get the black box.

• Conflict: The elevator shaft breaks and the user has no black box.

• Climax: The engineer helps the user find another way to find the box.

• Resolution: The user gets into the vehicle and ride towards the black box.

Fig. 3.2 Act I Storyboards

Act II:

• Setup: The user sees that the black box cannot be removed from the ice.

• Conflict: The user is unable to escape to the surface and the monster has appeared to the user.
• Climax: The commander tells the user to kill himself to get the information to mission command. The user realizes he is not human, but an android also.

• Resolution: The Engineer proposes an alternative plan that does not involve the death of the user.

Fig. 3.3 Act II Storyboards

Act III:

• Setup: The user wants to escape the caves alive.

• Conflict: The monster has the user cornered and is going to kill the user.

• Climax: The user, following Engineer’s suggestion, blows a hole in the ceiling using the last remaining power in the Engineer, sacrificing the Engineer.
• Resolution: The user makes it to the surface alive with the information on the black box.

The three act narrative structure works well in this instance. It is familiar and easy to understand for the user, and it can be utilized in this format to tell an entire story in a short period of time.

I chose to build this game using Unreal Engine 4.18. It was the most recent version of Unreal Engine that was available at the time I began the project, and it had all of the features that I was interested in using. While the debate as to which game engine is better has no definite winner, there were
three main reasons I chose Unreal Engine over Unity. First, I believe that Unreal Engine looks better than Unity. I believe that their reflection models are more pleasing, and their shadowing, lighting, and particle systems look more realistic. Second, I believe that Unreal’s node based systems are more powerful than Unity’s. I think that good results may take more effort to achieve in Unreal, but the end result comes out better. And lastly, I believe that the movie industry as a whole is moving towards using Unreal Engine for anything interactive and that it is more marketable to be well versed in this software at this point. I was very pleased with the choice to use Unreal Engine for this project. Having just come off another project using Unity, I conclude that I would not have been able to create a game that looked as good using Unity.

Unreal Blueprints were particularly helpful for this project [11]. We programmed the entire experience using Unreal’s node based Blueprint programing. The visual nature of the interface was very appealing to me. I found that debugging the code was much easier because I was able to see the flow more easily. Unreal also highlights nodes when they are executed and allows you to see the values of the variables in real time [11]. This was extremely helpful when programming the games more tricky elements. For example, when I was looking at why the vehicle wasn’t moving correctly in the experience, all I had to do was pause the execution and look in the Blueprints to see what was running and what was causing the issue. This also allowed for simple and reliable communication with the motion platform’s controller. I was able to easily
see what they were saying to each other and correct errors when problems arose.

Another reason I chose Unreal is for their virtual reality editor. It allows me to move scene elements from inside the headset [11]. This was invaluable for staging and quick scene generation. All of the caves in the game were made by hand using a finite number of rock assets. Each rock was placed by hand using a mix between the conventional editor and VR editor. Using a more standard approach, I would start by making the caves base shape in Maya. It would be very low poly and just a starting point for the rocks. Then I would import that mesh into Unreal and begin placing rocks along the surface to create the rock aesthetic I was trying to achieve. This would involve placing hundreds of rocks and doing this all in the computer on a two dimensional screen, which would have been much harder. With Unreal, I was able to use the VR editor to really get into the cave and place the assets I wanted much more precisely and quickly. I would simply reach into an existing rock that I wanted to reuse using the Vive controller, press the duplicate button, and then I move the rock wherever I wanted it.
I also designed and built a motion platform for this experience. I knew I wanted it to be easy to get in and out of for someone wearing a headset and I also knew that it needed to feel like a jeep transport to fit into the story. So with that in mind, I combed the Internet to see what other people were building in this regard. There were a lot of different designs out there with greater and lesser degrees of difficulty and expense. After looking around for some time, I settled on this design [12].
This design seemed to be fairly common, and I believed I would be able to build it for under under two thousand dollars. There are a few key design choices I was looking for here. My motion platform has two main driver motors with position feedback sensors held up by a universal joint. Most importantly, I wanted it to be built to feel like a jeep transport. The base in my design is eleven inches off of the ground, and a real life jeep is often around the same height. Knowing this I got to work and sourced some extremely strong right angle motors and some accurate position sensors and mounted them to a plywood frame.
Next, I designed the power-delivery system for the motors. Each motor could consume a rated max of 28 amps at 12 volts. So I purchased a 30 amp power supply for each motor. These power supplies were more than powerful enough to drive the motors. Next I went to work on designing the motor controllers. These motors have the potential to create a lot of feedback because of their large coils and the diodes on the h-bridge need to be able to constantly absorb this energy and turn it into heat without melting. This is why I ultimately split the load of each motor across two 43 amp motor controllers. I also made sure to have fans to actively cool the motor controllers further to prevent overheating.
Next I needed some way of transferring the rotational power from the motion simulator to linear power to drive the platform up and down. I settled on using a 70cm water-jet cut steel arm as a lever off of the motors to do the job.

Then my attention turned to how I was going to support the people riding the simulator. I settled on using a very overbuilt universal joint that would be guaranteed not to fail under any sort of regular load. I wanted to be sure that this simulator was completely safe. To ensure this, I over designed this pivot to attach the two pieces of plywood together.
Once I designed the main drive systems, I started work designing the secondary motion systems. I wanted the user to be able to feel the engine beneath their feet, so I built in rumble packs into the floor and seat of the platform. These were driven by a car subwoofer amplifier and a third power supply. Once the rumble pack was attached to the plywood and the power supply wired, I put the bottom of the motion platform together.
Next, it was time to design the seat for the user to step up into. The goal here was to design something that was easy to get in and out of. It needed to have easy to locate handrails and also a good seat that would hold the user in securely. I thought about using a seat belt system but it proved to be too difficult for the user. My solution was to reduce the motion platform’s range of motion, should the ride be too bumpy. After some thought and reference from the ride vehicle on *Indiana Jones and the Temple of the Forbidden Eye* [7,8], I settled on a design with a nice large standing area and large 1 1/4 inch quarter rails.
After all this, with the motion platform completed, the final add on needed to be attached. Having ridden and researched Disney’s *Soarin’ Around the World*, I realized that to create convincing forward motion in a motion simulator, I
need to add some fans to blow air at the user [13, 14]. I added some simple computer fans to the front of the motion platform and controlled them using the in-game speed of the vehicle. Construction was complete!

All of the motion platform’s movements are controlled by an Arduino Mega and an Arduino Nano watchdog [15]. The Arduino Mega gets movement commands from the game over USB serial and turns them into motor commands. It also uses a proportional integral motor controller design to drive the motors and reduce oscillation. The software then abstracts that controller into an interface where setting the motor to zero will be pointing directly down, and setting the motor to one thousand will be facing up. Any number in between can also be supplied to get any position desired. And each motor is controlled independently, allowing the platform to be tilted in any direction. The fans work similarly and are supplied numbers between zero and 1000 to describe all the way off and all the way on. There is also an Arduino Nano that reads the position of the motors and should they move out of their specified bounds because of some sort of unforeseen system fault, it will talk directly to the motor controllers and cut power to the motors until the operator can escort the user off of the platform and correct the fault. This was designed to be an added layer of safety for the user.

First and foremost, the real world simulator needed to match up as closely as possible to the in-game simulator. This meant that all the rails, floor, and seat
needed to be exactly replicated in the game. We modeled the in-game car to include a CAD version of the real world car and designed a system that allowed me to place a Vive tracker onto the simulator to calibrate it so that it lines up directly to its in-game counterpart. Once the two are co-located, the user can easily reach out into the virtual world confidently and come into contact with the real vehicle.

Next I set out to derive the motion of the platform from the motion of the in-game vehicle. I wanted this to feel as accurate as possible and I took a few different motion sources into account to achieve this. Starting out, I knew that the motion simulator has a limited range of motion. It is 5° side to side and 4° forward and 8° back. I started by pulling the vehicle's movement from the acceleration of the vehicle in the game. This helped capture sudden and more jarring movements from the vehicle. The second source of motion is from the angle of the track curve. This allowed me to simulate hill climbs and more gradual turns. The third source of motion is from a noise function that generates Fractal Brownian Motion for each axes of the platform [16]. This keeps the motion platform always moving a little during some of the more straight parts of the ride. It also adds to the rickety feeling of the car. Lastly, I used a puppeteer actor that allowed me to manually program in motion paths to the vehicle using the Unreal sequencer. This helped me add character to the simulator and fulfilled the important requirement of having the motion platform be a character in the game.
Lastly, I chose to use the HTC Vive as the head mounted display of choice for my experience. It seemed to me to be the perfect headset because of its room scale optimized design[17]. I was able to set up the system to easily track a 16 by 12 foot area. I was also able to use their external trackers to build in foot tracking and an automated simulator position calibration system. The Vive controllers are also easy to hold so a person can hold both the controllers and the motion platform railing when getting in and out [17].

Fig. 3.15. HTC Vive Headset and Controllers [17]
Conclusion:

I hope this experience leaves the user with two things. I hope that in the short term, they leave with a sense of accomplishment and thrill from an exciting ride. And in the long term, I hope that they question what it is to be human and prepare themselves to be open to new intelligences. I want to bring awareness to this problem and this experience’s technology serves to expose the user to this dilemma early so they will be more ready to grapple with it when it happens.

I also consider this ride system to be a success. I believe I’ve shown that it is possible for the average person to get in and out a motion platform while wearing a VR headset. I believe that this success will contribute to the emergence of a new era of immersive VR attractions that use all sorts of motion platforms to enhance experiences and tell all kinds of new stories.

In the future I would like to further refine the motion platform’s software to include more effects such as heat and directional wind flow. I would also like to refine the way that I generate the simulator’s motion path. I believe that there is still plenty of work to be done in this space to get a more accurate feeling experience. I would also like to polish the game and make more adjustments to the gameplay to make it more immersive. I would also like to make this game work without a motion platform so that I can put it online for anyone to download and play.
Lastly, I again want to thank all of my colleagues that contributed to this project. Without all of you, this game wouldn’t have been the success it has been. Thank you all so much!

Fig. 4.1 *The Road to Imagineering* [18]
References:


